ACTIVITY REPORT 2013-2014
Research groups and research lines
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2 OBJECTIVES AND ACHIEVEMENTS
This part of the report will allow you to describe the way in which the Unit or the LA is organized and managed, to give the general objectives of the research within the Unit or the LA and finally to give a brief description of the main achievements of the research carried out as a whole during the 2013-14 period. A maximum number of characters (without spaces) are allowed in each field. If the number of characters exceeds the maximum you will not be able to complete the form and an error message will appear when you try to save your work

2.1 Unit Description (3000 ca.)
Here indicate form of organization and management

IMPORTANT FOREWORD
INESC TEC (managed by INESC Porto) is reporting its activity in the period 2013-2014 following the general same template, with adaptations, used for the activities in 2011-2012, allowing a fair comparison. However, such format is not adequate to describe an organization as complex as INESC TEC. Therefore, this report must be understood as depicting only partially the description of the whole set activities developed.

The site http://profile.inescporto.pt/ includes historical charts, comparisons 2002-2007 and data from 2008 to 2014, some presentations in power point form and other material relevant to the understanding of all the dimensions of activity of the Unit.

This FCT report format was based on the assumption that the generic organization of an Associate Lab was based on “research groups” per scientific area, with multi-disciplinarity at the “research line” level. This was never the typical case with INESC TEC, which is organized in multi-disciplinary internal units, assimilated to Research Groups. In a Unit, one may find a blend of several skills or scientific knowledge in distinct areas, as required for technology transfer.

When examining this report, please note that:

a) The Section Research Groups is used to refer to our internal Research Units with a scientific multidisciplinary profile
b) The Section Research Lines is used just to refer to a second tier of interdisciplinary activities.

A monthly news bulletin is http://bip.inesctec.pt.
Some Units/RG that were defined as Associate Units to INESC Porto had their own sites:
LIAAD: http://www.liaad.up.pt/
CRACS: http://cracs.fc.up.pt/
CISTER: http://www.cister.isep.ipp.pt/
HASLab: http://haslab.di.uminho.pt/

MANAGEMENT
In 2013-2014 INESC TEC, while recognized as an Associate Laboratory, was composed of 8 Units hosted by INESC Porto, one of which actually is in the University of Minho, plus 4 autonomous Associate Units. In 2014 a new group denoted BRAIN – Biomedical Research and Innovation was launched, as a seed for a new RG to appear in 2015.
INESC Porto is a private non-profit institution with the following associates: UP - University of Porto, INESC and IPP – Polytechnic Institute of Porto.

INESC Porto acted as the coordinating entity for INESC TEC. The General Council of INESC Porto appoints the BD - Board of Directors for a 2-year mandate. It is organized in a Dpt. of Information and Logistics (DIL) and 5 Support Services (Communications and Informatics, Media, Informatics for Management, Building Manag., Lab and Workshop Service). Under DIL other services exist (juridical, human resources, accounting and treasury, project manag.). The BD meets every other week in the Units Council (UC) with Unit Coordinators (including Associates), DIL and support services. Decisions are collectively discussed and policies deployed through the UC mechanism. Processes of delegation of responsibility are also in place. The INESC Porto Units have independent executive management and complete scientific autonomy. The pool of resources is under common management and the solidarity among groups is a rule. The BD of INESC Porto has put in place the necessary set of regulations applying to the different statutes of researchers, working conditions, careers and rewards, and performance evaluation.

The Associate Units (LIAAD, CRACS, UGEI, CISTER snd HASLab) had independence of governance and autonomy of decision but they must however coordinate their scientific policy with one another and INESC Porto under the INESC TEC framework. As some of them were hosted in other institutions, they sometimes depended or local administrative staff while others are already integrated in administrative terms within INESC Porto.

The Scientific Council (SC) has representatives of the Units plus 3 members appointed by the BD.

The Scientific Advisory Board (SAB) is composed of invited high-profile international scientists and is now common to the entire INESC TEC.

2.2 General Objectives (3000 ca.)
This refers to the current aims of the Unit or LA as a whole

2.2.1 MISSION
INESC TEC extends the original mission of INESC Porto, which was created with the complementary objectives of developing high level scientific research and acting as an effective interface between university and economic agents and/or public administration. So, INESC TEC has activity both in Science and in Technology Transfer. In this respect, INESC TEC champions and has nurtured and evolved a technology transfer model different from other research institutions in Portugal, and which is also uncommon worldwide.

2.2.2 DOUBLE ROLE
INESC TEC, with INESC Porto as the coordinating entity, is recognized by the Ministry of Science as an Associate Laboratory within the Science and Technology System of Portugal.

At the same time, INESC Porto is also a Technological Infra-structure recognized by the Ministry of Economy and Innovation.

This double character means that its mission is not limited to scientific research but extends to the assistance of economic agents and public administration and institutions in general, through technology transfer and innovation as well as highly specialized consultancy.

INESC TEC also promotes spin-off and spin-out companies, hosting them during an early-stage pre-incubation phase and often participates in their capital. The profile of its researchers, therefore, reflects the large spectrum of responsibilities incurred in by the Associate Laboratory.

This means that the evaluation of the output and productivity must comply with all items identified in the Decree-Law 125/99, Art. 29 and cannot be condensed on an isolated "paper counting". For this exercise, one must take in account that a fraction of the research body is devoted to technology transfer. In this respect, the role and model of INESC TEC displays high similarities with the Fraunhofer Institutes in Germany.

2.2.3 STRATEGIC CONCEPT
INESC TEC embodies the concept of knowledge-to-value production chain: FROM KNOWLEDGE PRODUCTION TO SCIENCE-BASED INNOVATION. The working organization obeys to the concept of smooth integration of
knowledge producers (creating science) with developers (producing applications) and of these with appliers (transferring to industry, generating spin-off companies, etc.). Therefore, the profile of a typical Unit in INESC TEC includes all these components and is a more effective integration than the one achieved with the research lines.

Research projects generate new knowledge and excellence at the international level: post graduate theses and papers are published. Projects in tandem move knowledge along the chain: prototypes are developed and relationship with industry is strengthened. New projects are designed, materializing the value of innovation at the end of the chain: technology transfer, licensing. Eventually, new spin-off companies are incubated and launched.

This is done with a careful blending of scientists from the University with full time contracted researchers and full time contracted professionals – engineers, mathematicians, economists, physicists. And this is supported by a highly qualified staff in project management, juridical, public relations, human resources.

2.3 Main Achievements during the years of 2013-14

Highlights from past research over the reported period.

The elements reported below relate to the criteria defined in Art. 29 of the Decree-Law 125/99 from April 20, under which an Associate Lab activity should be evaluated.

2.3.1 SCIENCE AND TECHNOLOGY RESULTS AND EFFICIENCY

New record number of 316 papers published in international journals in 2014 (306 in 2013) and record total number of additional 745 publications in other journals, book chapters and international conferences in 2014 (711 in 2013).

New record number of 58 PhD theses completed by INESC TEC researchers in 2013 (52 in 2014).

Record turnover from projects, in 2014, of over 9 million Euro with an added yearly financing from FCT of 1 million Euro only (multiplying factor of 10). This result was achieved after two years of contraction – in 2011 the value was at 8 million with added 2 million from FCT, but in 2013 the value was of only 6.8 million with added 1 million from FCT.

Specific scientific results are reported by each RG in the corresponding sections.

2.3.2 DIRECT R&D CONTRACTS AND CONSULTING

R&D advanced projects and consulting, in direct contracts with national and international industry, represented about 33% of the income in project activity in 2014, with a record value of 3 million Euros (after a severe contraction on 2013 with a value of 1.8 million Euros).

Spin-off companies (with INESC Porto as shareholder) successfully sold to international companies.

2.3.3 CONTRIBUTION TO NATIONAL SCIENCE AND TECHNOLOGY POLICIES

Research results finding application in tech transfer in industry

E-Government projects contribution to management of municipalities and regions

Exporting technology (e.g., robotics)

2.3.4 INTERNATIONALIZATION/WORLD RECOGNITION

Large no. of papers co-authored with researchers from foreign institutions

Exporting technology and consultancy: contracts with ESA (EU), ONS (BR), and other prestigious organizations in Europe and Brazil

32 European projects simultaneously run in 2014 (record of 34 in 2013).

34% of project activity income derives from international activity in 2014.

Record of 92 grantees from foreign countries, most of them PhD students, in 2014 (79 in 2013)
Projects with top USA Universities: CMU, MIT and UT Austin
INESC TEC in Brazil consolidated via INESC P&D Brasil, with increasing project activity.
1 IEEE Fellow with permanent link, other IEEE Fellows with regular collaboration. International prizes gained by INESC TEC Researchers.

2.3.5 QUALITY OF MANAGEMENT AND ORGANIZATION
The quality of the management and support services has been externally considered exceptional. A process of reorganization of its management and services was launched and the new scheme will enter in operation in 2015.

The economic crises of the country was dealt with adequate responses, in policy but also in prudent management, resulting in the continuous growth of the organization in spite of the external difficulties.

INESC TEC managed, in the period 2013-14, a high number of collaborators, which may be estimated at the end of 2014 as circa 900 people, among which 270 integrated members holding a Doctoral degree.

2.3.6 COOPERATION WITH OTHER INSTITUTIONS
A large body of evidence shows that the cooperation with other institutions is very strong.

In 2013-14, INESC TEC conducted a consolidation policy instead of expansion. However, it is worth noting the agreement signed with the Polytechnic Institute of Bragança (IPB) to create there a nucleus of the Unit.

It started operating the Centre of Knowledge for Sustainable Energy (including investment of about €3.5 M in 2010-2012). This includes the Laboratory for Smart Grids and Electric Vehicles, recognized by FCT as a Technologic Infrastructure in 2014.

The cooperation with CMU, MIT and UTexas Austin was promoted to a stronger level with joint projects and activities.

INESC TEC reinforced its cooperation with Brazilian Universities by an action of consolidation of INESC P&D Brazil (the IB), a non-profit association with headquarters in São Paulo where INESC TEC is the major owner. The IB is now recognized as a Brazilian Institute of Science and Technology.

2.3.7 DISSEMINATION OF RESULTS
External impact (national and international) of INESC Porto Bulletin BIP (read in 143 countries in 2014, with 340 visits on average per day in 2011).

Record number of 554 papers in international conferences in 2014.
2.4 Activities

This part of the report will allow you to describe general activities of the Unit or the LA that are aimed at integrating the research of various groups of which multidisciplinary and/or trans-disciplinary activities are of particular relevance. The second part is aimed to describe work that the Unit or the LA does to extend beyond the scientific environment and to reach the general public, schools or other forms of engaging the public in the work of the Unit or the LA.

2.4.1 Integrative/multidisciplinary activities during the year of 2011 (3000 ca.)

Special activities that aim to carry out research across disciplines.

According to the reports of our Scientific Advisory Board, the successes of INESC Porto are centred at its ability to bring "on-demand" to the technology transfer activities an effective blend of engineering disciplines. This is achieved because its Research Groups are formed and run under the concept of being multi-disciplinary. Therefore, for INESC TEC the need for a special reporting section to declare activities aiming to stimulate and carry out research across disciplines is somewhat redundant.

Furthermore, an important number of projects gather together resources from different groups, as it may be observed in the activity reports of each group.

To enhance cross-communication, several Groups organize a regular (weekly or bi-weekly) series of scientific discussion meetings, which receive the name of “Lab Meetings”. The most active are on Telecommunications, Power Systems, Optoelectronics and Technology Transfer.

The Board of Directors (BD) also promotes, with the supervision of the Scientific Council and under the recommendation of the Scientific Advisory Board, a strain of activities denoted LAI (Inter-unit Action Lines).

A LAI is a coherent scientific or technological domain that cuts across INESC Porto organization and promotes scientific discussion, workshops, exchange of experience and ideas in an organized fashion. To support this activity, the BD defined a set of supporting measures including guaranteeing a base budget to each self-organized LAI. The Scientific Council manages the recognition of each LAI proposal and monitors its activity. There are scientific and activity targets that must be met in order to maintain the recognition of a LAI. LAIs in Optimization or in Machine Learning and Signal Processing are examples of this.

This structuring of scientific coordination cross-groups is built over an increasing number of projects being tackled by 2 or more Groups is consortium. A growing number of examples can be found in 2011, either in European projects or in direct research contracts with industry, e.g., joining power systems and telecommunications, manufacturing engineering systems with information systems, telecommunications with optoelectronics, power systems with artificial intelligence, manufacturing engineering systems with management and industrial engineering, telecommunications with robotics, etc.

This multidisciplinary integration encompasses all Units (INESC Porto and Associate).

The constitution of a new Centre of Knowledge for Sustainable Energy is a new organized effort to support research across disciplines. In 2010 the approval of funding was obtained, and in 2011 the works began for the erection of a new building next to INESC Porto headquarters. Also, INESC TEC is providing support for the Associate Unit CISTER to move into a new building, improving considerably the working conditions including cross-cooperation.

2.4.2 Outreach activities during the year of 2011

Science and Society/general public/schools, etc.

INESC TEC gives great importance to communication with citizens. In 2013-14 this activity followed the general trend of recent years:

The Communication Service (SCom) includes three specialists with post-graduation in Media and Communication and in Translation. Monitoring for 2013 and 2014 identified a total of 648 news items regarding INESC Porto/INESC TEC in the main Portuguese media.

The SCom, among other duties, runs a digital monthly Bulletin (BIP, http://bip.inesctec.pt/) in Portuguese, with news on science and projects developed, that reaches a vast community of readers in Portugal and Brazil. A version of BIP in English (http://bip.inesctec.pt/en) is also published every 3 months and is sent to 25 countries.
AWStats provided a counting of accesses to BIP. In 2013, people from 86 countries accessed BIP, with Portugal, USA, Brazil, Canada, and the United Kingdom being the most frequent, in a total of 603,616 hits and 157,365 visitors. In 2014, people from 143 countries accessed BIP, with Portugal, USA, Germany, Brazil and France being the most frequent, in a total of 521,763 hits, and 123,991 visitors.

INESC TEC developed a consistent action of presence in the civil society with participation in a diversity of events and initiatives. As a consequence, experts from INESC Porto are regularly interviewed by TV and radio stations (beside the press) on the hot topics that the society is debating.

INESC Porto, the coordinator of INESC TEC, is one of the partners of the Ciência Viva (CV) association whose aim is to promote science among youth. It has regularly cooperated with the CV initiatives, namely in the annual programs to receive students from secondary schools for short periods of time in its laboratories. Also, a member of the Board of Directors is a member of the Scientific Advisory Board of the Ciência Viva Center of Bragança.

INESC TEC also participated in several national Exhibitions (e.g. Forum do Mar), and supported to the University of Porto annual event as well as the Engineering and Sciences Faculties Open Days.

The SCom also organised diverse external and internal initiatives.

Public talks and lectures were given by the senior members of INESC TEC in various locations, in secondary schools and in Civic Associations, beside scientific and technical meetings.
2.5 Funding

In this section include funding details during the reporting period. In the item LA FCT include the total sum of the Base+Programmatic funding of the Associate Laboratory.

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA FCT</td>
<td>1,993,314</td>
<td>1,006,697</td>
<td>3,000,011</td>
</tr>
<tr>
<td>Projects FCT</td>
<td>995,585</td>
<td>866,679</td>
<td>1,862,264</td>
</tr>
<tr>
<td>Other National</td>
<td>2,045,369</td>
<td>2,392,645</td>
<td>4,438,014</td>
</tr>
<tr>
<td>Other International</td>
<td>1,987,021</td>
<td>2,868,924</td>
<td>4,855,945</td>
</tr>
<tr>
<td>National Industry</td>
<td>1,410,086</td>
<td>2,741,841</td>
<td>4,151,927</td>
</tr>
<tr>
<td>International Industry</td>
<td>410,369</td>
<td>258,562</td>
<td>668,931</td>
</tr>
<tr>
<td>Total</td>
<td>8,841,743</td>
<td>10,135,349</td>
<td>18,977,092</td>
</tr>
</tbody>
</table>

2.6 Other General Indicators

This section is designed to provide information regarding the researchers and the technical personnel hired, and the total number of completed PhDs thesis during the reported period.

2.6.1 Composition and Training

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nº Researchers Hired (LA)</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>No. of Researchers Hired (Ciencia Programme)</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>No. of Researchers integrated with PhD (*)</td>
<td>254</td>
<td>269</td>
</tr>
<tr>
<td>Training PhDs (PhD thesis completed)</td>
<td>34</td>
<td>44</td>
</tr>
</tbody>
</table>

(*) Number of eligible integrated researchers holding a doctoral degree.
3 RESEARCH GROUPS

In this section of the report you have the names of each Research Group and their Principal Investigators that were indicated in the last report. By following the link in the groups name you will be able to access the individual form of the group.

This list includes the currently active Research Groups as well as the Research Groups reported to be active in the previous year.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Group Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG-Norte-50014-3346</td>
<td>Manufacturing Systems Engineering</td>
</tr>
<tr>
<td>RG-Norte-50014-3347</td>
<td>Telecommunications and Multimedia</td>
</tr>
<tr>
<td>RG-Norte-50014-3348</td>
<td>Optoelectronics and Electronic Systems</td>
</tr>
<tr>
<td>RG-Norte-50014-3349</td>
<td>Power Systems</td>
</tr>
<tr>
<td>RG-Norte-50014-3351</td>
<td>Innovation and Technology Transfer</td>
</tr>
<tr>
<td>RG-Norte-50014-3406</td>
<td>LIAAD Laboratory of Artificial Intelligence and Decision Support</td>
</tr>
<tr>
<td>RG-Norte-50014-3435</td>
<td>Information Systems and Computer Graphics</td>
</tr>
<tr>
<td>RG-Norte-50014-3507</td>
<td>CRACS Center for Research in Advanced Computing Systems</td>
</tr>
<tr>
<td>RG-Norte-50014-3946</td>
<td>Robotics and Intelligent Systems</td>
</tr>
<tr>
<td>RG-Norte-50014-3947</td>
<td>High Assurance Software Laboratory</td>
</tr>
<tr>
<td>RG-Norte-50014-3948</td>
<td>UGEI Unidade de Gestão e Engenharia Industrial</td>
</tr>
<tr>
<td>RG-Norte-50014-3949</td>
<td>CISTER Centro de Investigação em Sistemas Confiáveis e de Tempo Real</td>
</tr>
</tbody>
</table>
3.1 Group Description - UESP

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>Manufacturing Systems Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Jorge Manuel Pinho de Sousa</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
</tr>
</tbody>
</table>

3.2 Objectives & Achievements

3.2.1 Objectives (4000 ca.)

FOREWORD
The Coordinators of this Centre during 2013 and 2014 were Prof. Jorge Pinho de Sousa (PhD) and Luís Carneiro (MSc).

OBJECTIVES
The mission of the Centre for Enterprise Systems Engineering (CESE) can be summarized by the following general goals:

i) to contribute for the performance improvement of industrial and service companies, through R&D projects, consultancy, technology transfer and advanced training;

ii) to foster high quality research initiatives in a set of specific areas where the elements of the group have international recognition, and to start innovative research programs in new emergent topics;

iii) to transfer the resulting knowledge and technologies to software houses, equipment producers and industrial companies, through applied research, technology transfer and consultancy projects.

Along with a strong application focus, the group is committed to conduct high quality research projects. The main activity areas of the group are: Enterprise Collaborative Networks, Operations Management, Decision Support Systems including Production Planning and Cutting and Packing Problems, Transportation Systems and Logistics, Systems Integration, and Consultancy services.

The Centre for Enterprise Systems Engineering (CESE) undertakes research and development activities of a multidisciplinary nature, in broad domains such as decision support systems and operations management. The research activities are structured in four main research vectors:

1 – Operations Management and Logistics
2 – Collaborative Networks
3 – Decision Support and Business Analytics
4 – Enterprise Information Systems

The OPERATIONS MANAGEMENT AND LOGISTICS research vector covers a broad set of topics such as operations strategy, operations management, performance management, layouts design, supply chain management, logistics, and transportation systems.
Research is focused on the design and development of models and innovative techniques for operations management and logistics, including the definition of strategies for the manufacturing of complex and customized products. Advanced multi-objective optimization and simulation models are used to support decision-making for these problems. More recently, a strong effort has been put in logistics problems and on the design and management of multi-modal transportation systems.

COLLABORATIVE BUSINESS NETWORKS form a strong interdisciplinary research area that covers topics such as networked business models, supply-chain management, virtual organizations or organizational networks, collaboration and network governance, or collaborative performance management. Special focus is given to information and knowledge management in collaborative networks, including topics such as knowledge and collaboration organization systems, information organization and retrieval, as well as IT platforms for collaborative networks management.

The DECISION SUPPORT AND BUSINESS ANALYTICS research vector deals with methods and techniques such as structuring of decision-making problems, mathematical programming, multi-criteria decision analysis, combinatorial optimization and meta-heuristics, simulation, decision support systems, business intelligence, and data mining.

Applications cover a broad range of problems, including planning and scheduling problems, layout design, vehicle routing and distribution, predictive maintenance, and recommender systems. For the centre, operations scheduling and planning problems are one key research area and an important field for the development of software solutions. More recently research has been directed to the development and assessment of innovative hybrid approaches particularly on what concerns the integration of optimization and simulation.

ENTERPRISE INFORMATION SYSTEMS play an important role on the research activities of the centre, particularly in what concerns the design of advanced information systems, the design of information systems supporting new organisational paradigms, systems integration and inter-operability. The main applications of these competencies are on industrial companies and on supply-chain design and management.

It should also be emphasized that the centre has a very strong link with industry. It develops regular collaboration with technology suppliers, software houses or equipment manufacturers, on the design and development of new products. For industrial companies the centre supplies consultancy services on manufacturing systems design and industrial management, and support to the selection and implementation of advanced information systems and equipment. It also provides RTD services to meet specific requirements that are not answered by available commercial solutions and that require innovative solutions and a clear research component.

3.2.2 Main Achievements (4000 ca)

During the period under analysis (2013/2014) the centre has reinforced its strong links with industry while increasing its scientific output. In terms of publication in peer-reviewed journals, the group has published 14 papers in 2013, and 12 in 2014.

13 PhD theses were concluded during the period, strongly contributing to the positive scientific performance of the group.

The centre has a strong tradition of participation in large European research projects. These projects have highly contributed to achieving critical mass in the fields of Enterprise Collaborative Networks and Operations Management and to strengthening partnerships with leader research organisations in Europe. During this period the group has participated in 11 projects, representing a total funding of about 900 K Euro.
The very active participation in the MANUFUTURE and Footwear European Technology Platforms led to the establishment of important partnerships at a European level. These partnerships have played an important role in the preparation and set-up of several European projects that strongly contributed to the results of the group.

A large number of projects has also been pursued at a national level, including research projects funded by FCT, RTD projects in partnership with technology based companies and consultancy firms funded by the QREN programme. A total of 15 projects were executed, representing a total funding of 959 K Euros.

During the period under analysis a total of 18 research and technology transfer projects directly contracted by companies were active, representing a total income of 815 k Euros.

A number of relevant outcomes can be highlighted:

- A new framework was designed and developed, to support the definition and implementation of hierarchic and compound performance measurement systems (VFF - Virtual Factory Framework, European project). The framework was implemented at VW Autoeuropa plant with quite good results.

- Within several consulting projects with IKEA, a new simulation framework has been developed to represent production lines and evaluate different scenarios according to multiple perspectives. This framework was used to support decisions concerning layouts, lot sizes, sequencing, etc. The methodology was applied first in the IKEA plant in Portugal and later in a factory in Lithuania. The good results achieved so far are motivating the design of new projects.

- A very large national RTD project on Production Technologies, within the scope of the PRODUTECH competitiveness pole, was concluded with excellent results. Some of the main results include: an innovative logistic system for machine tools assembly lines including AGVs; an integration platform, data model and definition of standards for the interoperability of manufacturing companies; a framework for the quick development of simulation models of manufacturing systems and a methodology and support ICT tool for the design of innovative business models for production technologies suppliers. These results were implemented and demonstrated in companies such as Adira, Tegopi, Silampos and CEI. Several publications were submitted and presented in international conferences.

- Within the HighSpeedShoeFactory project a new production and logistic system for shoe manufacturing, with 24 to 48 hours lead time, was designed and implemented at Kyaia. This new system has enabled a fast response time and reduced costs for the production of small series.

- Within the PT21 project (the shop of the future), systems and technologies were developed in order to generate new experiences of interaction between customer and point of sale. Moreover, a demonstrator was designed and implemented at CITEVE, to provide an integrated approach to collection, processing and provision of varied information, relevant to the point of sale management.

- Innovative business analytics, recommender systems and software to manage market trends, using information from social networks, were designed in projects such as Creative Retail, Corenet and PT21.

- The centre played a key role in the design and implementation of interoperability architectures and platforms, to enable the integration of SMEs for the European electronic market, in several industrial sectors (Automotive, Textile and Garments, Footwear, and Food). During this period the Unit participated in the eFood-Chain EU project.

- Research and developments on the multi-objective optimisation “scheduler” have been pursued, leading to an innovative up-graded software tool that has been integrated with several ERP systems, with a considerable commercial success. More than 30 licences have already been sold internationally, in countries such as Portugal, Spain, Germany, Austria, Poland, Peru and Brazil.

- In the European projects FOCUS (Advances in Forestry Control and Automation Systems in Europe) and MOFSS (Make to Order Fast and Smart Scheduler), both having started in January 2014, new innovative approaches are being developed, to exploit the integrated use of simulation and optimization techniques in advanced production and logistic systems.
• In the BEST CASE project (research line “Smart Manufacturing and Logistics”) coordinated by CESE, but integrating multiple research teams at INESC TEC, significant developments in terms of mathematical programming models and heuristics were achieved, and interesting results and innovative approaches in hybrid implementations were obtained. Some successful applications of these techniques took place in planning problems in production and operations scheduling (“scheduling”), or problems of cutting and packing. The integration of simulation to optimization in their multiple variations was also deeply explored.

In summary, during the period 2013/2014, 13 PhD theses were successfully finished, 26 papers were published in peer review journals, and 56 in international conference proceedings subject to a refereeing process. Moreover several papers have been accepted for publication in peer review journals, and some of these were published or are expected to be published during 2015. Due to a significant increase of PhD students in recent years, there are currently 26 on-going doctoral projects, with 13 concluded or expected to be concluded during 2015.

During these 2 years, several initiatives have been launched to strengthen the interaction with other research groups within the INESC TEC universe, as reported in other points of this document.

In total, 11 European projects were active during 2013/2014. An important critical mass has been achieved in the fields of Enterprise Collaboration Networks and Operations Management.

### 3.3 Productivity

#### 3.3.1 Publications in peer review Journals (6000 ca.)

2013
[14]


2014

[12]


3.3.2 Other international publications (6000 ca.)

Total number of publications: 56
The complete list can be consulted in: http://profile.inescporto.pt

2013
[35]


Simon Fischer, Ingo Mierswa, João Mendes Moreira, and Carlos Soares, editors. Proc. of the 4th RapidMiner Community Meeting and Conference (RCOMM 2013) 2013

Gil Gonçalves (Inovamais SA, University of Porto, Faculty of Engineering); Catarina Azevedo (Inovamais SA); César Toscano (INESC Porto); Gaelle Chéry Pottiou (Agro EDI Europe); Bruno Prépin (Agro EDI Europe). “Assisting SMEs to integrate digital Food Supply Chains”. In “Proceedings of EFITA 2013 International Conference on Sustainable Agriculture through ICT innovation”, 2013, Turin, Italy.


Nazare Rego, João Claro, Jorge Pinho de Sousa, “An innovative framework for the simulation of manufacturing systems: an application to the footwear industry” em Azevedo, A. (editor), Advances in Sustainable and


2014

[21]


Ahm Shamsuzzoha, Filipe Ferreira, Sven Abels, Americo Azevedo and Petri Helo5, “Visualization functionality of virtual factories: an enhancement to collaborative business process management”, 16th International Conference on Enterprise Information Systems (ICEIS 2014), At Lisbon, Portugal

Filipe Ferreira, Ahm Shamsuzzoha and Americo Azevedo, “Predictive industrial maintenance: a collaborative approach”, 7th International Conference on Interoperability for Enterprise Systems and Applications, At Albi, France


Evelyn Paola Soto Rojas and Américo Azevedo, “Pillars and Elements to Develop an Open Business Model for Innovation Networks”, 15th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2014 in Collaborative Systems for Smart Networked Environments - IFIP Advances in Information and Communication Technology Volume 434, 2014, pp 71-79


Pinto, F; Mendes-Moreira, JM; Soares, C; Rossetti, RJF; “Simulation of the ensemble generation process: The divergence between data and model similarity”, Modelling and Simulation 2014 - European Simulation and Modelling Conference, ESM 2014, PAGES: 5; PUBLISHED: 2014


Pedro Abreu, Carlos Soares, Rui Carlos Camacho: Distributed Environment Framework for Optimization Experiments. ICCSA (Workshops/Short Papers/Posters) 2014: 256-259

Fábio Pinto, Carlos Soares, João Mendes-Moreira: An Empirical Methodology to Analyze the Behavior of Bagging. ADMA 2014: 199-212


José Soeiro Ferreira (Editor), Rui Carvalho Oliveira (Editor). Investigação Operacional em Ação - Casos de Aplicação. Imprensa da Universidade de Coimbra, 2014

3.3.3 Ph.D. thesis completed (3000 ca.)

Marisa Oliveira, Modelos matemáticos e heurísticas para problemas de posicionamento de polígonos ortogonais, PhD thesis, Programa Doutoral em Engenharia Industrial e Gestão, February 2013 (supervisor: António Miguel Gomes)

Reza Fazeli, A combined multi-criteria and system dynamics methodology for mid-term planning of light duty vehicle fleets, PhD thesis, Programa Doutoral em Sistemas Sustentáveis de Energia, March 2013 (supervisors: Jorge Pinho de Sousa, Vitor Leal)


Vitor Santos, Human and Technological Dynamics in Complex Research and Development Projects, PhD thesis, Programa Doutoral em Sistemas e Tecnologias de Informação (U Minho), April 2013 (supervisors: João Álvaro Carvalho, António Lucas Soares)


Lia Oliveira, Dealing with uncertainty in supply chains design in automotive industry, PhD thesis, Programa Doutoral em Líderes para Indústrias Tecnológicas, November 2013 (supervisors: Jorge Pinho de Sousa, João Claro)

André Rossi, Meta-aprendizado aplicado a fluxos contínuos de dados PhD thesis, Programa Doutoral em Ciências de Computação e Matemática Computacional (U São Paulo), December 2013 (supervisors: André Carvalho, Carlos Soares)


Ana Maria Rodrigues, Sectores e rotas na recolha de resíduos sólidos urbanos, Programa Doutoral em Engenharia Industrial e Gestão, PhD thesis, March 2014 (supervisor: José Soeiro Ferreira)


On-going PhD projects (and expected conclusion date): 26

Edgar Jimenez Perez, Airport strategic planning in the context of low-cost carriers ascendency: insights from the European experience (concluded February 2015)

Cristóvão Sousa, Collaborative knowledge representation processes and techniques to support domain experts in conceptual modelling (2015)


Senay Sadic, Managing Dynamic Supply Networks through SME Collaboration (2015)


Ana Simões, Assessment of the value creation in management models of hospitals – a conceptual framework for a multiobjective and multi-perspective alignment (2015)

Manuela Azevedo, Reconfiguration of facilities and supply networks for higher levels of flexibility (2015)

Nazaré Rego, Supporting the definition of strategies in the configuration of health care supply chains (2015)

André Alho, Improved mobility and more sustainable urban logistics through the configuration and enforcement of (un)loading bays (2015)

Artur Aiguzhinov, Predicting rankings of financial analysts (2015)

Cláudio Sá, Association Rules for Label Ranking (2015)

Pedro Abreu, Machine Learning to Improve Heuristic Search Methods for the Job-Shop Scheduling Problem (2016)

Pedro Saleiro, Mining of News and Twitter (2016)

Fábio Pinto, Model Management using Metalearning (2016)

Ricardo Almeida, Flexible information technologies for complex and non-hierarchical supply chain networks (2016)

Pedro Strecht, Educational Data Mining (2016)

Tiago Cunha, Metalearning for Recommender Systems (2016)

Luís Cruz, Living Analytics for Educational Data Mining (2016)

Parisa Sadeghi, Assembly Line Balancing and Scheduling – Applications in the Footwear Industry (2016)

Solang Mazarotto, Creative and adaptive information models and architectures to support knowledge management in collaborative networks (2017)

Eric Costa, Information, knowledge and collaborative networks in internationalisation processes of SMEs (2017)

Catarina Oliveira, Metalearning and Tranfer Learning (2017)


3.3.4 Patents/prototypes (2000 ca.)
Prototypes:

Name: New framework to define and implement complex (hierarchic and compound) performance measurement systems (New version with improvements after the end of the EU project)
Developed under the project: VFF – Virtual Factory Framework
Demo Place: VW - AutoEuropa
Development Period: 2014

Name: Multi-criterion scheduling and optimisation for projects in a production environment
Developed under the project: Proj-plan
Demo Place: INESC Porto, Softi9
Development Period: 2014

Name: Market trends using social networks and analysis
Developed under the project: Corenet
Demo Place: INESC Porto, Bivolino (B)
Development Period: 2012-2014

Name: Process modelling and monitoring for plug and play virtual factories
Developed under the project: Adventure
Demo Place: INESC Porto, Azevedos Industria
Development Period: 2012-2014

Name: New production and Logistic System for shoe manufacturing with 24 to 48 hours lead time
Developed under the project: High Speed Shoe Factory
Demo Place: Kyaia
Development Period: 2013-2014

Name: A system for reliable exchange of business documents in the Agrifood industry
Developed under the project: eFoodChain
Demo Place: INESC Porto, Associação dos Produtores Agrícolas da Sobrena
Development Period: 2013-2014

Name: Performance measurement system supporting data collection, fusion and KPI calculation
Developed under the project: Bidirco
Demo Place: Sonafi and Creative Systems
Development Period: 2008-2011
Name: Data analysis and recommender system for fashion products
Developed under the project: Creative Retail
Demo Place: INESC Porto, Creative Systems
Development Period: 2013-2014

Name: Innovative Logistic System for machine tools assembly lines including AGVs
Developed under the project: Produtech-PSI
Demo Place: Adira
Development Period: 2013-2014

Name: Integration platform, data model and definition of standards for the interoperability of manufacturing companies
Developed under the project: Produtech-PSI
Demo Place: Silampos
Development Period: 2013-2014

Name: Framework for the quick development of simulation models of manufacturing systems
Developed under the project: Produtech-PTI
Demo Place: INESC Porto, Adira
Development Period: 2013-2014

Name: Methodology and support ICT tool for the design of innovative business models for production technologies suppliers
Developed under the project: Produtech-PTI
Demo Place: INESC Porto, Azevedos
Development Period: 2013-2014

Name: Shop of the future, enabling new experiences of interaction between customer and point of sale, analysis and new services
Developed under the project: PT21
Demo Place: CITEVE
Development Period: 2013-2014

3.3.5 Organization of Conferences (2000 ca.)

2013

- XV Latin-Iberoamerican Congress of Management of Technology (ALTEC), October 2013, Porto, Portugal [Scientific Committee – Ana Barros]
• 23rd International Conference on Flexible Automation and Intelligent Manufacturing (FAIM), June 2013, Porto, Portugal [Conference Chair - Américo Azevedo; Scientific Committee – Ana Barros]

• 2nd International Conference on Creative Learning for Innovation (CAL4INO), May 2013, Porto, Portugal [Scientific Committee – Ana Barros]

• 2nd International Conference on Creative Learning for Innovation (CAL4INO), May 2013, Porto, Portugal [Organizing Committee – Ana Barros]


• 7th Terminology & Ontology: Theories and applications TOTh International Conference. Chambéry, France. June 2013 [Program Committee – António Lucas Soares; Américo Azevedo; Jorge Pinho de Sousa]


• 10th ESICUP Meeting. Lille, France. April, 2013 [Program Committee – António Miguel Gomes (chairman)]

• EWGT2013 Euro Working Group on Transportation. Porto. September 2013 [Organizing Committee - Jorge Pinho de Sousa; Program Committee – Carlos Soares]

• European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases. Prague. September 2013 [Program Committee – Carlos Soares]

2014

• 10th Workshop on Ontology Content OntoContent 2014. Part of the “On the move Conferences”. Amantea, Calabria, Italy. October, 2014 [Organizing Committee – António Lucas Soares; Carla Pereira]

• Pro-VE 2014 – 15th IFIP Working Conference on Virtual Enterprises. Amsterdam, October 2014 [Program Committee – António Lucas Soares; Américo Azevedo; Jorge Pinho de Sousa]

• 8th Terminology & Ontology: Theories and applications TOTh International Conference. Chambéry, France. June 2014 [Program Committee – António Lucas Soares]

• CAPSI 14ª Conferência da Associação Portuguesa de Sistemas de Informação. Santarém, Portugal. October 2014 [Program Committee – Américo Azevedo]

• DET 2014 8th International Conference on Digital Enterprise Technology. Stuttgart, Germany. March 2013 [Program Committee – Américo Azevedo]

• 11th ESICUP Meeting. Beijing, China. March, 2014 [Program Committee – António Miguel Gomes]

• Brazilian Conference on Intelligent Systems (BRACIS), São Carlos, SP, Brazil. October 2014 [Program Committee – Carlos Soares]

• Encontro Nacional de Inteligência Artificial e Computacional (ENIAC), São Carlos, SP, Brazil October 2014 [Program Committee – Carlos Soares]

• European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases, Nancy. September 2014 [Program Committee – Carlos Soares]


• 14th edition of the Ibero-American Conference on Artificial Intelligence (IBERAMIA’2014), Santiago de Chile. November 2014 [Program Committee – Carlos Soares]
3.3.6 Industry contract research (2000 ca.)

National direct RTD contracts: 18

CESE has a very strong link with industry and regular collaboration with technology suppliers. The centre provides consultancy services on industrial management, on requirements analysis, and on the selection of technical solutions. For suppliers of technologies in industry, the group offers RTD services on the design and development of new products they commercialize, in fields such as production planning and scheduling, optimization of cutting and packing, automation and logistics, enterprise collaboration and interoperability.

Some of the main industry contracted research, consultancy and technology transfer projects during the period 2013/2014 were:

- PMD - Performance measurement and management;
- ESPP - Extended Shoe Production Planning;
- Proj-Plan - Multi-criterion scheduling and optimisation for projects in a production environment;
- CRITICAL – Production scheduling optimisation for the semiconductor and high-tech industries;
- HFAPS - Specialised consulting to improve a manufacturing system in the electronics sector;
- SPS - Specialised consulting to improve a manufacturing system;
- ESI - Business Process Engineering and Information System;
- Bi4UP - Business Intelligence (BI) tool;
- BSHM - Automatic identification of pathologies in steel-concrete connectors in composite bridges;
- LOG-Config - Internal logistics configuration system;
- FLUPLAN – Design of operations planning processes and IT requirements;
- COOL - Paper cutting optimisation module;
- RCE - Platform to manage information and knowledge for the European collaboration network of players in the textile and clothing sector;
- ParqueEscolar – Construction works standardisation and support system.

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level

International projects (2013/2014): 11

International consultancy: 01

- VFF (Holistic, extensible, scalable and standard Virtual Factory Framework) – developing a simulation framework to support the design and reconfiguration of factories;
- CORENET (Customer-ORiented and Eco-friendly NETworks for healthy fashionable goods);
- ADVENTURE (ADaptive Virtual ENTERprise ManufacTURING Environment);
• PROsumer.NET (European Consumer Goods Research Initiative - Networking European Technology Platforms addressing Design-based Consumer Goods Industries and Related RTD Fields);
• FoodManufuture (Conceptual Design of a Food Manufacturing Research Infrastructure to boost up innovation in Food Industry);
• APPS4aME (Engineering Apps for advanced Manufacturing Engineering);
• EXPLORE (Extended exploitation of European Research Project’s Knowledge and Results);
• STAMINA (Sustainable and reliable robotics for part handling in manufacturing automation);
• FOCUS (Advances in FOrestry Control and aUtomation Systems in Europe);
• MOFFS (Make to Order Fast and Smart Scheduler);
• FoodSupplyChain (Stimulating innovation in the food supply-chain through smart use of ICT: assisting SME’s participate in digital supply chains in the single market);
• IzaroGrey (Maintenance and licensing of the new versions of the "IZARO GREY" software module).

International educational programs
Active participation in the MIT Portugal Program (MPP), namely in the doctoral programs in Engineering Design and Advanced Manufacturing (EDAM) and Transportation Systems. These participations are an important opportunity for the exchange of information and experiences.

International Associations
• EFFRA - European Factories of the Future Research Association (J C Caldeira, Board Member);
• Manufuture European Technology Platform (J M Mendonça, J C Caldeira, Members of management bodies);
• Footwear European Technology Platform (L Carneiro, J M Mendonça, Members of management bodies);
• EURO Special Interest Group on Cutting and Packing of EURO, the Association of European Operational Research Societies (A M Gomes).

Number of papers in journals in cooperation with authors from foreign institutions: 13

3.3.8 Other national publications (6000 ca.)

3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

National programs – FCT: 06; QREN: 09
The Centre participated in a total of 14 projects with support or collaboration with national agencies. Some of the main national projects during the period 2013/2014 were:
• SysMAP- Modular and intelligent production equipment;
• HighSpeedShoefactory - Model to manufacture customised footwear;
• Produtech-PSI - New products and services for the manufacturing industry;
• PRODUTECH_PTI - Innovative processes and technologies for the manufacturing industry;
• PowerTextilesXXI - Collective R&D initiatives with the participation of companies within the textile and clothing industries;
• NEWALK - Materials, components and technology for the footwear of the future;
• GNOSIS - Knowledge management for the improvement of manufacturing equipment and tools in the stone industry;
• PLM4all - Low-cost toolbox to help manage the lifecycle of manufacturing equipment;
• Micro-Fab – Methodology and support systems for the design and operation of micro-factories (one container factory).

Participation in sectorial initiatives:

The following are some key sectorial initiatives in which members of the Centre participate actively:
• MANUFUTURE European Technology Platform and EFFRA (European Factories of the Future Research Association);
• Footwear European Technology Platform;
• PRODUTECH – Competitiveness Pole for Production Technologies;
• NEWALK – Mobilization R&D project for the footwear sector (promoted by the associated Competitiveness Pole);
• PowerTextilesXXI – Mobilization R&D project for the textile sector (promoted by the associated Competitiveness Pole).
3.1 Group Description - UTM

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>Telecommunications and Multimedia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>José António Ruela Simões Fernandes</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
</tr>
</tbody>
</table>

3.2 Objectives & Achievements - UTM

3.2.1 Objectives (4000 ca.)

OBJECTIVES

The Telecommunications and Multimedia Unit (UTM) is a main contributor of a RL that envisions a lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content. The RG defined as its mission the development of advanced systems and technologies enabling high capacity, efficient, and secure communications, media knowledge extraction, and immersive ubiquitous multimedia applications. This mission is being accomplished by directing the activities towards four main research areas.

INFORMATION PROCESSING AND PATTERN RECOGNITION

The main goal of this area is to develop intelligent automatic or semi-automatic audiovisual applications that enhance people’s life across different dimensions. This requires investigating techniques for efficient automatic extraction of high-level features of video, audio and image signals and the generation of additional knowledge and rich models from the extracted data.

These aspects are addressed by combining fundamental and applied research in machine learning, signal processing and human-computer interaction, with applications in computer vision, image and video processing (medical images, manuscript documents and video object tracking), sound and music computing (music information retrieval, interactive music systems and musical robotics) and network information processing.

MULTIMEDIA COMMUNICATIONS TECHNOLOGIES

The main goal of this area is to devise solutions to ease the access to distributed multimedia resources in heterogeneous environments to any user in a seamless and adaptable way. This includes metadata and multimedia content management, context-aware multimedia services, adaptable mobile and immersive multimedia applications.

The main research topics focus on personalised access and consumption of multimedia content through context awareness; content recommendation using hybrid approaches; immersive multi-view experiences; metadata in collaborative annotation systems employing concepts of crowdsourcing and Games With a Purpose to motivate users. The goal is also to: investigate efficient search and content analysis methods; accurate algorithms to validate annotations; to devise metadata model and tools for sensing, representing and reproducing multi-sensorial real-life experiences.

COMMUNICATIONS NETWORKS
The main goal of this area is designing and evaluating new architectural solutions suitable for next generation networks. The focus is on wireless networks and mobile communications, extending infrastructure networks and enabling the emergence of the Internet of Everything in terrestrial and maritime environments. This requires theoretical and simulation modelling, implementation, and experimental evaluation of communications networks and their elements.

The main research topics include the development of solutions for medium access control in and self-configuration of static and mobile multi-hop wireless networks, large scale networks, network congestion control, optimisation using cross-layer techniques and machine to machine communications.

OPTICAL TECHNOLOGIES AND ELECTRONICS
The main goal of this area is to integrate advanced skills in optical communications and microwaves, and microelectronics and programmable logic.

Research activities in optical communications and microwaves addresses the development of optical and wireless communication systems, including the convergence between both wireless and optical systems, and passive optical access networks, supported in advanced modulation formats and signal processing techniques as well as the R&D of novel microwave/radio devices and antennas.

Research in microelectronics and programmable logic addresses design and testability of circuits, characterisation and adaptive correction of performance, RF design and transparent electronics, A/D and D/A conversion, dedicated computing applications in reconfigurable logic, and hardware/software co-design and VLSI design.

3.2.2 Main Achievements (4000 ca)

INFORMATION PROCESSING AND PATTERN RECOGNITION
A 3D Low-cost Solution for the Aesthetic Evaluation of Breast Cancer Treatment
The Data Replication Method for the Classification with Reject Option
Algorithms for people detection and localization in retail environments
Language for expression of Computer Vision Metadata
Algorithms for physical activity classification using video
A real-time beat tracking method designed for drums
A real-time music mashup system
A new evaluation methodology for beat tracking systems
A method for real-time automatic piano accompaniment
A system for manipulation of syncopation in MIDI data
Paper wins the SoundSoftware.ac.uk Prizes for Reproducibility in Audio and Music Research 2013
A robot audition system for real-time music genre recognition
First Place in the IEEE BTAS 2013: LivDet – Iris 2013: Iris Liveness Detection Competition,
First Place in the ICDAR 2013 Music Scores Competition: Staff Removal, August 2013

MULTIMEDIA COMMUNICATIONS TECHNOLOGIES
Performance evaluation of content recommendation algorithms
Contextualized user profiling techniques
Context sensing middleware platform for Android OS
Human activity recognition in Android devices
Content recommendation in mobile environments
Personalized multiview system
Adaptable video streaming
Collaborative multimedia annotation application based on concepts of Games with a Purpose

COMMUNICATIONS NETWORKS

Simulation framework for 802.11-based WMN using directional antennas
Power interference model for CSMA/CA based networks using directional antennas
Energy-efficient scheduling mechanism for 802.11-based WMN using FM as a control channel
Accurate positioning technique in underground tunnels using Software Defined Radio
Energy-Aware routing for biomedical wireless sensor networks
Simple and backwards compatible routing for Multi-technology Personal Area Networks
Cooja simulation framework for 802.15.4 wireless sensor networks in Smart Grids
Energy-efficient packet relaying mechanism in Wireless Visual Sensor Networks
ns-3 based simulation framework for TCP/IP Wireless Underground Networks
Simple multi-hop scheduling mechanism for single-radio 802.11-based WMN
QoS-based management mechanism for biomedical wireless sensor networks
RSSI prediction algorithm for 802.11-based communications
Dynamic MTU Algorithm for 802.11-based maritime communications

OPTICAL TECHNOLOGIES AND ELECTRONICS

Assessment of Digitised radio techniques for fibre-wireless applications
Evaluation of modulation for pico-cellular access networks based on resonant tunneling diodes
Evaluation of a digitized fiber-wireless system employing sigma delta modulation
Performance assessment pre-distortion techniques in multicarrier digitised RoF system
Performance comparison of OFDM and SC-OFDM in Radio-over-fiber systems
Propagation model accounting for the attenuation of radio electromagnetic waves in underwater
Novel layer-peeling algorithm for the synthesis of nonuniform transmission lines
Design and synthesis of band-stop filters with arbitrary group delay lines and wide-band couplers
Novel analog-to-digital transformation for minimum length synthesis of transmission lines
Evaluation of a differential GPS-over-fiber system for aircraft attitude determination
Inverted-L antenna design using fractal geometry for dual band WLAN
Design and test of omnidirectional antennas using LTCC substrates for UWB.

IC design and test, in 130nm, of an UWB LNA.
Design of DC/DC converters for MPPT in PV panels of 140W
Integration of multipanel power-adaptation and testing
Circuit design and testing using a-GIZO devices
Hybrid packet/circuit switching protocol for sensor networks
Compact open-loop clock and data recovery method for use in wearable system
Data over power supply communication chip for wearable wired network
Sensor network for capturing and transmission of biomedical signals
Processing of biomedical signals for dependability analysis
Study of supercontinuum generation in the normal dispersion regime

3.3 Productivity - UTM

3.3.1 Publications in peer review Journals (6000 ca.)

2013
Bispo, J., Paulino, N.M., Cardoso, J., Canas Ferreira, J., "Transparent Trace-Based Binary Acceleration for Reconfigurable HW/SW Systems", IEEE Transactions on Industrial Informatics, August 2013, DOI:10.1109/TII.2012.2235844, vol.9, no.3.


2014


### 3.3.2 Other international publications (6000 ca.)

**Books and book chapters**

2013


2014


### 3.3.3 PhD thesis completed (3000 ca.)

**PhD THESES AUTHORED BY MEMBERS OF THE UNIT**

2013


2014


3.3.4 Patents/prototypes (2000 ca.)

Framework for recognition of musical characters
Framework for Staff line detection
Software for 3D reconstruction
Modules for people detection in retail environments
Modules for people localization in ambient assisted living scenarios
Graphic interface for video annotation in sport scenarios
RAMA for Spotify - an app to explore a network of favourite music artists
earGram - a software for exploration of large databases of audio snippets
Loopalooza - estimates and manipulates rhythmic structures from audio loops
Spatium - a spatialization software for the CARA concerts
Improvasher - a real-time music mashup system
CAMR - Contextualised Multimedia Recommendations in Android devices
Platform to evaluate video recommendation algorithms
Personalised Multiview video streamer
Tag4Vid - a video annotation tool
ns-2 simulator for 802.11-based WMN using directional antennas
ns-3 simulator for Underwater Wireless Networks
ns-3 simulator for Wireless Underground Networks
802.15.4 wireless sensor network for monitoring photo-voltaic power plants
Maritime wireless network for ship-to-shore communications
Green LED transceiver for underwater optical wireless communications
WiFi-over-fiber system
Differential GPS-over-fiber system
UWB LNA
TFT a-GIZO dynamical Models
MPPT and DC/DC converter in PV arrays
TFT Amplifiers
Elliptical antennas for UWB communications
Wired sensor network for capture of human locomotion signals
ASIC for wired sensor networks (CMOS 0.35 um)
Tools for hardware generation for loop accelerators
Prototype of transparent pipelined loop accelerator
Prototype of transparent modulo-scheduled loop accelerator
Telemetry system for monitoring a body implanted pressure sensor
Power-line communication for wired wearable network demonstration chip
Wearable cardiovascular monitoring system
Patent No 107537, ”Mixed signal bus module for multiple circuit resources management”

3.3.5 Organization of Conferences (2000 ca.)

IbPRIA 2013 - Iberian Conference on Pattern Recognition and Image Analysis, Funchal, Portugal, Jun. 2013 (J. Cardoso – Local Chair; L. Teixeira, L. Ciobanu, I. Domingues, H. Oliveira, E. Pereira – Organising committee)
ISMIR 2013 – Int. Society for Music Information Retrieval Conference, Curitiba, Brazil Nov. 2013 (F. Gouyon – Program Chair, M. Davies - Program Committee)
ISMIR 2014 – Int. Society for Music Information Retrieval Conference, Taipei, Taiwan, Oct. 2014 (M. Davies - Program Committee)
ACM Immersive Media Experiences 2013 - workshop in the 21st ACM International Conference on Multimedia, 21-15 October 2013, Barcelona, Spain (P. Viana – Program Committee)
ACM Immersive Media Experiences 2014 - workshop in the 22nd ACM International Conference on Multimedia, 3-7 November 2014, Orlando, Florida, USA, (P. Viana – Program Committee)
IFIP WD 2013 - Wireless Days 2013, Valencia, Spain, Nov. 2013 (M. Ricardo - Chair Broadband Wireless Track)
IEEE/IFIP WD 2014 - Wireless Days 2014, Rio de Janeiro, Brazil, Nov. 2014 (M. Ricardo – Chair Simulation Track)
WNS3, Workshop on ns-3, May 7, 2014, Georgia Institute of Technology, Atlanta GA (M. Ricardo – Steering Committee)
DCIS 2013 – XXVIII Conf. on Design of Circuits and Integrated Systems, Avignon, França, Nov. 2013 (J.S. Matos; J. M. Silva – Steering Committee; J. C. Ferreira – co-program chair)
DCIS 2014 – XXIX Conf. on Design of Circuits and Integrated Systems, Madrid, Espanha, Nov. 2014 (J.S. Matos; J. M. Silva – Steering Committee)

3.3.6 Industry contract research (2000 ca.)

Direct contracts with the industry:
vCardID – Solução Nacional para identificação Biometrica através de impressões digitais, with INCM
ASSIST – ANALYSIS OF SPORT STATISTICS
HONDA - Research contract between INESC, LIAAC and Honda Research Institute in Japan

Projects with industrial partners in the framework of QREN (Quadro de Referência Estratégico Nacional), either in partnership or under contract:

AAL4ALL – Ambient Assisted Living for ALL
ARENA – Plataforma para Análise da Performance Desportiva
RetailPro - Desenvolvimento de uma Plataforma Integrada de Gestão Estratégica de Ambientes de Retalho
SARA - Sistema de Gestão de Ativos de Redes Rodoviárias.
QREN PGlobal
MTGrid - Multi Technology Communication Infrastructure for the Smart Grid
HiperWireless - Point-to-Multipoint Microwave Communications using the 17GHz License-free Band
UniSat - Triple band transceiver for the Ku/Ka band, QREN (Vale ID&T)
WiSat - Passive Devices for the S and Ka band QREN (Vale ID&T)

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

The participation in a number of projects funded by research programmes of the European Union (listed below) allowed consolidating the position of the Unit at international level and establishing strategic partnerships with leading R&D institutions in Europe.

PICTURE - Patient Information Combined for the Assessment of Specific Surgical Outcomes in Breast Cancer, FP7 ICT Programme
MPM4CPS - Multi-Paradigm Modelling for Cyber-Physical Systems, ICT COST Action IC1404
CONFINE - Community Networks Testbed for the Future Internet, FP7 ICT programme
SUNNY - Smart UNattended airborne sensor Network for detection of vessels used for cross border crime and irregular entry, FP7 ICT programme
DAPHNE – Developing Aircraft PHotonic Networks, FP7 ICT programme
OPTICWISE - Optical Wireless Communications-An Emerging Technology, COST Action IC1101
MiMed - Development of a European-based Collaborative Network to Accelerate Technological, Clinical and Commercialisation Progress in the Area of Medical Microwave Imaging, COST action TD1301
WIPE - Wireless Power Transmission, COST action IC1301
EMF-MED - European network for innovative uses of EMFs in biomedical applications, COST Action BM1309
Senseiver – Low-cost and energy-efficient LTCC sensor/IR-UWB transceiver solutions for sustainable healthy environment, Marie Curie programme
3.3.8 Other national publications (6000 ca.)

The complete list of publications be consulted in: http://profile.inescporto.pt

2013

National conferences


International conferences:

Andrade, M.T., Almeida, F., "Novel Hybrid Approach to Content Recommendation based on Predicted Profiles", UIC 2013 - The 10th IEEE International Conference on Ubiquitous Intelligence and Computing, December 2013, Vietri sul Mare, Italy.


2014

National conferences


International conferences:


Lopes, M.J., Borges Teixeira, F., Mamede, J., Campos, R.L., "Wi-Fi Broadband Maritime Communications Using 5.8 GHz Band", UComms - Underwater Communications Networking, September 2014, Sestri Levante, Italy.


Paulino, N.M., Canas Ferreira, J., Cardoso, J., "Trace-Based Reconfigurable Acceleration with Data Cache and External Memory Support", ISPA 2014 - 2014 IEEE International Symposium on Parallel and Distributed Processing with Applications, August 2014, Milan, Italy.


Sequeira, A.F., Murari, J., Cardoso, J., "Iris liveness detection methods in the mobile biometrics scenario", Proceedings of IJCNN05 - International Joint Conference on Neural Networks 2014, Montreal, Canada.


3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

Projects funded by FCT:

3dBCT - 3D Models for Aesthetic Evaluation and Prediction of Breast Cancer Interventions
NeTS - Next Generation Network Operations and Management
MC-WMNs - Multiple Context-based Wireless Mesh Networks
SELF-PVP Self-organizing power management for photo-voltaic power plants (CMU programme)
CPT: Cartesian Polar Transmitter, FCT PTDC/EEA-TEL/121101/2010
SIVIC - Portable Integrated System for Cardiovascular Monitoring, FCT PTDC/EEI-ELC/1838/2012
CPT - Cartesian Polar Transmitter, FCT PTDC/EEA-TEL/121101/2010)
Steering – Steering of light in nonlinear waveguides with resonant interactions, FCT PTDC/FIS/112624/2009
WOWi - Wireless-optical-wireless interfaces for picocellular access networks, FCT PTDC/EEA-TEL/100755/2008
TWave - Phase conjugated twin waves to unlock the potential of future spatial division multiplexed systems, FCT EXPL/EEI-TEL/1748/2013

Projects funded by UP

Computational Vision Applied to the Segmentation and Morphometric Characterization of Nerve Histology in Microscopic Images

Projects funded by ON.2 O Novo Norte
BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL6 - Multimedia Art Technologies

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL3 - NETWORK SENSING FOR CRITICAL SYSTEMS MONITORING

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL4 - Cooperation and perception for augmented autonomy

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL5 – Smartgrids
3.1 Group Description – UOSE

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>OPTOELECTRONICS AND ELECTRONIC SYSTEMS</th>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>Paulo Vicente Silva Marques</td>
</tr>
<tr>
<td>Research Area</td>
<td>Physics</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
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3.2 Objectives & Achievements - UOSE

3.2.1 Objectives (4000 ca.)

FOREWORD

The Coordinator of this Unit during 2013 and 2014 was Prof. Paulo Marques.

OBJECTIVES

The roots of this Unit (named UOSE) go back to 1985, when INESC in Porto was funded in the context of the realization of a large project in optical communications. Along the years the activity was developed along several research areas following its established mission to perform internationally recognized research, development and training in Optoelectronics.

The research objectives embrace modelization, design, process development and Optoelectronics integration.

The following areas were addressed in a chain that proceeded from technology to systems and applications:

- Fabrication of thin films, planar optical devices and fibre optics components;
- Optical imaging;
- Optical sensing heads and some types of electrical sensing heads based on thin films;
- Optical sensors for real-time dosimetry
- Synthesis of novel glasses for sensing
- Optofluidics sensor system
- Development of chemical (gases) and biochemical (cyanobacteria, for example) sensors
- Fibre lasers for sensing;
- Optical fibre sensing systems; field tests and applications.

Specific objectives involved the acquisition of operational competences in those areas, the establishment of attractive post-graduated programmes, and the development of consultancy and technology transfer initiatives.

The field of optical sensors has been again the main topic of research. In addition, the cooperation within the group between the several areas of expertise has been enhanced. The scientific objectives remain broadly the same but have been a larger effort to create internal critical mass around the projects considered to be the most relevant for the future. The traditional fields of research in traditional fiber sensors (strain, temperature, curvature, etc) has been performing extremely well, the efforts in recent years to enhance the progress in chemical and bio-chemical sensors is showing consistent results, as a result of the acquisition of several multidisciplinary competencies (fibers optics and optoelectronics, materials science, chemistry, microfabrication and instrumentation).
Recently UOSE has been also focused in supporting the implementation and operation of a large microfabrication infrastructure within Porto University. This include a 180m2 cleanroom ISO6/7 which will have all the microfabrication techniques available (lithography, dry-etching, deposition, mask production, etc). This facility has been design under the responsibility and guidance of INESC Researchers, together with other from UP.

In the last couple of years the Group was particularly active in continuing to strengthen the relations with the local industry, following the nature of the institution centered in the interface between academia and industry.

In addition, the relation with the Group with the other research units has been increased strongly and has a result several joint projects submitted and other running.

Broadly, for the next period, the objectives is to continue to maintain a good balance between research and development; the success is achieved if the Group maintains a good level of participation in international conferences and a high standard of scientific publications allied to a good number of industrial contracts. The group feels the need to increase the participation in European projects and several proposals where submitted during the period.

3.2.2 Main Achievements (2000 ca)

Improvements, as well as novel configurations were obtained in the following areas:

Implementation of Rayleigh scattering for vibration sensing
Integrated refractometers based on single and multimode interference
Fiber Cavity ring down
Demonstration of utility of suspended core fibers in the implementation of high sensitivity optical sensors
Development of new interrogation schemes with long period gratings
Development of tapers based on CO2 Laser
New Cavity Fabry-Perot based on microstructured tube combined with glass spheres.
Sensors based on hyperspectral processing
FBG in Focused ion beam for high temperature sensor
Laser direct writing of first order gratings with femtosecond pulses (point by point)
Demonstration of optical coherence tomography in different application areas
Novel optical fiber geometry designs for sensing purposes (H-shaped, suspended twin core fiber, as examples)
Fabrication of waveguides in pure silica through femtosecond laser writing
Fabrication of integrated polarizers based on directional couplers fabricated in pure silica plates by direct writing
Fabrication of refractive index sensors in slotted multimode integrated devices for chemical and biochemical sensing
Optical fiber sensor for hydrogen and metals
Development of glasses for biomedical applications (prosthesis)
Sensors for determination of Quaternary Ammonium Compounds
Sensors for determination of crotaline
Sensor for B. cereus and cereulide determination
Microstructured fiber for vapour and liquid sensing
Wearable Macrobending Fiber Optic Sensor for Human Joint Angle Determination
Vibration sensor based on a distributed Bragg reflector fibre laser
Next generation of Fabry-Perot sensors for high-temperature
Interrogation sensing scheme based on 'Figure-of-Eight' fiber loop mirror configuration
Temperature-Independent Torsion Sensor Based on 'Figure-of-Eight' Fiber Loop Mirror
H2 sensor Based on a Pd-Coated Tapered-FBG Fabricated by DUV Femtosecond Laser Technique
LPG sensor for the detection of E. Coli proteins
Novel dissolved CO2 sensor for utilization in environmental monitoring and aquaculture industry
Computational models for new fiber optic tweezers
Development of an electrical current sensor prototype for application in high-power lines
Wearable Monitoring Unit for Swimming Performance Analysis
A Fabry-Perot sensor prototype for low-pressure measurements
Optical Inclinometer Based on a Phase-Shifted Bragg Grating in a Taper Configuration
Low-Cost Wearable Data Acquisition for Stroke Rehabilitation: A Proof-of-Concept Study on Accelerometry for Functional Task Assessment
Advanced Fiber-Optic Acoustic Sensors
An all-fiber Fabry-Pérot interferometer for pressure sensing in different gaseous environments
Evanescent wave DNA-aptamer biosensor based on long period gratings for the specific recognition of E. coli outer membrane proteins
Development of software/simulation code for solving the Generalized Nonlinear Schrodinger equation
Development of a numerical tool kit based on MEEP for the analysis of electromagnetic waves in nanostructures
Development of a metamaterial for the detection of H2 Gas

3.3 Productivity - UOSE

3.3.1 Publications in peer review Journals (6000 ca.)


24. Ferreira, M.S., Santos, J.L., Frazão, O., "Figure-of-eight cavity fiber laser based torsion sensor", Proceedings of SPIE - The International Society for Optical Engineering 2013.


3.3.2 Other international publications (6000 ca.)


2. Ferreira, M.S., Santos, J.L., Frazão, O., "Figure-of-eight cavity fiber laser based torsion sensor", RIAO/OPTILAS 2013 - VIII Iberoamerican Conference on Optics XI Latinamerican meeting on Optics, Lasers and Applications, July 2013, Porto, Portugal.


3.3.3 Ph. D. thesis completed (3000 ca.)


3.3.4 Patents/prototypes (2000 ca.)

PATENTS
N/A

PROTOTYPES
Dosimeter for radiation therapy
Long cavity fiber laser
Optical flowmeter
Integrated polarization beam splitter
Instrumented PVC foil for smart skin
Many different types of sensor heads for temperature, strain, inclination, refractive index
Broadband optical source for low coherence tomography
An internet driven transducer for biosensor measurements
Low cost optoelectronic platform for CO2 sensing comprising low cost LED based interrogation system and novel polymeric sensing layer for aquaculture applications
Optoelectronic system for label free biosensing for following hybridization of DNA (vitis vinifera) and E. Coli.
detection
Novel laser based magnetic field sensors comprising a fiber laser cavity with spectral filtering element (FBG)
New vibration fiber sensor based on low order optical fiber long period grating
A prototype system was assembled and calibrated for reproducible fabrication of the polymer microlenses. Selection and control of the fabrication parameters such as power, exposure time, fibre modal excitation was optimized and implemented with adequate software
A modular prototype setup to test the fibre optic tweezers was implemented using an inverted microscope setup and a suitable lens camera system together with a laser diode and micro-manipulators. The system was modular and suitable for rapid installation in other microscopes
Novel optical fiber tweezers

3.3.5 Organization of Conferences (2000 ca.)

The Research Group was involved through several of its members in the Committees of SEON 2013 and SEON 2014. The workshops had the participation of around 50 national and international researchers each year. The program included invited speakers and poster sessions.
Also, several UOSE researchers where involved in the organization of International Conference on Applications of Optics and Photonics (AOP’2014). The event had the participation of researchers from Europe, USA, South Africa and Far East countries with distinguished papers and oral presentations from international researchers from both academia and industry. In 2013 a co-joint initiative gathered RIAO/OPTILAS/ETOP at Porto with the collaboration of several UOSE researchers at both the scientifical and organizational levels.

3.3.6 Industry contract research (2000 ca.)

The Unit continued the contract with Fibersensing in the framework of its development. Consultancy in monitoring systems for aeronautical applications, namely in-flight structural health monitoring involving a dedicated measurement unit and athermal strain sensors, were the subjects considered.
ThermalMonitor aimed at the development of the company own capabilities in the area of optical fiber sensors manufacturing, testing and characterization according to international standards.
An international R&D contract, TECCON, with Brazilian universities and electrical power companies is the main achievement concerning industry contract research area.

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level
Two main actions were strategically adopted during 2013 and continued during 2014: active participation in COST actions (with group members in the respective management committees) and in bi-lateral cooperation schemes involving the group and other international research groups, with special focus on European groups.

As a result, several proposals are under evaluation/study and bilateral researchers exchange is common. Beyond that, 86 conference presentations and papers were published with foreign institutions as result of this internationalization effort.

The strong collaboration with Brazilian groups continued, and an industrial contracted project is being carried out in Brazil, with several R&D proposals being under evaluation.

LIST OF COST ACTIONS

BM1205 European Network for Skin Cancer Detection using Laser Imaging
IC0806 Intelligent Monitoring, Control and Security of Critical Infrastructure Systems (IntelliCIS)
IC1101 Optical Wireless Communications - An Emerging Technology
MP0604 Optical Micro-Manipulation by Nonlinear Nanophotonics
MP0803 Plasmonic components and devices
MP1001 Ion Traps for Tomorrow's Applications
MP1005 From nano to macro biomaterials (design, processing, characterization, modeling) and applications to stem cells regenerative orthopedic and dental medicine (NAMABIO)
MP1205 Advances in Optofluidics: Integration of Optical Control and Photonics with Microfluidics
MP1209 Thermodynamics in the quantum regime
MP1401 Advanced fibre laser and coherent source as tools for society, manufacturing and lifescience
MP1403 Nanoscale Quantum Optics
TD1001 Novel and Reliable Optical Fibre Sensor Systems for Future Security and Safety Applications (OFSeSa)
TD1404 Network for Evaluation of One Health (NEOH)
TD1405 European Network for the Joint Evaluation of Connected Health Technologies (ENJECT)

BI-LATERAL ACTIONS

During 2013 and 2014 there were integrated actions with Spain, Germany, Hungary and India.

Under all the schemes above the Group received 10 researchers. Also, 6 researchers of our group spent some periods abroad.

One important reason for this effort is the need we feel to have more European projects running, and therefore, the cost actions and the bilateral exchange programs are a great opportunity to establish new partnerships and to fertilize ideas about future applications to funding. As a consequence of this activity several European proposals were submitted during the second semester of 2014.

A FP7 project in the area of biosensors for food security is being carried out with several relevant European partners.

3.3.8 Other national publications (6000 ca.)


3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

During 2013 and 2014 the Unit was involved in 15 R&D national projects. Eight of these projects were concerned with optical fibre sensors principles and applications; two dealt with monitoring of biomedical signals, other two were dedicated to novel materials and the remaining two with medical physics. The sensors projects were dedicated to applications in composite materials systems, characterization of optical fiber sensing heads for civil engineering applications, measurement of dissolved oxygen by fluorescence and biochemical sensors and measurement of hydrogen. The novel materials projects were related to multiferroics and glasses for prosthesis applications. The medical physics projects were dedicated to the radiation monitoring in cancer treatments. Another project dealt with materials synthesis for sensors.

FCT projects (name and coordinator):
AQUAMONITOR - Pedro Jorge
FIBDOSE - Carla Rosa
FLUOROCT - Carla Rosa
Hybrid - José Luís Santos
InCell - Pedro Jorge
IORT - Carla Rosa
MCP - Nandyala Sooraj
Microphyte - Pedro Jorge
Multiferroicos - José Ramiro Fernandes
Spin_Fonão - José Ramiro Fernandes
SPR - José Luís Santos
WineBioCode - Pedro Jorge
Wood - José Ramiro Fernandes

QREN projects (name and coordinator):
Sensing - Paulo Marques
SmartGrids – Pedro Jorge
3.1 Group Description - USE

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>Power Systems</th>
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</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Manuel António Cerqueira Costa Matos</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
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</tbody>
</table>

3.2 Objectives & Achievements - USE

3.2.1 Objectives (4000 ca.)

The Power Systems Unit (USE), is the core research group for the line of research entitled "Sustainable Energy Systems and the Smart Grid".

The mission of the Power Systems Unit is centred on the development of advanced research in emergent modelling, optimization and control techniques applied to Power Systems characterized by large scale integration of renewable power sources, distributed generation and electric vehicles, under the Smart Grid paradigm. In scientific terms, this corresponds to combining the traditional analytical models and tools of power systems with the emergent techniques of operational research and computational intelligence the group has been applying and with economic models of the new organization of the power sector, in order to develop multidisciplinary integrated models and tools useful for the relevant agents (system operators, producers, regulators, government) and for global understanding of the complex phenomena under research. The main objectives for 2013-14 follow and develop the guidelines for the previous period, with the main additional focus issues:

- Contributions to the detailed conceptualisation of the future electric networks organisation, in the framework of the European Projects where INESC TEC is involved.
- Development and evaluation of multi-terminal HVDC transmission solutions, namely for off-shore wind parks integration.
- Addressing the recent tendency for a high penetration of solar photovoltaic dispersed generation due to cost decrease with foreseeable home and grid parity in a nearby future.
- Taking advantage of the new laboratorial infrastructure (Laboratory of Smart Grids and Electric Vehicles) of INESC TEC.

Along with:
- Development of knowledge, studies and tools to support the increase in the integration of renewable energy into the electric power system.
- Development of new control strategies for large scale integration of distributed generation and large off-shore wind farms.
- Development of knowledge and tools to forecast variable energy sources including energy produced in large off-shore wind farms.
- Designing decision support tools for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes to evaluate various long-term energy strategies.
- Development of specific simulation tools.
- Conceptualisation of the remuneration of ancillary services using Distributed Generation.
- Development of new methodologies for market settlement.
- Development of new concepts and tools for operational reserve definition.
- Evaluation of the Security of Supply in the presence of variable energy sources.
- Conceptualisation of new organisation schemes for the electric sector including smart metering, microgrids, multimicrogrids together with the integration of electric vehicles and dispersed stationary storage devices.
- Development of models for components, monitoring, decision and control mechanisms and communication architectures, evaluation tools and market integration models including remuneration schemes.
- Conceptualisation of innovative SCADA systems for low-level control and data acquisition.
- Knowledge extraction from newly available information on detailed consumption and microgeneration.
- Development and testing of prototypes of control devices in laboratorial environments and pilot sites.
- Development of new concepts and definitions of aggregation agents for mass electric vehicle deployment.
- Development of control and remuneration mechanisms for active load control and demand side integration.
- Development of advanced generation coordination solutions for complex systems with stochastic storage and generation.
- Development of new security assessment tools and advanced restoration strategies for the operation of the pan-European network.

More specifically:
- Algorithms and tools for DMS and for industrial application.
- Variable power sources integration: analysis, control, forecasting, operation optimization, system management, off-shore wind generation.
- Electricity markets: load profiling, remuneration schemes, uncertainty modelling, optimization and decision-aid, adequacy evaluation.
- Microgeneration, microgrids and smart metering: conceptualisation, models, specification, control, stability analysis, operation procedures, islanding operation and system restoration.
- Electric vehicles integration: business and technical models, aggregators, communications, network impact, ancillary services provision.
- Forecasting: innovative models applied to load curve prediction, wind power and solar PV forecasting.

The USE Research Group has a strong tradition of technology and know-how transfer to utilities and manufacturing companies and advanced consulting and support to regulatory authorities, public sector and energy agencies. This effort forms an important part of its portfolio of activities and is supported by knowledge generated upstream in the scientific activity. This objective of knowledge valorisation will be pursued both at international level, namely in the European Union and Brazil.

3.2.2 Main Achievements (4000 ca)

Within the Smart Grid paradigm, the Power Systems Unit consolidated the research achievements with different activities, from fundamental research to prototyping and technology transfer. It is important to highlight the relevance of the Smart Grid and Electric Vehicle Laboratory that supported the development and testing of several solutions and prototypes, both for hardware and software modules related to Smart Grid applications. It consists of a test bed that allows an individual and fully integrated development and testing of concepts, algorithms and communication solutions that support the operation of a distribution network under normal and emergency conditions.
The main achievements were:

- Definition of Smart Grid reference architectures (including communications and hardware) in the range of the physical electrical system structure up to the global control and management systems, involving the microgrids and virtual power plant concepts. The result of this work resulted in the overall technical architecture that embodies the SuSTAINABLE concept based on the reference architecture already deployed in the main test site of SuSTAINABLE – the InovGrid test site in Évora, Portugal.

- Identification and development of management and control solutions for large scale EV and microgeneration deployment with a strong presence of active demand response.

- Development of advanced management functionalities for distribution grids with large-scale deployment of DER.

- Development and testing of prototypes of new control devices and software modules for smart grid applications in laboratory and pilot sites, namely in the real test pilot in Évora for advanced functionalities, namely Renewable Energy Sources (RES) forecasting at the MV level, grid monitoring / state estimation at the MV level and voltage control At the MV and LV levels.

- Development of new concepts and definitions of aggregation agents for mass electric vehicle.

- Development and validation of coordinated control strategies exploiting the role of EV, storage devices, microgeneration units and responsive loads, in order to ensure a seamless transition to islanding mode and avoid MG collapse due to reserve and storage capacity shortage.

- Development and validation of MG service restoration procedure including the V2G concepts.

- Development, together with EFACEC, of a charging infrastructure that interacts with the EV and EV charges, designed to manage the electric vehicle charging with the goal of avoiding increasing the peak load in distribution networks and improving the quality of service, namely by reducing line overloading, voltages outside the allowable limits and interruption times.

- Development of a MG test bed at the SGEVL and implementation of the MG architecture, where software prototypes of the MG controllers were developed and tested in order to demonstrate the effectiveness of the proposed solutions.

- Development of unified control strategies for HVDC grids with respect to the compliance with new grid code requirements.

- Identification and development of unified control strategies not resorting in communications that should be able to deal with grid code requirements regarding synthetic inertia and primary frequency regulation from HVDC grids and for FRT capability.

- Specification and development of a reduced scale DC-grid test in order to support the proof-of-concept of the control strategies identified through numerical simulation.

- Identification of innovative procedures for power system restoration following a general blackout in electric power systems with by a large share of renewable-based energy sources connected the transmission and distribution levels.

- Development and validation of dynamic simulation models for variable speed pumped storage units, operating either in turbine or pump mode, together with the definition of control functionalities for the provision of specific grid services.

- Development of models for estimation of the amounts of mandatory investments in the distribution network, for each voltage level and region.

- Development of models and tools for assessing the impact of investments on the quality of service, network losses and operational efficiency of the distribution network.

- Impact analysis of the integration of commercial losses in the loss profiles used in the electricity market.
• The loss profiles computed by the USE team were adopted by the Portuguese regulatory agency to be used in the electricity market in the years of 2013 and 2014.

• Platform for supporting decision aid in distribution systems reinforcement planning. This tool is able to compute the long term impact (technical and financial) of network upgrade policies in smart grids, considering the combined effects of load growth, DSM, distributed generation and electric vehicles.

• Software tool to automate the construction of models to estimate the mandatory investments in the distribution network. A complementary tool was developed for the identification of the factors that most affect these investments.

• Development of data structures to deal with data acquisition of LV networks and the corresponding topology processor, considering different kind of distribution energy resources.

• Development of a new algorithm for state estimation on networks without information about their characteristics, using an autoencoder trained using historical data and on real-time only need data from a small percentage of meters.

• Development of a new algorithm to generate pseudo-measurement for MV state estimator using real-time data from LV networks using autoencoders.

• Development of a new algorithm to do the load and distribution energy resources allocation for unbalanced distribution networks.

• Development of a new upscaling algorithm for wind power forecasting aiming to estimate the total wind power generation in Portugal, using a subset of wind farms. This new algorithm was transferred to one company (Prewind), which is now providing the service to EDP.

• Algorithms to forecast the availability and charging requirements of electric vehicles were developed and published in two journal papers.

• Preliminary development of new short-term solar power forecasting algorithms that cover two situations: (a) medium/large-scale solar power plant with a time horizon ranging between 1 hour and 7 days ahead; (b) micro-generation/secondary substation with a time horizon ranging between 15 minutes and 6 hours.

• Development of a new algorithm, inspired by dynamic graph models and state space framework, for very short-term wind power forecasting and corresponding comparison with the Rapid Update Cycle (RUC) weather prediction model.

• Consolidation of existing probabilistic forecasting algorithms and technology transfer in a project with the Portuguese TSO. These algorithms were applied to different renewable energy sources, such as wind, solar and small-hydro.

• The scientific background from previous projects was used in a consultancy project in order to improve the forecasting algorithms of a company (Prewind).

• A short-term solar power forecasting system, which includes a decision-making module for maintenance planning, was developed and transferred to a company (Prewind).

• Developments in the Iberian Electricity Market – design of the market, impact of the eventual elimination of the day ahead market and substitution by a larger number of intraday markets reducing the interval from gate closure and real time operation;

• Impact of the development of new technologies and resources in the market operation – impact of electric vehicles, of storage (namely small and medium scale storage), and DSM;

• Development of innovative models for long term generation and transmission investment planning, namely considering generation systems having a large penetration of hydro resources and using Agent Based Models.

• Evaluation of the long term impact of feed-in generation in the electricity market prices of MIBEL

• Planning the operation of hydro stations including pumping storage using Genetic Algorithms, Particle Swarm Algorithms as well as built in optimization function of Matlab.
• Impact of the demand/price elasticity on the MIBEL electricity prices considering feed in generation
• Forecasting of the bid curve of generation agents in the Iberian Electricity Market prices

3.3 Productivity - USE

3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 40
The complete list can be consulted in: http://profile.inescporto.pt


3.3.2 Other international publications (6000 ca.)

Total number of publications: 108.

The complete list can be consulted in: http://profile.inesctec.pt


47. Travassos Valdez, M.M., Machado Ferreira, C.M., Maciel Barbosa, F., "Distance Education Using a Desktop Virtual Reality (VR) System", The 24th EAEIE Annual Conference, May 2013, Chania, Grécia.


3.3.3 Ph. D. thesis completed (3000 ca.)

Theses supervised by members of the research group:


3.3.4 Patents/prototypes (2000 ca.)

Very short-term Wind Power Forecasting Platform

Developed under ARGUS

Demo Place: U.S.A (Horizon Wind Energy)

Development Period: 2013
Solar Power Forecasting Software for Smart Grids
Developed under SuSTAINABLE
Demo Place: Évora, EDP Distribuição
Development Period: 2013-2014

Solar Power Forecasting System
Developed under PrevSol
Demo Place: Villares del Saz, Spain
Development Period: 2013-2014

Wind Power Upscaling Systems
Developed under Prev_Agreg
Demo Place: EDP Serviço Universal
Development Period: 2013-2014

Probabilistic Renewable Energy Forecasting System
Developed under Prev_PRE
Demo Place: REN
Development Period: 2014

Improved Wind Power Forecasting Software
Developed under ModPrev
Demo Place: Portuguese wind farms, Prewind
Development Period: 2013-2014

Software prototypes for the microgrid central controller
Developed under BEST CASE
Demo Place: SGEVL – INESC TEC
Development Period: 2013-2014

Medium Behaviour Controller for the emulation of communication characteristics in smart distribution grids
Developed under BEST CASE
Demo Place: SGEVL – INESC TEC
Development Period: 2013-2014

Event Scheduler for MicroGrid operation
Developed under BEST CASE
Demo Place: SGEVL – INESC TEC
Development Period: 2013-2014

Data Acquisition Manager
Developed under BEST CASE
Demo Place: SGEVL – INESC TEC
Development Period: 2013-2014

Electric Vehicle Charging Management Module
Developed under EFA-iCharge
Demo Place: SGEVL – INESC TEC
Development Period: 2013-2014

DMS/EMS upgrade modules – Topology Processor (switching devices measurements), Power Flow (running for some voltage levels)
Developed under EFACEC-DMS
Demo Place: EFACEC

LV Topology Processor with Modelization of all LV Network Equipments
Developed under SCADA-BT
Demo Place: EFACEC, INESC and EDP
Development Period: 2014

LV State Estimator without network data
Developed under SCADA-BT
Demo Place: EFACEC, INESC and EDP
Development Period: 2014

Pseudo-measurement generator for the MV State Estimator using LV real-time data
Developed under Sustainable
Demo Place: EDP
Development Period: 2014

DER and Load Allocation for an Unbalanced Distribution Networks
Developed under 3Phase
Demo Place: EFACEC
Development Period: 2014

3.3.5 Organization of Conferences (2000 ca.)


3.3.6 Industry contract research (2000 ca.)

MECOORD – Efficient Methodology for Optimal Coordination of Directional Overcurrent Relay in Mashed Systems, P&D ANEEL, USE – USP São Carlos, Brazil, 2011 – 2013
DMS - Development of Advanced Modules for Network Management Systems, EFACEC, since 1997 - ...
Prev_Agreg – Development of an upsizing wind power forecasting algorithm for the total generation in Portugal – R&D work (with technology transfer) for the Portuguese Last Resort Retailing company, EDP Serviço Universal, 2013-2014.
PrevSol – Development of a solar power forecasting system – R&D work (with technology transfer) for a forecasting services provider company, Prewind, 2014.
MECOORD – Efficient Methodology for Optimal Coordination of Directional Overcurrent Relay in Mashed Systems, P&D ANEEL, USE – USP São Carlos, Brazil, 2011 – 2013
Perfis de Perdas - LOSS PROFILES FOR THE ELECTRICITY MARKET, EDP Distribuição, 2013-2014
AERI_LOAD - consulting services on Load Research, USAID, 2013-2014
SIMULESP - Expert system to support the network operator in real time decisions, UNISANTA, 2011-2014
Map_medidas – Mapping measures on switching devices, EFACEC, 2013
PowerFlow – Powerflow per voltage level, EFACEC, 2013
PROB – Estimation of the mandatory investments in electric distribution networks, EDP, 2012-2015
EFA- iCHARGE – Advanced smart charging systems for EV management, EFACEC (QREN), 2012-2014
SCADA-BT – Development of a control and management system for smart LV distribution networks, EFACEC (QREN), 2012-2014
PredictEV – Mobile Sensing and Reliable Prediction of Electric Vehicle Charging in Smart Grids, CISCO, 2013
IB_FALCAO – Technical solution for adequate connection of Chão Falcão wind park, IBERWIND, 2012-2013
ENERCON - Studies for the definition of control parameters of wind generators for new wind parks, ENERCON, 2007-2013
Energeo – Plataforma de Suporte à Rede de Inovação e Comunicação em Energia e Geologia, LNEG, 2013
3PHASE – Unbalanced 3-PHAsE State Estimator for distribution networks considering distributed energy resources, EFACEC (QREN), 2014-2015

Madeirarenov_2014 - Evaluation of existing operation criteria to maximize renewable integration, EEM, 2014

3.3.7 Internationalization (2000 ca.)
Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level


EUROPEAN PROJECTS
CitInES - Design of a decision support tool for sustainable, reliable and cost-effective energy strategies in cities and industrial complexes, 2011-2013
STABALID - StaTionary Batteries Li-ion safe Deployment, EU, 2012-2015
SuSTAINABLE – Smart distribution System operaTion for mAximizing the INtegration of renewABLE generation, EU, 2013-2015
TWENTIES - Transmission system operation with large penetration of Wind and other renewable Electricity sources in Networks by means of innovative Tools and Integrated Energy Solutions, EU, 2010-2013

INTERNATIONAL CONTRACTS
SIMULESP - System to support the operation of electric power sub-transmission grids in contingency situations, UNISANTA, Brazil, 2010-2013

INTERNATIONAL TRAINING
Coordination of the training activities of the European consortium EES-UETP

Organization of the EES/UETP course “Microgrids – the building block of a smarter grid
June 2nd to 4th, 2014 – INESC Porto – Porto – Portugal

No. of papers in cooperation with authors from foreign institutions: journal – 6, other int - 24

3.3.8 Other national publications (6000 ca.)


3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice.

Research projects funded by FAI (Innovation Support Fund) from the Ministry of Economy, Innovation and Development:

SmartGrids, QREN, 2013-2015

Research projects funded by FCT:

DYMONDS - Toward Dynamic Monitoring and Decision–Based Smart Distribution Systems (with IST/UTL and CMU), FCT, 2010-2013 (coord. J. A. Peças Lopes)

SMAGIS - A Smart Energy Grid Integration System Configuration of an Energy Storage System in presence of RES Microgeneration, EDVs and Polygeneration (with IST/UTL), FCT, 2011-2013 (coord. Carlos Moreira)


Comute-DC - Control and operation of multi-terminal HVDC links in off-shore wind parks, FCT, 2013-2015
3.1 Group Description - UITT

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>Innovation and Technology Transfer</th>
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<tr>
<td>Principal Investigator</td>
<td>João Alberto Vieira de Campos Pereira Claro</td>
</tr>
<tr>
<td>Research Area</td>
<td>Economics and Management</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
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</table>

3.2 Objectives & Achievements - UITT

3.2.1 Objectives (4000 ca.)

FOREWORD

The on-line form does not maintain fixed the Unit Coordinator names, allowing permanent updating with the effect of changing past reports. The Coordinators of this Unit during 2013 and 2014 were Prof. João Claro and MSc Alexandra Xavier.

MISSION

The mission of the Innovation and Technology Transfer Unit (UITT) is to perform R&D, advanced consulting, and executive education in the areas of Technology and Innovation Management, and Technology Entrepreneurship.

STRATEGIC OBJECTIVES

In the area of Technology and Innovation Management, the unit’s main objectives are: to improve INESC TEC’s R&D management practices, in collaboration with the Board of Directors and other R&D units; and to support public and private organizations in their Technology and Innovation Management processes.

In the area of Technology Entrepreneurship, the main objectives are: to support researchers and promoters in technology transfer and knowledge valorisation; to support the Board of Directors in the continuous effort to establish an innovative and entrepreneurial environment and culture at INESC TEC; to support public and private organizations that carry out initiatives to support technology entrepreneurship.

Concerning R&D activities, the main objectives are: to create knowledge in Technology Management, Innovation Management, and Technology Entrepreneurship; to host and support MSc and PhD students carrying out research in the areas outlined above; to promote the valorisation of knowledge through the development of conceptual frameworks, methodologies, tools and executive education programmes, to be provided to private and public organizations.

MAIN RESEARCH AND DEVELOPMENT AREAS AND ACTIVITIES

- Technology entrepreneurship. Particular focus is placed on factors that influence early stages of entrepreneurial ventures, and the ways different organisational solutions address the equity gap problem. The design and impact of collaborative environments involving university, industry, and the public sector, to promote entrepreneurship and knowledge transfer and valorisation in Creative Industries, is also considered.
- Technology and Innovation Management. This area focuses on innovation management practices, tools and metrics, building on contributions to the Portuguese Standard for R&D&I Management and subsequent consulting. The research also focuses on multidisciplinary approaches to enabling the Front End of Innovation combining methods and tools that build on state-of-the-art concepts and trends in: enterprise information systems; enterprise integration; information and communication technology and business narrative modelling and analysis.

- Innovation networks. The research in this area involves analysing open innovation in multiple countries and studying the degrees of openness observed in different open innovation initiatives. The impact of framework conditions in the operations of Technology Transfer Offices is also examined. Scientometric tools are used to analyse R&D collaborative networks, such as technology clusters or international collaborations.

- Technology strategy. UIIT is examining how uncertainty and flexibility are considered in technology roadmapping. Researchers at UIIT also study the interactions between technology strategy and operations strategy.

- Flexibility in engineering design. Methods to design complex products and systems with flexibility, to enhance their performance in relation to uncertain future conditions, are being developed. This includes extending flexible design from individual projects to networked systems, and improvements in design methods aiming at a better integration of engineering, management and social sciences aspects.

- Science and technology policy. This area includes studying the relationship between foreign trade, human capital development, local R&D efforts and economic growth. The role of networks as fundamental enablers of early technology development and commercialization is also examined.

3.2.2 Main Achievements (4000 ca)

TECHNOLOGY ENTREPRENEURSHIP

UIIT partnered with ANJE on a project to foster the development of technology-based entrepreneurial ventures for the software, multimedia, textiles and clothing industries. During 2013 and 2014, the project developed workshops and coaching activities.

CEICI (Centre of Excellence for Creative Industries and Innovation) was a project promoted by INESC TEC, as part of the Centre for Creative Industries (P.INC I), to promote, support, network and disseminate CI businesses. During 2013 and 2014, the project carried out workshops and coaching activities to entrepreneurial projects, and a set of Case Studies about the processes of start up development and knowledge valorisation.

The unit was also involved in a EU funded project aiming at creating an entrepreneurship training and coaching programme focused on university spin-offs. During 2013, the project implemented that training methodology.

A researcher hired by the unit in 2014 completed his PhD in Entrepreneurship Strathclyde and has been developing key relationships with the leading research groups in academic spinoffs in Europe, and the development of a proposal, and the first steps, for the creation of an observatory of academic spin-offs in Portugal.

TECHNOLOGY AND INNOVATION MANAGEMENT

Building on its recognition for experience and knowledge in Innovation Management, the unit had continued to carry out consulting to companies in this area. In 2014, the unit developed a set of tools and a workshop model for product idea generation, using Design Thinking methodologies and trends analysis, and implemented it in companies.

In the area of “ENABLING THE FUZZY FRONT END OF INNOVATION” (FFE), the research focuses on the multidisciplinary nature of the FFE and on supporting tools and concepts. Several articles were published in 2013 and 2014, one PhD student graduated, and two others continue their research in this area.
INNOVATION NETWORKS

Unit researchers have continued to lead studies for the UTEN initiative, on the professionalization of technology transfer and commercialization in Portugal, and on characteristics of, and recent trends on, academic spin-offs in Portugal.

TECHNOLOGY STRATEGY

A research collaboration with ARSN to study implementations of technology innovation in interorganizational networks has been on-going, focusing on the adoption of the screening of retinopathy by healthcare networks in the north of Portugal.

A research collaboration with Produtech and a EU funded project is studying the process of translating manifested priorities in specific R&D activities, as well as the characteristics of technological developments that face difficulties in commercialization.

FLEXIBILITY IN ENGINEERING DESIGN

Two key projects in this area were completed in 2013 and 2014. NODES focused on the design of networked infrastructures for uncertainty, and allowed the development of multiple models and applications spanning several areas – energy, automotive supply chain, healthcare supply chains, and airport networks among others. FIRE-ENGINE focused on the design of forest fire management systems, and was carried out with MIT, grupo Portucel Soporcel, ISA and UTAD, in the scope of the MIT Portugal Program. The results of the project have been very well received by its Stakeholder Committee and knowledge transfer activities are on-going.

Two PhD students are enrolled in the dual degree PhD Program in Engineering and Public Policy at FEUP and Carnegie Mellon University, researching in energy network infrastructures.

OTHER

UITT has continued to hold its weekly research seminar, and has continued to cooperate with other units in projects, as well as participating in other cross-unit activities. This is reported in the Research Lines report sections.
3.3 Productivity

3.3.1 Publications in peer review Journals (6000 ca.)

2013


2014

3.3.2 Other international publications (6000 ca.)

2013


2014


4. Pereira Pacheco, A., Claro, J., "Flexible planning of the investment mix in a wildland fire management system: spatially-explicit intra-annual optimization, considering preparedness and escape costs", IFORS


BOOK


3.3.3 Ph. D. thesis completed (3000 ca.)

1. Lia Oliveira (2009 - 2013). Dealing with uncertainty in supply chain design in the automotive industry. PhD Program in Leaders for Technological Industries, MIT Portugal Program, FEUP.

3.3.4 Patents/prototypes (2000 ca.)

3.3.5 Organization of Conferences (2000 ca.)

1. José Manuel Mendonça (co-chair), Aurora Teixeira, João Claro - Organizing Committee, XV Congresso de Gestão de Tecnologia Latino-Iberoamericano - ALTEC 2013, Alfândega do Porto, October, 2013


3. José José Pinto Ferreira - Organizing Committee, IWSMAI2014 - International Workshop on Multidisciplinary Approaches on Innovation, 24th November 2014 - Austrian Federal Economic Chamber - Wiedner Hauptstraße 63, 1045 Vienna, Austria

4. José Coelho Rodrigues - Organizing Committee, IEMS ’14 | 5th Industrial Engineering and Management Symposium, January 7th, Porto / Fundaçao Dr. António Cupertino de Miranda; organized by the Department of Industrial Engineering and Management, Faculty of Engineering, University of Porto.


8. Marko Torkkeli, Organizing Committee, Innovation for financial services conference, Montreal, Canada, 16-17.10.2014, Editors: Mention A-L and Torkkeli M

3.3.6 Industry contract research (2000 ca.)

Entrepreneurial coaching:
- under a contract with IAPMEI (“Passaporte do Empreendedorismo”), 28 entrepreneurial projects were given business and technical support;
- in the scope of the TEC EMPREENDE project, 4 Companies (Grabmark, Bewarket, TopResearch and Kognit) were mentored;
- in the scope of the PINC Project, 17 entrepreneurial projects are incubated in UPTEC PINC were supported.

Innovation Management Systems:
- implementation at Flupol;
- audits at Flexipol and Markayakes.

Consulting services in Business Model Innovation and Product Development:
- Heliotextil, Ideavity and Metalduf.

Studies and reports:
- 10 technical reports for companies and entrepreneurial projects receiving specialized advisory support for business model and/or product development under private contracts or public-funded projects (Passaporte para o Empreendedorismo);
- 4 case studies about the process of start up development (Beinteractive, Blip, Claan, Douro Prime)
- 3 case studies of R&D valorisation strategies for other INESC TEC units

- Training & Workshops

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

COLLABORATIVE RESEARCH
- longstanding strategic collaboration with Prof. Marko Torkkeli, from the Lappeenranta University of Technology in Finland, who is a visiting researcher at INESC TEC.
- on-going research collaborations with Prof. Richard de Neufville, from the Engineering Systems Division of MIT, Prof. Steve Markham, from North Carolina State University, and Prof. Angus Kingon, from Brown University;
co-advising of two dual degree PhD students with Paul Fischbeck, from CMU, and Randy Kirchain, from MIT.

INTERNATIONAL PROJECTS

- SPIN-UP was an ERASMUS project with Technical University of Delft, Advancis, Leaders2Be, Lappeenranta University of Technology (Kouvola Unit), and University of Lodz.
- STAMAR is an INTERREG project with Marine Institute (IR), AMTEGA (SP), University of Porto (PT), University of Algarve (PT), University of Strathclyde (SCo), Technopole Brest Iroise (FR), GAIN (SP).
- FIRE-ENGINE was a project with MIT, funded by the MIT Portugal Program.
- The unit collaborated with COTEC Portugal in CAL4INO, a Lifelong Learning project with Cambridge Judge Business School, Queen’s University Belfast, Laurea University, RISEBA, Emerald, University of Wuppertal and University of Piraeus.

TRAINING NETWORKS

- collaboration with UT Austin in UTEN, in particular in a research component of the initiative;
- collaboration with the MIT Portugal Program, hosting PhD students and lecturing in the program;
- collaboration with the CMU Portugal Program, hosting PhD students from the dual degree PhD program in EPP, and contributing to lecturing and leadership in that PhD;
- João Claro is the national director of the CMU Portugal Program since 2013.

3.3.8 Other national publications (6000 ca.)

3.3.9 Government/Organization contract research (2000 ca.)

(Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice)

The involvement of the unit in a collaboration with COTEC Portugal led to the proposal of a set of policy recommendations and a handbook of best practices on technology entrepreneurship education for the European Commission.
3.1 Group Description - LIAAD

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>LIAAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Alípio Mário Guedes Jorge</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
</tr>
</tbody>
</table>

3.2 Objectives & Achievements - LIAAD

3.2.1 Objectives (4000 ca.)

OBJECTIVES

The LIAAD Associate Unit is the core Research Group of the research line "Intelligent and Adaptive Systems and Mathematical Modelling in Decision Support". LIAAD continues the tradition of conducting both fundamental and applied high quality research. The main aim is to develop new methods and techniques in the areas of data mining and modelling and use these for decision support. Many of the activities are carried out by postgraduate students under the supervision of their peers and thus contributing to their training.

The scientific competences associated with this line require a combined effort from researchers, professionals and post-graduate students with competences in diverse areas including artificial intelligence, machine learning, data mining, multi-agent modelling, as well as information systems, information management and retrieval, spatio-temporal information, simulation, optimisation, statistical and mathematical modelling in economics and management science.

The work required to achieve these research goals is described in the following sections.

LEARNING AND EXTRACTING INFORMATION

Developing and improving data mining algorithms and methodologies for solving complex decision problems taking into account, for instance, the ability to deal with new data types, new ways of collecting data, new decision problems, new computational models, etc.

Developing and enhancing methods for learning, in real-time, from distributed data streams and evolving data, requiring the ability to adapt decision models in environments with unknown dynamics. Developing and enhancing methods for resource-aware data mining, including distributed online algorithms for change detection, summarisation, classification, regression, clustering, etc.

Developing and enhancing metalearning methods to aid the user in selecting appropriate machine learning / data mining method or sequence/combination of such methods. Exploiting past information to determine which algorithms are likely to produce better results on a new task.

Developing and enhancing ILP relational methods. The aim is to investigate how to speed-up these methods, taking advantage of parallel, distributed approaches and grid computing with application to bioinformatics, and NLP.

Developing methods for automation and personalization of web sites, including recommender systems, maintenance of contents and document classification, extracting information from text/web documents: automatic methods for sentiment analysis.
MATHMATICAL AND STATISTICAL MODELLING AND DECISION SUPPORT

Studying and enhancing methods for statistical modelling, in particular parametric models for interval data that allow for inference and hypothesis testing; clustering methods for symbolic data and methods for variable selection and grouping.

Developing and enhancing methods useful in simulation, modelling and optimisation, focusing on decision problems in management science, among other application areas. Incorporating methods that include meta-heuristics and optimisation techniques based on genetic algorithms, and other bio-inspired systems.

Developing and enhancing methods in mathematical modelling focusing on dynamical systems, game theory and mathematical economy and finances, also applicable to mathematical physics, mathematical biology, time series analysis, and models of industrial organisation. Developing and enhancing methods using AI-based approaches, such as multi-agent framework, by simulating firms for specific industries and locations and studying their interactions and cooperation.

RESEARCH GROUP INTERACTION and TECHNOLOGY TRANSFER

The research activities of LIAAD have interacted with other specific competences, such as:

LIAAD has some interactions with companies and organizations that are interested in intelligent solutions. Namely: NOS telecomunicações, Universidade do Porto, Porto Editora.

3.2.2 Main Achievements (6000 ca)

HIGHLIGHTS

In 2014 the group had a high number of publications (34) in international journals. We also counted 24 articles in highly ranked conferences (CORE>=B), including CIKM, ECAI, IDA and UMAP. Overall the group published more than 100 articles in journals, conferences and books. A special highlight to the publication in 2014 of 2 articles in the high impact journal ACM Computing Surveys.

Researchers from the group have participated in the organization of many international conferences, as organization committee members, track chairs, area chairs and program committee members.

1 new book was published with a collection of articles.

13 PhD theses and 54 MSc dissertations with supervision or co-supervision of LIAAD members were concluded and defended last year.

Paula Brito continued her presidency of IASC - International Association for Statistical Computing (http://www.isac-is.org/node/54).

Many of our researchers participate as members of editorial boards of scientific journals and scientific committees of international conferences.

LIAAD cooperated in projects with USIG, CRACS, UTM, USE, CESE, UGEI and ROBIS.

LEARNING FROM DATA STREAMS

**Outstanding publication**


The book "Knowledge discovery from data streams" by João Gama (2010) reached 254 citations (source Google Scholar)
**Software for the community**
AMRULES available in MOA and SAMOA

**Awards**

MODELING DYNAMIC SYSTEMS
**Outstanding publication**
Book "Data Mining with R, learning with case studies" by Luís Torgo (2010) has reached 136 citations (source Google Scholar).

**Software for the community**
R package "performanceEstimation" for performance estimation and comparison of predictive models (http://cran.r-project.org/web/packages/performanceEstimation)

WEB AND TEXT MINING
**Outstanding project**
The European project e-Policy, with the participation of LIAAD AND CRACS, finished in 2014 and was reviewed as "The project has fully achieved its objectives and technical goals for the period and has even exceeded expectations".

**Outstanding publication**

DATA MINING AND DECISION SUPPORT
**Award**
Best paper award, conference on Advanced Data Mining and Applications (ADMA 2015), Guilin, china, with paper "Merging Decision Trees: a case study in predicting student performance" by Pedro Strecht, João Mendes-Moreira, Carlos Soares (Joint with CESE)

DATA ANALYSIS AND STATISTICAL METHODS
**Outstanding publication**

**Outstanding Scientific Role**
Paula Brito continued her presidency of IASC - International Association for Statistical Computing (http://www.iasc.isi.org/node/54).

SIMULATION, MODELING AND OPTIMIZATION
**Highly cited publication**
491 citations, 40 of which in 2014 (source Google Scholar)

GAME THEORY AND MATHEMATICAL FINANCE

**Outstanding publication**

**Outstanding Scientific Role**
Founder and editor in chief, together with Michel Benaim, of the Journal of Dynamics and Games (JDG) published by the American Institute of Mathematical Sciences

COOPERATION WITH OTHER CENTERS

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

As main results of the cooperation of this research group with other competences we highlight:

CRACS - joint MSc student on recommender systems with a GPU approach;

CESE – a business intelligence solution has been deployed at Universidade do Porto; joint papers published; joint supervision of students;

CEGI - joint papers published.

CPES - co-supervision of an MSc dissertation.

3.3 Productivity - LIAAD

3.3.1 Publications in peer review Journals (6000 ca.)

The complete list can be consulted in: http://profile.inescporto.pt.


8. João Gama, Indrê Zióboań, Albert Bifet, Mykola Pechenizkiy, Abdelhamid Bouchachia; A survey on concept drift adaptation; ACM Computing Surveys (CSUR); Volume 46 Issue 4, p.37; April 2014; DOI: 10.1145/2523813


3.3.2 Other international publications (6000 ca.)

13 Book Chapters by major international publisher (selection follows)


20 articles in major conferences referenced in ISI, Scopus or having CORE ranking =>B (selection)


3.3.3 Ph. D. thesis completed (3000 ca.)

Ana Raquel Ferreira de Almeida Sebastião, Learning From Data Streams: Synopsis and Change Detection, PhD in Applied Mathematics, Supervisor: João Gama, Co-Supervisor: Teresa Mendonça, January 2014.


Activity report PESt-C/EEI/LA0014/2013 Página B-104

Elaine Ribeiro de Faria Paiva; Detecção de novidade em fluxos contínuos de dados multiclasse; Supervisor: Andre P.L. Carvalho, Co-Supervisor: João Gama ICMC, USP, Brasil, November 2014.

Isabel Maria Perdigão Figueiredo, Modelos Matemáticos em Imunologia e em Investigação e Desenvolvimento, PhD in Applied Mathematics, Supervisor: Bruno Oliveira, Co-Supervisor: Alberto A. Pinto, July 2014.

Joana Becker Paulo (Alberto Pinto) - entregou a tese em Março 2013, ainda não defendeu?


Mohammad Choubdar Soltan Ahmadi, Mathematical Economics Sunspot equilibrium and International trade with tariffs, PhD in Mathematics, Supervisor: Alberto A. Pinto, September 2014.

Mohammadreza Valizadeh, Improving the Performance of Text Summarization, Doctoral Program in Computer Science of the Universities of Minho, Aveiro, and Porto (MAPI), Supervisor: Pavel Brazdil, December 2014.

Sónia Dias, Linear regression with empirical distributions, PhD in Applied Mathematics, FCUP, Supervisor: Paula Brito, June 2014.

Susana Filipa Couto da Silva Salgado de Abreu de Araújo Pinheiro, Dynamics of Holomorphic and Stochastic Differential Equations, PhD in Applied Mathematics, Supervisor: Helena Reis, Co-Supervisor: Alberto A. Pinto,

### 3.3.4 Patents/prototypes (2000 ca.)

(void)

### 3.3.5 Organization of Conferences (2000 ca.)

Organization


3. Dalila Fontes - Optimization Control and Applications in the Information Age, Chalkidiki, Greece, June 2014.


As Program Committee member, Senior Program Committee, Area chair or track chair (selection)
3.3.6 Industry contract research (2000 ca.)

The Unit participated in industry contracted projects, together with other groups of INESC TEC.

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

15 of our Journal papers had authors from foreign countries.

**Leading roles in scientific societies**

President of the International Association for Statistical Computing (IASC) (2013-2015) - Paula Brito

President of CIM (Centro Internacional de Matemática) - Alberto Pinto
**International Projects**

ePolicy (FP7) Engineering the PPolicy-making Life CYcle - http://www.epolicy-project.eu/

MAESTRA (FP7) Learning from Massive, Incompletely annotated, and Structured Data - http://maestra-project.eu

**Leadership in international journals**

Editor in chief of the Journal of Dynamics and Games (JDG) published by the American Institute of Mathematical Sciences - Alberto Pinto

Guest editors of the special issue of Data Mining and Knowledge Discovery of ECML PKDD 2015 - João Gama, Alípio Jorge

Guest editors of the special issue of the Machine Learning Journal of ECML PKDD 2015 - João Gama, Alípio Jorge

Associate Editor, Progress in Artificial Intelligence, Springer – João Gama

Guest editor of the special issue in “Cutting and Packing” of the International Transactions in Operational Research, 2014 - José Fernando Gonçalves

Associate Editor, International Transactions in Operational Research, José Fernando Gonçalves

Associate Editor of "Advances in Data Analysis and Classification - Paula Brito

**Participation in Editorial Boards of int. journals**

Machine Learning – João Gama

Data Mining Knowledge Discovery – João Gama

Intelligent Data Analysis – João Gama

New Generation Computer – João Gama

Machine Learning – Pavel Brazdil

International Journal of Computational Intelligence in Bioinformatics and Systems Biology (IJCIBSB) – Rui Camacho

Modulad Journal, "La revue Modulad - Paula Brito

Data - Alexandre Faria de Carvalho

**Senior Research Visitors**

Lubos Popelinsky, Univ. of Masaryk, Czech Republic

Albert Bifet, Huawei, Hong Kong

**Visiting Post-Graduate Students**

Pawel Matuszyk, Otto-von-Guericke University, Germany

Roberta Sinoara, Universidade de São Paulo, Brazil

Jorge Rebazas, Universidade de São Paulo, Brazil
3.3.8 Other national publications (6000 ca.)

5 articles in books


3.3.9 Government/Organization contract research (2000 ca.)

(Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice)

(void)
3.1 Group Description - USIG

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<th>INFORMATION SYSTEMS AND COMPUTER GRAPHICS</th>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>Gabriel David</td>
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<td>Electrical and Computer Engineering</td>
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3.2 Objectives & Achievements - USIG

3.2.1 Objectives (4000 ca.)

FOREWORD

The Coordinators of this Unit during 2013 were Prof. Gabriel David and M.Sc. António Gaspar.

OBJECTIVES

The Information Systems and Computer Graphics Unit (USIG) mission is to pursue high quality research, strongly linked to industrial partnerships, consultancy and technology transfer, in five main areas: Computer Graphics, Information Management, Software Engineering, Special Purpose Computing Systems, and Accessibility and Support Technologies. The unit is particularly well positioned to address complex and difficult engineering problems faced by industry as it has the expertise to analyse, design, mine and implement large information systems, using best software engineering practices for design, development and testing, and also provide the visual and user interaction components such a solution may require. Furthermore, the unit is also strongly committed to the training of young researchers and professionals. The Special Purpose Computing Systems and Accessibility and Support Technologies areas correspond to new researchers who have joined the centre.

USIG main research goals are organized as follows:

SOFTWARE DEVELOPMENT METHODOLOGIES - Improve and innovate on current software development methodologies with particular emphasis on model-driven development with formal methods, agile and collaborative development methodologies, and software quality assurance based on software testing, verification and certification.

INFORMATION MANAGEMENT, RETRIEVAL AND PROCESSING - Investigate frameworks for information management, retrieval and processing in contexts such as web mining, recommender systems, social web, semantic web, time aware information retrieval and personalised information retrieval. This leads to the development of innovative systems such as federated libraries of socially assisted annotated documents, digital cultural heritage portfolios and e-learning environments and tools.

DIGITAL PRESERVATION - Devise models, methods and tools for digital preservation. At the management level, the establishment of digital preservation plans is studied. Techniques to include the preservation of databases in digital repositories are developed. Research data management is approached in two ways: by building repositories for large monitoring data sets and by developing tools to help adding metadata to research data sets.

LARGE SCALE INFORMATION SYSTEMS - Develop innovative models, methodologies and architectures for large-scale information systems. We focus on system integration and interoperability, authentication, access authorisation, security and auditability mechanisms.

INNOVATIVE METHODS IN COMPUTER GRAPHICS AND VIRTUAL ENVIRONMENTS - Investigate innovative methods in computer graphics and virtual environments, as well as in natural user interfaces, especially with
applications in serious games, immersive and interactive urban planning based on virtual environments. Special focus has been given to mobile devices, modeling and visualization of large scenes for immersive environments, and image synthesis.

COMPILATION FOR RECONFIGURABLE COMPUTING ARCHITECTURE – Build high-performance embedded systems and to develop languages and compilers to leverage such systems, using aspect-orientation, domain specific languages and loop-critical hardware accelerators.

ACCESSIBILITY AND SUPPORT TECHNOLOGIES – Research and build systems that improve the performance of disabled or physically impaired people, be it a visual, auditory, motor or cognitive weakness.

USIG activity is also driven by applications with particular emphasis in the areas of public administration (local, regional and central government), healthcare, telecommunications, transport and industry and the commerce and services sectors. The e-Government and e-Health areas expected to be major areas of application in the near future.

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### 3.2.2 Main Achievements (4000 ca)

2013

The group continued to improve the research production. The fastest growing category has been journal papers, with 23 being published. The number of conference papers has also grown to 75, most of them presented at international events with refereeing.

The budget suffered a sharp decrease in European and National projects, since most of them ended, synchronised with the end of public funding programmes (FP7 and QREN). This has been partially compensated by a significant increase in services projects (60%). New partnerships where created or reinforced with: APDL, TRIEDE TTI, IM3DICAL, Monte Adriano, Ordem dos Arquitetos, Portugal Telecom Inovação and IDMEC.

In the area of compilation for reconfigurable computing architecture, the main achievements are high-performance embedded systems and a new, versatile, and powerful, aspect-oriented programming (AOP) language, named LARA. LARA allows developers to capture non-functional requirements from applications in a structured way, leveraging high-level abstractions such as hardware/software design templates and flexible toolchain interfaces. Developers can thus benefit from retaining the original application source while exploiting the automation benefits of various domain-specific and target component-specific compilation/synthesis tools.

Another relevant result was the development of a new domain-specific language (DSL) to program loop-critical hardware accelerators targeting FPGAs. The new language and associated compiler are able to achieve superior performance than commercial high-level synthesis tools.

In the area of information management two tools (UPBox and DataNotes) contributed to create a collaborative data management environment for the long tail of research data.

Systems were produced in projects TICE.Mobilidade, AAL4AL, AVESAT, GIE-GNP, MedicalSoft, OARSN and PWA. Prototypes were produced in ERAS, CNG, RAIA.co and OnlineGYM. ECOPLANNER project ended with a pilot installation at a factory.

The group continued its involvement in industrial fora, like CEDT – Excellence Center for Transaction Dematerialization (Membership of the Board of Directors), DANOTEC – New Technologies and Defense Association (Representation of INESC Porto), AIFF – Forest Industries Association (Representation of INESC Porto), ITS Portugal – Intelligent Transportation Systems (Membership of the Board of Directors), ELANET – European Local Authorities Association (Membership of the Board of Directors) and Hillside Group – Non-Profit Corporation for Software Patterns promotion (Vice-Presidency of the Board of Directors).

2014

The group slightly increased its research production, despite the difficult conditions caused by research budget cuts that reduce the number of projects and PhD students. There was an increase to 27 journal papers and 59 conference papers published, with about one third indexed by Springer, ACM, IEEE and/or ISI-Proceedings.
One of the researchers in the Accessibility and Support Technologies area was one of the winners of the 2014 awards for Inclusion and Digital Literacy, awarded by the network ICT and Society.

In 2014 budget was around 1M€. Services increased by 6%, national projects decreased 38%, due to the end of QREN funding and were compensated by European projects which increased 178%, thanks to two new projects: E-COMPARED and LeanBigData, both funded by FP7. Most of the service contracts that had started in 2013 continued in 2014 and were joined by new contracts with INCM, AMBIFOOD, PT Inovação, Porto Municipality, Público newspaper and APDL. Systems were produced in projects TICE.Mobilidade, GIE-GNP and SARA. Prototypes were produced in MASSIVE, ICARUS, E-COMPARED, LeanBigData, OnlineGYM and MIELE. Pilot installations were deployed in AAL4ALL, OASRN and SIGAP2.

The group continued its involvement in industrial fora, like CEDT – Excellence Center for Transaction Dematerialization (membership of the Board of Directors), DANOTEC – New Technologies and Defense Association (representation of INESC Porto), AIFF – Forest Industries Association (representation of INESC Porto), ITS Portugal – Intelligent Transportation Systems (membership of the Board of Directors), ELANET – European Local Authorities Association (membership of the Board of Directors) and Hillside Group – Non-Profit Corporation for Software Patterns promotion (vice-Presidency of the Board of Directors).

The cooperation with other INESC groups has increased, both through joint participation in R&D projects and by aligning strategies.

3.3 Productivity - USIG

3.3.1 Publications in peer review Journals (6000 ca.)

2013: Total number of publications: 23

The complete list can be consulted in: http://profile.inescporto.pt


2014: Total number of publications: 29
The complete list can be consulted in: http://profile.inesporto.pt


3.3.2 Other International publications (6000 ca.)

Number of publications: 75


49. Ricardo Nobre, Pedro Pinto, Tiago Carvalho, João M. P. Cardoso, Pedro C. Diniz, LARA-based Strategies for Targeting Multicore Architectures, in 17th International Workshop on Compilers for Parallel Computing (CPC’2013), July 3-5, 2013, Lyon, France.


59. Adão, Telmo; Baptista, Ricardo; Peres, Emanuel; Magalhães, Luís; Coelho, António: Reconstructing traversable buildings for archaeology with ERAS. In proceedings of 2nd International Conference on Virtual and Networked Organizations Emergent Technologies and Tools (ViNOrg ’13), Póvoa de Varzim, Portugal, 2013.


62. José Bernardino Lopes, José Cravino, Ana Maia, Leonel Morgado, Paulo Martins, Gonçalo Cruz, Paulo Fernandes, André Pinheiro, 3D simulators in professional training learning complex tasks overcoming material, economic, and human constraints, exp.at”13 - 2nd Experiment@International Conference, pp.6-10, Coimbra, Portugal, 2013.


64. Paulo Fernandes, André Pinheiro, Gonçalo Cruz, Ana Margarida Maia, Leonel Morgado, Paulo Martins, Hugo Paredes, Benjamim Fonseca, José Bernardino Lopes, José Cravino, Demo: Multi-user virtual world simulator of F-16 aircraft engine mechanical maintenance, exp.at”13 - 2nd Experiment@International Conference, pp.166-167, Coimbra, Portugal, 2013.


2014

Number of publications: 61


Machado Carvalho, D., Bessa, M., Magalhães, L.G., "Different interaction paradigms for different user groups: an evaluation regarding content selection", INTERACCIÓN 2014 - XV International Conference on Human Computer Interaction 2014, Puerto de la Cruz, Espanha.


Nobre, R., Pinto, P., Carvalho, T., Paiva Cardoso, J., Diniz, P., "On expressing strategies for directive-driven multicom programing models" 2014, 0, 0, p.7-12.


3.3.3 Ph. D. thesis completed (3000 ca.)

2013

Thesis advised by members of USIG: 5


2014


3.3.4 Patents/prototypes (2000 ca.)

Several prototypes were developed in 2013:
- ERAS - 3D Reconstruction of historic buildings based on textual descriptions and geospatial data.
- RAIA.co – Final version of sensor observation service and catalog service for a web based oceanographic georeferenced sensor network.
- OnlineGYM – Online gymnasium implemented with avatars representing personal trainer and trainees, animated using movement captured by KINECT cameras at their homes and synchronised in a virtual world displayed in their PCs.

Several prototypes were developed in 2014:
- MASSIVE – Editor of virtual multisensorial experiences.
- ICARUS – Serious game for training of search and rescue SUV and UAV operators.
- E-COMPARED – Mobile and fixed IT infrastructure for depression data gathering and evaluation.
- LEANBIGDATA – Spatial-temporal data retrieval algorithm based in RB-interval trees and visualization prototypes.
- ONLINEGYM – Final version of an online gymnasium implemented with avatars representing personal trainer and trainees, animated using movement captured by KINECT cameras at their homes and synchronised in a virtual world displayed in their PCs.
- MIELE – Multimodal multicriteria e-logistics marketplace simulator.

3.3.5 Organization of Conferences (2000 ca.)

Some of the events in which members of USIG participated are:
- ACM SAC; João Pascoal Faria - PC member
- C3S2E’13, Sixth International C*; Ricardo Costa – Track Chair
- DSAI 2013; João Barroso - Steering Committee; Paulo Martins, Hugo Paredes, Benjamim Fonseca – PC Members
- EXP’13; Augusto Sousa – PC member and SC member
- HCI 2013/MOBACC 2013; João Barroso - Track Chair; Hugo Paredes- PC member; Benjamim Fonseca - SC member
- HCist2013; Emanuel Peres - PC member
- HDRI 2013 - First International Conference on HDR imaging; Maximino Bessa – Co-Chair; Luís Magalhães - PC member
- PCG’2013; Rui Rodrigues - PC member; António Coelho – OC member
- PLE 2013; Ademar Aguiar - OC member
- PLOP 2013; Ademar Aguiar - OC member
- RTE’13; Maximino Bessa - Co-Chair
- SeGAH 2013; Rui Rodrigues - PC member; OC member
SLACTIONS 2013; Paulo Martins - Co-Chair; Luis Magalhães – PC member; Paulo Martins, Emanuel Peres – SC member.

2014

Some of the events in which members of USIG participated are:

ACM CHI 2014. Benjamim Fonseca – Scientific Committee

ACM GROUP2014. Benjamim Fonseca – Scientific Committee


ADM 2014 - Congresso Internacional de Administração. Luis Magalhães – Scientific Committee


CAPSI- Conferência da Associação Portuguesa de Sistemas de Informação 2014. Ramiro Gonçalves - Scientific committee;


CONFOA’14: 5ª Conferência Luso-Brasileira sobre Acesso Aberto. Cristina Ribeiro – Program Committee

COOP2014. Benjamim Fonseca – Scientific Committee

CRIWG. Benjamim Fonseca; Hugo Paredes – Scientific Committee

DASIP2014-8th Conference on Design and Architectures for Signal and Image Processing; October 8-10, 2014, Madrid, Spain. João Paiva Cardoso – Co-Chair


EPCG- 21º Encontro Português de Computação Gráfica. Luis Magalhães- Scientific Committee


FPL2014 - 24th International Conference on Field Programmable Logic and Applications, Munich, Germany, Sep. 2 - 4, 2014. João Paiva Cardoso - Steering Committee


ICFPT’2014 - International Conference on Field-Programmable Technology, Shanghai, China, 10-12 December 2014. João Paiva Cardoso – Technical Program Committee

IDEAS’14: 18th International Database Engineering & Applications Symposium. Cristina Ribeiro; Gabriel David; Sérgio Nunes – Program Committee


INForum 2014, João Pascoal Faria; Hugo Sereno Ferreira – PC Members; Antonio Coelho- Scientific Committee

Inter-University Programming Marathon (MIUP 2014), Porto@FEUP, Portugal. Hugo Sereno Ferreira – Chair


OTM’14: OnTheMove Federated Conferences & Workshops. Cristina Ribeiro – Program Committee

PARMA-DITAM 2014 Workshop, 5th Workshop on Parallel Programming and Run-Time Management Techniques for Many-core Architectures, Vienna, Austria, January 22, 2014. João Paiva Cardoso - Program Co-Chair


PROPOR 2014, International Conference on Computational Processing of Portuguese. Vitor Rocio – PCMember


ReConFig’2014 - International Conference on ReConFigurable Computing and FPGA’s; December 8-10, 2014, Cancun, Mexico. João Paiva Cardoso – Track Co-Chair


SEDES 2014, João Pascoal Faria – PC Members

SLATE’14, “Symposium on Languages, Applications and Technologies”., Bragança, Portugal, 10 - 20 June de 2014. João Correia Lopes; Cristina Ribeiro; Gabriel David -Program Committee


TESTBEDS’14 (Fifth International Workshop on TESTing Techniques & Experimentation Benchmarks for Event-Driven Software). Ana Cristina Paiva – Organizing Committee


9th Int. Conf. on the Quality of Information and Communications Tech. (QUATIC 2014). Hugo Sereno – Program Committee; Ana C. Paiva-Business Day

10th Latin-American Conf. on Pattern Languages of Prog. (sugarloafplop 2014) Hugo Sereno – Program Committee.


### 3.3.6 Industry contract research (2000 ca.)

RAIA.co – POCTEP funded project (former INTERREG), under subcontract by Porto University, aiming at creating an Oceanographic Observatory of the Iberian Coast, providing e-Science services for researchers and thematic services for end users, like fishermen, surfers and general public.

Corredor Azul – Development of a regional development benchmarking platform for Corredor Azul, an association of municipalities in southern Portugal, under contract with Quaternaire.

Medicalsoft – Development of mobile and portable medical imaging applications for IOS and MacOS, for IM3DICAL.

SARA – Development of motorway maintenance information system, using automated data gathering based on georeferenced image recognition, for Monte Adriano construction company.

OASRN – Information systems consultancy and portal development for the Architects Professional Association.

OnlineGYM – Research and development of a virtual reality based online gymnasium, under contract with Portugal Telecom Inovação.


IPMAPS – Development of a framework for georeferenced information based applications for IPBRICK.

SIOCER – Information systems consultancy for APCER.

SIGAP2 – Development of a wemap based port environmental management system, funded by QREN, under contract from TRIEDE TTI.

PWA – Development of warehouse real estate portal for IMOFILTER.

2014

SARA – Development of motorway maintenance information system, using automated data gathering based on georeferenced image recognition, for Monte Adriano construction company.

OASRN – Information systems consultancy and portal development for the Architects Professional Association.

OnlineGYM – Research and development of a virtual reality based online gymnasium, under contract with Portugal Telecom Inovação.

SIGAP2 – Development of a wemap based port environmental management system, funded by QREN, under contract from TRIEDE TTI.
PWA – Development of warehouse real estate portal for IMOFILTER.

EYEFRY – Development of an information system for quality evaluation of frying oil (polar compounds), composed by an android mobile phone application for data gathering from dedicated optical sensors and a server based application for data evaluation and customer management. System developed for AMBIFOOD under contract funded by QREN.

INMERSE – Evaluation of natural interaction and immersive visualization functionalities using low cost off the shelf equipments, for networked entertainment applications, under contract with Portugal Telecom Inovação.

PGLOBAL – Platform for automated news gathering and selection from several Portuguese speaking foreign newspapers, under contract with Público newspaper, funded by QREN.

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

In 2013, members of USIG have co-authored 8 joint publications resulting from international collaborations. Some of the active collaborations are:

- Image synthesis and virtual reality: U. Warwick (UK)
- Procedural Modeling: U. Jaén (Spain), ETH Zurich
- Serious games: U. Delft (Holland), U. Coventry (UK)
- Information retrieval and digital preservation: David Allen (U. Leeds), Savvas A. Chatzichristofis (Cyprus U. T.), Nuno Vasconcelos (U. California San Diego), Mark Sanderson (RMIT U.)
- Software Engineering Institute at CMU
- Ambient Assisted Living: Telefonica I+D (Spain), U. Limerick (Ireland)

Further evidence can be seen through participation in EU projects and international networks:

- ICT4DEPRESSION - First e-Health project applied to mental health, funded by FP7.
- ICARUS – Unmaned search and rescue, funded by FP7.
- COST IC1005 – COST Action addressing digital capture, storage, transmission and display of real-world lighting.
- ELANET - European Local Authorities’Telematic Network, an association promoted by CEMR, with the goal to develop the Information Society at local and regional level.
- HILLSIDE Group - Is a private non-profit devoted to the advance of software patterns. One collaborator is Vice-President.

2014

In 2014, members of USIG have co-authored 22 joint publications resulting from international collaborations. Some of the active collaborations are:

- Image synthesis and virtual reality: U. Warwick (UK)
- Procedural Modeling: U. Jaén (Spain), ETH Zurich
- Serious games: U. Delft (Holland), U. Coventry (UK)
- Information retrieval and digital preservation: David Allen (U. Leeds), Savvas A. Chatzichristofis (Cyprus U. T.), Nuno Vasconcelos (U. California San Diego)
- Software Engineering Institute at CMU
- Ambient Assisted Living: Telefonica I+D (Spain), U. Limerick (Ireland)

Another vector of internationalization is the number (47) of conferences in which members of the group served as organizers or program committee members.

Further evidence can be seen through participation in EU projects and international networks:

- ICARUS – Unmanned search and rescue, funded by FP7.
- LEANBIGDATA – Data visualization tools for an ultra-scalable and ultra-efficient integrated big data platform, funded under FP7.
- COST IC1005 – COST Action addressing digital capture, storage, transmission and display of real-world lighting.
- ELANET - European Local Authorities’Telematic Network, an association promoted by CEMR, with the goal to develop the Information Society at local and regional level.
- HILLSIDE Group - Is a private non-profit devoted to the advance of software patterns. One collaborator is Vice-President.

3.3.8 Other national publications (6000 ca.)

National Conference Proceedings with Scientific referees


2014

Number of papers: 4

PAPERS IN PORTUGUESE CONFERENCES/WORKSHOPS, ETC.:

Baptista, R.J., Nobrega, R., Coelho, A., Vaz de Carvalho, C., "Juegos para la certificación de guías turísticos de espacios urbanos" [In-Game Certification for Urban Tourism Guides], Revista de la Asociación de Técnicos de Informática, December 2014, no.230, p.64-70.


3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

CCDRN-EA – Support of the Atlantic Area platform, a transnational programme funded by the EU and managed by CCDRN, a portuguese regional governmental body.

AVESAT – Part of APSAT, a SUDOE INTERREG IV B project, for the development of innovative applications using satellite technology, under subcontract with CIM do AVE, a regional association of municipalities in northern Portugal.

MIELE - Design of an interoperable middleware platform able to interface ICT systems in Ports, based on the Model Driven Development paradigm. Project supported by Leixões Port Authority under MIELE TEN-T project.
GIE-GNP – Collaborative platform for the euro-region northern Portugal / Galicia, contracted by the European Grouping for Territorial Cooperation Galicia-Norte de Portugal (AECT – GNP)

SMICE – Development of an online platform for an energy behavior monitoring system for AdEPorto, under contract with IDMEC.

ERAS - Virtual Expedite Reconstruction of Cultural Heritage Sites, a FCT project.

2014

CCDRN-EA – Support of the Atlantic Area platform, a transnational programme funded by the EU and managed by CCDRN, a portuguesees regional governmental body.

MIELE - Design of an interoperable middleware platform able to interface ICT systems in Ports, based on the Model Driven Development paradigm. Project supported by Leixões Port Authority under MIELE TEN-T project.

GIE-GNP – Collaborative platform for the euro-region northern Portugal / Galicia, contracted by the European Grouping for Territorial Cooperation Galicia-Norte de Portugal (AECT – GNP)

VCARDID – Software verification and validation project, under contract with INCM.

CAP@CIDADE – Enterprise Architecture (Information Architecture and Business Process Architecture) modelling, under contract with Porto Municipality, funded by SAM.

WIDERMOS – Specification and prototyping of interoperability e-tools for freight exchange in multimodal motorways of the sea, under contract with APDL, funded by TEN-T programme.
3.1 Group Description - CRACS

Research Group Title
Center for Research in Advanced Computer Systems

Principal Investigator
Fernando Silva

Research Area
Electrical and Computer Engineering

Home Institution
INESC Porto

3.2 Objectives & Achievements - CRACS

3.2.1 Objectives (4000 ca.)

OBJECTIVES
The Center for Research in Advanced Computing Systems (CRACS) focuses on developing scalable software systems for challenging, multidisciplinary applications. Towards this goal, we have contributed to, and aim for scientific excellence in, the areas of programming languages, parallel and distributed computing, security and privacy, information mining, and Web based systems. Research is organized in three foundational areas:

LANGUAGES AND DISTRIBUTED COMPUTING
Our team leads in the design of high-level programming languages that integrate logical and probabilistic reasoning, supporting tabling and parallelism. YAP Prolog and Logtalk are our flagship systems, used worldwide both for research and in industry. Applications include machine learning and software engineering. Our interest in systems that are “correct-by-design” led us to further target languages for mobile distributed environments, namely wireless sensor networks (WSN). We aim at designing middleware frameworks for large WSN deployments, with a focus on scalability, energy efficiency and seamless management. A major application is in middleware for cloud-computing platforms designed for ad-hoc networks of mobile devices.

SECURITY AND PRIVACY
We contribute both to fundamentals in cryptography and complexity theory, and to applied work in improving privacy and security usability in software and systems. Applications include user-controlled identity management systems, secure identity cards, strong authentication and digital signature mechanisms; specialized algorithms and tools for sharing sensitive data while preserving privacy; robust anonymization techniques and protocols for data-sets with specially sensitive personal data; ethical hacking and penetration testing for preemptive vulnerability detection. We collaborate with the Portuguese Data Protection Commission as consultants in national projects, and with the Portuguese National Security Agency on auditing systems and developing solutions to secure mobile communications.

KNOWLEDGE IN A WORLD OF DATA
We collaborate with teams from academia and the broader community, focusing throughout in applications that challenge our core technologies. Example work includes author identification, recommendation systems, sentiment discovery, complex network analysis, electronic health records (EHR) analysis, early cancer detection, fetal monitoring, and processing high-throughput genomics data.
INTERNATIONAL COLLABORATION

Although CRACS members are, for very long, well connected internationally, a transversal goal is to reinforce most recent collaborations, in particular with CMU, in the areas of Logic Programming for large-scale distributed and crowdsharing of mobile edge clouds, UT-Austin, in high performance graph analytics, text mining and sentiment analysis, U. Wisconsin on machine learning for medical data, K.U. Leuven on probabilistic logic learning, U.T. Dallas on co-induction, U. York on “Adaptive systems security and networking”, and U. Vigo on Bioinformatics.

COOPERATION WITH INESC-TEC units:
CSIG – on adding secure authentication and identification technologies to online services;
LiAAD – on multi-relational data mining to support the development of large-scale mining systems using inductive logic programming;
CAP – on the development of innovative sensors for measuring environmental variables.

3.2.2 Main Achievements (4000 ca)

CRACS was quite successful in consolidating the research team, attracting young talented researchers, sustaining the publication ratio of the team at an excellent level, increasing international cooperation, and participating in program committees of reputable international conferences. Some highlights of 2013-2014 follow:

RESULTS
CRACS was successful with 9 new projects: 5 FCT projects, all as leader, and 4 QREN ON.2 projects, 1 as leader, totaling over 1,000,000 euros of competitive funding.
CRACS published over 123 publications: 27 in journal, 76 in conferences (51 of which in proceedings by Springer, ACM, or IEEE), 2 technical books, 10 book proceedings, and 7 book chapters.
CRACS members participated in the organization and/or PCs of a good number of relevant conferences, such as AAAI, CBMS, DS, ICLP, PADL, ILP, EPJA, EURO-PAR, PPDP and ECML PKDD.

Regarding advanced training: 22 MSc and 3 PhD theses were concluded; there are 15 MSc and 10 PhD ongoing; 20 junior researchers were hired with project funding.

ACTIVITIES
YAP: a highly reliable and performing Prolog system.
Research is focused on further improvements to tabled and incremental computations; explicit and implicit parallel models of execution; high performance implementation through demand-driven compilation; supporting the next generation constraint systems.

A new open research direction: the integration of YAP in mobile devices.

Logtalk: 3rd generation of Logtalk.
Advancements include an optimized compiler, full compiler and runtime code review, code refactoring in key areas, support for message delegation, support for structured message printing, an extended set of unit tests, and improved reflection support, notably for tools requiring full cross-referencing information.
MACAW: A resource-aware, type-safe, programming language for embedded devices.

The language compiler and runtime system were designed and implemented. The system has been used to program a commercial WSN deployment for remote management of community gardens.

SONAR: a Publish/Subscribe middleware for seamless access to data streams generated by wireless sensor networks (WSN).

WSN are programmed in SONAR using a DSL called STL (for SONAR Task Language) that is portable across WSN architectures and allows dynamic reprogramming of the networks. We have a fully functional prototype for the P/S system and for the STL language compiler and virtual machine.

Development of several hardware sensors based on distinct technologies to measure: gas concentration in the environment, the concentrations of pharmacological pollutants in water treatment stations (under development) and the quality of oils used in the food industry.

Work on the HYRAX project focused on the development of communication layer, for the Hyrax middleware, that seamlessly supports WiFi, WiFi-Direct, Bluetooth and TLDS protocols, and includes discovery services.

Graph Mining: focused on novel sequential algorithms for discovering subgraph patterns. Extended the work to develop parallel algorithms for distributed and shared memory, and also for the GPU. We extended the g-trie data structure to support colored graphs and large scale networks. We also focused on new methods to characterize and compare time evolving networks.

MammoClass: a web tool to predict probability of malignancy based on a selected set of mammography features.

### 3.3 Productivity - CRACS

#### 3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 27


3.3.2 Other International publications (6000 ca.)

Edited Proceedings + Book Chapters (4 of 17):
2. F Silva, I Dutra, VS Costa, Euro-Par2014, LNCS 8632
3. L Lopes et al., Euro-Par2014 Workshops, LNCS 8805 & 8806, 2014
4. M Hanus, R Rocha, KDPD2013, LNCS 8439, 2014

In Proceedings by Springer, ACM and IEEE (49 of 73):
112.J Côrte-Real, I Dutra, R Rocha, A Hybrid MapReduce Model for Prolog, ISIC2014, IEEE
115.R Camacho, R Ramos, NA Fonseca, AND Parallelism for ILP: the APIS System, ILP2013, LNCS 8812, 2014
118.F Cruz, R Rocha, SC Goldstein, Design and Implementation of a Multithreaded Virtual Machine for Executing Linear Logic Programs, PPDP2014, ACM
119.A Pereira et al. USB Connection Vulnerabilities on Android Smartphones: Default and Vendors' Customizations, CMS2014, LNCS 8735
120.D Aparicio, P Ribeiro, F Silva, Parallel Subgraph Counting for Multicore Architectures, ISPA2014, IEEE
122.R Queirós, JP Leal, A survey of E-Learning Content Aggregation Standards, KMEL2014, LNCS 8699
123.CA Martinez-Angeles, I Dutra, VS Costa et al. A Datalog Engine for GPUs, KDPD2013, LNCS 8439, 2014
124.T Costa, JP Leal, Challenges in computing semantic relatedness for large semantic graphs, IDEAS2014, ACM
126.C Amaral, M Florido, VS Costa, PrologCheck – Property-Based Testing in Prolog, FLOPS2014, LNCS 8475
127. M Araújo et al. Com2: Fast Automatic Discovery of Temporal ('Comet') Communities, PAKDD2014, LNCS 8444
128. A Gonçalves, IM Ong, JA Lewis, VS Costa, Discovering Differentially Expressed Genes in Yeast Stress Data, CBMS2014, IEEE
130. A Ferreira et al. Envisioning secure and usable access control for patients, SeGAH2014, IEEE
132. P Ribeiro, F Silva, Discovering Colored Network Motifs, CompleNet2014, SCI 549
133. M Areias, R Rocha, On the Correctness and Efficiency of Lock-Free Expandable Tries for Tabled Logic Programs, PADL2014, LNCS 8324
136. AP Tomás, JP Leal, Automatic Generation and Delivery of Multiple-Choice Math Quizzes, CP2013, LNCS 8124
137. J Côrte-Real, I Dutra, R Rocha, Prolog Programming with a Map-Reduce Parallel Construct, PPDP2013, ACM
139. JP Leal, Testing the perception of time, state and causality to predict programming aptitude, FedCSIS2013, IEEE
140. P Paredes, P Ribeiro, Towards a Faster Network-Centric Subgraph Census, ASONAM2013, ACM
141. F Mota, S Aaronson, L Antunes et al. Sophistication as Randomness Deficiency, DCFS2013, LNCS 8031
142. E Cunha, ÁR Figueira, ÓE Mealha, Clustering documents using tagging communities and semantic proximity, CISTI2013, IEEE
144. H Rodrigues, L Antunes, ME Correia, Proposal of a secure electronic prescription system, i-Society2013, IEEE
145. PM Ferreira, TTV Vinhoza, A Castro, I Dutra et al. Knowledge on Heart Condition of Children based on Demographic and Physiological Features, CBMS2013, IEEE
146. C Santos-Pereira, AB Augusto, R Cruz-Correia, ME Correia, A secure RBAC mobile agent access control model for Healthcare Institutions, CBMS2013, IEEE
148. T Loureiro, R Camacho, J Vieira, NA Fonseca, Boosting the Detection of Transposable Elements Using Machine Learning, PACBB2013, AISC 222
149. N Cravino, ÁR Figueira, Community Detection by Local Influence, WorldCIST2013, AISC 206
150. S Soares, ÁR Figueira, Creating Interoperable e-Portfolios for Different Educational Levels, EDUCON2013, IEEE


154. P Moura, A Portable and Efficient Implementation of Coinductive Logic Programming, PADL2013, LNCS 7752


3.3.3 Ph. D. thesis completed (3000 ca.)

Theses advised or co-advised.

PhD completed: 3

159. Elisabete Cunha, Scalability in Semantic Digital Libraries, PhD in Information and Communication in Digital Platforms, Univ. of Aveiro, Jul 2014, Advisors: Á. Figueira and Ó. Mealha (UA)

160. Carlos Ferreira, Exploring Temporal Patterns from Multi-relational Databases, PhD in Computer Science, FCUP, Jun 2014, Advisors: J. Gama (LIAAD) and V.S. Costa

161. Mário Alves, Adaptive Hypertext. The shattered documents approach, PhD in Computer Science, FCUP, Jul 2013, Advisors: A. Jorge (LIAAD) and J.P. Leal

MSc completed: 22

162. João Silva, High-Level Primitives for Solution Searching in Or-Parallel Prolog Systems, MSc in Network and Information Systems Engineering (MIERSI), FCUP, Dec 2014

163. Gustavo Augusto, Computer Aided Diagnosis for Breast Cancer Detection, MSc in Computer Science (MCC), FCUP, Dec 2014

164. Mário Pinto, Design and implementation of an algorithmic trading system for the Sifox application, MCC, FCUP, Dec 2014

165. André Rodrigues, Paralelização de algoritmos de fatorização de matrizes para recomendação usando GPU, MCC, FCUP, Dec 2014

166. Liliana Dores, Análise de dados de cancro da mama de duas populações geograficamente diferentes: EUA e Portugal, MSc in Medical Informatics (MIM), UP, Nov 2014

167. Sérgio Moreira, Monitorização de Redes e Sistemas Informáticos, MCC, FCUP, Oct 2014

168. David Aparício, Pattern Discovery in Complex Networks using Parallelism, MCC, FCUP, Jul 2014


170. André Pereira, USB connection vulnerabilities on Android smartphones, MIERSI, FCUP, Jul 2014

171. Ricardo Ferreira, Visualization of Passively Extracted HL7 Production Metrics, MIERSI, FCUP, Jul 2014
172. Diogo Teixeira, A Computational Platform for Gene Expression Analysis, MSc in Informatics and Computing Engineering (MIEC), FEUP, Jul 2014
173. Daniela Cardeano, Data Mining em aplicações de Desenho Racional de Fármacos, MIEC, FEUP, Jul 2014
175. Luís Maia, On the Integrity and Trustworthiness of web produced data, MIERSI, FCUP, Dec 2013
176. Ana Isabel Dias, Construção de uma base de dados e repositório de casos clínicos em Cardiologia, MCC, FCUP, Nov 2013
177. Xu Yi, Análise de algoritmos de particionamento de restrições, MCC, FCUP, Nov 2013
179. Silvia Almeida, Aplicação Web para Cálculo de Métricas de Avaliação da Verdura de Reações Químicas em Laboratório, MSc in Physics and Chemistry for School Teachers, FCUP, Nov 2013
181. Teresa Costa, Publishing Relational Data as Linked Data, MIERSI, FCUP, Sep 2013
182. Joana Côrte-Real, A MapReduce Construct for Yap Prolog, MSc in Electrical and Computers Engineering, FEUP, Jul 2013
183. Francisco Mota, A Monotone Modal Logic for Algorithmic Statistics, MCC, FCUP, Jul 2013

3.3.4 Patents/prototypes (2000 ca.)

Software prototypes and systems (year indicates year of 1st version):

YAP Prolog System, a high performance Prolog compiler. It is part of several Linux distributions and used worldwide, especially by the machine learning practitioners (latest version 6.2.1). Yap also includes YapTab, a tabling LP system, YapOr and ThOr, or-parallel Prolog systems, and OPTYap, an or-parallel tabling system.


Mooshak: a system for managing programming contests on the Web, v1.5.2.

EOID: OpendID 2.0 Server with extensions for secure attributes management and smart card interactions, 2008.


Lineage Sequence Discovery (LSD) - discovery of patterns within biological sequences, 2010.

MammoClass: an online application to classify mammograms, 2011

PopAffiliator: an online calculator for predicting individual affiliation to a major population group, 2011

LogCHEM: a prototype for discriminative interactive mining of chemical fragments, 2011.

L-FLAT: Logtalk Toolkit for Formal Languages and Automata Theory, 2011.


MACAW - A resource-aware programming language for embedded devices.

SONAR - Publish/Subscribe middleware for seamless access to data streams from wireless sensor networks.

STL/SONAR Task Language - programming language for wireless sensor networks

SVM - Operating system and virtual machine installed in wireless sensor networks allowing multitasking and dynamic reprogramming of the nodes.
Modular colorimetric sensor for measuring gas concentration in the environment.

Electrochemical sensor based on doped graphene to determine the concentrations of pharmacological pollutants in water treatment stations (under development).

A sensor to determine the quality of oils used in the food industry.

3.3.5 Organization of Conferences (2000 ca.)

185. Euro-Par 2014, Portugal: F. Silva, I. Dutra, V.S. Costa [PC Co-Chairs]; L. Lopes [PC Member and Workshops Co-Chair]; P. Ribeiro, R. Rocha [PC Members]
186. SLATE 2014, Portugal: J.P. Leal [PC Co-Chair]; R. Queirós, R. Rocha [PC Members]
187. INAP 2013, Germany: R. Rocha [PC Co-Chair]; V.S. Costa [PC Member]
188. ILP 2013, Brazil: V.S. Costa [PC Co-chair, Track Chair and Proc. Manager]
189. ICLOPS 2013, Turkey: R. Rocha [PC Co-Chair]
190. CBMS 2013, Portugal: A. Augusto, C. Pereira, I. Dutra, L. Antunes, M.E. Correia [Special Track PC Co-Chairs]; R. Correia [PC member]
191. SLATE 2013, Portugal: J.P. Leal, R. Rocha [PC Co-Chairs]
192. Breast Cancer Workshop, Portugal: I. Dutra [Workshop Chair]; P. Ferreira [Co-Organizer]

As PC Members:
1. ICCSM 2014, Oct, UK: M.E. Correia, M. Antunes
2. MPP 2014, Oct, France: I. Dutra, V.S. Costa
3. BRACIS/ENIAC 2014, Oct, Brazil: I. Dutra, V.S. Costa
4. WSCAD 2014, Oct, Brazil: F. Silva, I. Dutra, V.S. Costa
5. SUM 2014, Sep, UK: V.S. Costa
6. ECML PKDD 2014, Sep, France: I. Dutra, V.S. Costa
7. ILP 2014, Sep, France: I. Dutra, N. Fonseca, V.S. Costa
8. StaRAI 2014, Jul, Canada: V.S. Costa
10. ICLP 2014, Jul, Austria: V.S. Costa
11. PLP 2014, Jul, Austria: V.S. Costa
12. CBMS 2014, May, USA: V.S. Costa
13. WSCAD 2013, Oct, Brazil: F. Silva, I. Dutra, V.S. Costa
14. KDIR-SNAM 2013, Sep, Portugal: P. Ribeiro
15. ECML PKDD 2013, Sep, Czech Republic: I. Dutra, V.S. Costa
17. PPDP 2013, Sep, Spain: V.S. Costa
18. EPIA 2013, Sep, Portugal: I. Dutra, V.S. Costa
19. INForum 2013, Sep, Portugal: L. Lopes, V.S. Costa
20. WLPE 2013, Aug, Turkey: V.S. Costa
21. ICLP 2013, Aug, Turkey: R. Rocha
22. FSKD 2013: Jul, China: F. Silva
23. StaRAI 2013, Jul, USA: V.S. Costa
24. AAAI-13, Jul, USA: V.S. Costa
25. PADL 2013, Jan, Italy: V.S. Costa

3.3.6 Industry contract research (2000 ca.)

Security, Access Control and Auditability of Information Systems
Cooperation with the Central Services of the University of Porto in: deployment of the University of Porto Public Key Infrastructure (PKI) supported by smart-cards, de-materialization of course grades reported by faculty (with electronic signatures), and advise the University on the acquisition of a large hardware secure module.

3.3.7 Internationalization (2000 ca.)
Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

Members of CRACS maintain active international collaborations that resulted in 24 joint papers in 2013-2014. Here are some of those collaborations:

LANGUAGES AND DISTRIBUTED COMPUTING
Middleware for Distributed Systems: Priya Narasimhan, CMU (USA)
Logic Programming and Tabling: T. Swift, Johns Hopkins Univ. (USA); Taisuke Sato, Tokyo IT (Japan); Jan Wielemaker, Univ. Amsterdam (The Netherlands)
Probabilistic Prolog & ILP: Angelika Kimmig, Luc de Raedt, Bart Demoen, Hendrik Blockeel, Tom Schrijvers, Jesse Davis and Gerda Janssens, K. U. Leuven (Belgium)
Coinductive Logic Programming, G. Gupta, Univ. Texas @ Dallas (USA)
Programming Language Symbiosis, University Catholique of Louvain-La-Neuve (Belgium).
Parallel Programming: K. Pingali, Univ. Texas @ Austin (USA)
Distributed Programming of Large Ensembles: F. Pfenning, Seth Goldstein, M. Ashley-Rollman, Carnegie Mellon (USA)

SECURITY AND PRIVACY
Information security: Chris Mitchell and Jason Crampton, Univ. London (UK)
Computational complexity: L. Fortnow, Georgia Tech (USA)

KNOWLEDGE IN A WORLD OF DATA
e-Health: David Page, Jude Shavlik and Elizabeth Burnside, Univ. Wisconsin, Madison (USA)
Complex Networks: Luis-Francisco Revilla, UT@Austin, (USA), Marcus Kaiser, Univ. Newcastle (UK), S. Parthasarathy, Ohio State U. (USA)

3.3.8 Other national publications (6000 ca.)

Books (2):
194. R Queirós, Android - Introdução ao Desenvolvimento de Aplicações, FCA - Editora de Informática, Lda., Apr 2013

In National Conferences (3):
196. PM Ferreira, TTV Vinhoza, A Castro, F Mourato, T Tavares, S Mattos, I Dutra and M Coimbra, Knowledge on Heart Condition of Children based on Demographic and Physiological Features, in 19th Portuguese Conference on Pattern Recognition (RecPad 2013), Lisbon, November 2013
197. A Afonso, MJ Antunes and FM Pinto, Validação remota de aplicações de informática forense com recurso a dongles por USB/IP, in 13ª Conferência sobre Redes de Computadores (CRC 2013), Leiria, pp.131–133, November 2013

3.3.9 Government/Organization contract research (2000 ca.)
Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

Members of CRACS have served as consultants for the Portuguese Ministry of Health, Portuguese National Security Agency, and Portuguese Data Protection Commission on issues related with information security and data privacy.
CRACS members are collaborating with INCM on developing innovative solutions for secure identity cards and authentication.
### 3.1 Group Description - ROBIS

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>ROBOTICS AND INTELLIGENT SYSTEMS</th>
</tr>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>António Paulo Gomes Mendes Moreira</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
</tr>
</tbody>
</table>
3.2 Objectives & Achievements - ROBIS

3.2.1 Objectives (4000 ca.)

FOREWORD
The Coordinators of this Unit during 2013 and 2014 were Prof. António Paulo Moreira and Eduardo Silva.

OBJECTIVES
The main goal of the Unit ROBIS is the development of innovative robotic solutions and intelligent systems for different application areas where standard platforms are not optimal. Research activities address not only relevant problems in robotics but also application areas where technologies used in robotics play an important role, like control, automation, simulation, modeling, intelligent systems, etc.


The Unit’s activity is grounded in research in the following scientific domains:
Mobile Robotics: Robotic platform architectures; Control of mobile platforms; Smart and Lean AGVs for logistics.
Marine Robotics: Design of surface and underwater autonomous vehicles; underwater positioning and navigation, multiple platform systems, supervision of autonomous platforms, robotic based environment monitoring.

Cooperative robotics: Warehouses and Logistics applications.
Industrial Manipulators: Rapid teaching and programming interfaces; Hyper-flexible cells; Co-Worker scenarios; Mobile manipulators;
Intelligent sensors: Smart sensors and image processing; Applications in robotics and automation; adaptive sampling strategies in environment monitoring.

Intelligent control and simulation: control algorithms for complex dynamics systems. Simulation applications for complex dynamic electro/mechanical systems

Intelligent systems and technologies in precision agriculture applications involves several competences of ROBIS, directed to the system development integrating sensors, actuators, signal communication, intelligent decision making, management and control.

The ROBIS UNIT is engaged in discovering and developing fundamental scientific principles and practices, such as perception, control and planning, which are applicable to intelligent robot systems and other complex dynamic systems. In addition, it is the goal of this group to facilitate technology transfer of its research results to yield solutions to real world problems for a wide range of application domains, namely, robots that navigate through complex indoor and outdoor spaces and advanced flexible manufacturing support systems.

3.2.2 Main Achievements (4000 ca)


FOCUS - Advances in FOestry Control and AUtomation Systems in Europe; 7th Framework Programme for Research; Funding Scheme : SME-targeted collaborative projects: advancing forestry control and automation through the development of an integrated technological solution that combines predictive control with processing and planning processes.
STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies: holistic approach by partnering with experts in each necessary key fields, thus building on previous R&D to develop a fleet of autonomous and mobile industrial robots with different sensory, planning and physical capabilities for jointly solving three logistic and handling tasks: De-palletizing, Bin-Picking and Kitting.

CLARISSA - Cooperative Dual-Arm Robot for Structural Steel fFabrication; 7th Framework Programme for Research; Funding Scheme SMERobotics: path planning for dual arm robotic welding.

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7: unmanned SAR technologies for detecting, locating and rescuing humans.

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7: new tool for collecting real-time information in operational scenarios, capable of improving the effectiveness of the EU border monitoring.

QREN - TURTLE – Autonomous Support System for SubSea Operations: robotic ascend and descent energy efficient technologies to be incorporated in robotic vehicles used for dual-use (civil and military).

SCAN – Aquaculture Calibration System- aims to develop a robotic system for biomass and calibration of Pleuronectiformes species in underwater aquaculture tanks. The system works completely autonomous and its partially submerse, being the first non-intrusive and without fish injuries. It can be adjust dynamically and is built using laser and computer vision techniques to obtain underwater perception capabilities.

FCT – RobArq - Robotic Technologies for Non-Standard Design and Construction in Architecture: robotic fabrication of complex geometries and variable customized assemblies employing Portuguese materials (e.g. cork, ceramics, wood);

FCT – OCHERA - Optimal Control: Health, Energy and Robotics Applications: analyze, simulate and solve numerically various problems modeling situations in areas as different as health, energy and robotics.

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts; Research Line 4 – Cooperation and perception for augmented autonomy: application of new concepts of autonomous systems (robots).

Produtech – Systems and applications for mobile and flexible robotics, organized in three activities.

Rapid teaching and programming of industrial manipulators. The robotic system is able to acquire this programming by rapid learning. This learning system is based on Sincrovision System. Allows a non-expert operator can teach the handler by demonstration.

Robotic automation is usually related to rigid processes. Based on new sensors, actuators and its integration, the development of low cost industrial applications that provide automatic detection and adjustment of objects are the main topics for this activity.

Technologies for mobile robotics, aims the develop modules that can be incorporated into existing robotic systems on the market (eg AGVs), in order to significantly increase their potential for use into new areas in the industry.

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

3.3 Productivity - ROBIS

3.3.1 Publications in peer review Journals (6000 ca.)

3.3.2 Other International publications (6000 ca.)

3.3.3 Ph. D. thesis completed (3000 ca.)

198. Miguel Armando Miguel Pinto, SLAM for 3D map building to be used in a matching locatization algorithm, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de
Engenharia da Universidade do Porto. (Orientador em co-orientação com o Prof. Aníbal Matos – Departamento de Engenharia Electrotécnica e de Computadores - FEUP), concluída em Janeiro de 2013

199.Marcelo Roberto Petry, A Vision-based Approach Towards Robust Localization for Intelligent Wheelchairs, Programa Doutoral em Engenharia Informática, FEUP. (Orientador em co-orientação com o Prof. Luís Paulo Reis – Departamento de Engenharia Informática - FEUP ), concluída em Setembro de 2013


203.Luís André Freitas da Rocha, Programação de Robôs Industriais em Células Robotizadas Flexíveis, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação do Prof. Vitor Manuel Ferreira dos Santos, Departamento de Engenharia Mecânica da Universidade de Aveiro, concluída em Abril de 2014


3.3.4 Patents/prototypes (2000 ca.)

Prototypes
1-TIGRE – An Autonomous Ground Robot for Outdoor Exploration
2-Hex- cooperate field robot
3-PRODUTECH - “Sincrovision” marker for programming by demonstration
4-REDi - Robô Didactic Educational robot
5-RobArq - Cable Robot para operações de pick and place
6-GroundTruth System for Underwater Benchmarking
7-Turtle- Deep sea Observer
8-Swift -Small Waterjet intelligent Flexible Transport System
9- Robotic capsule for rescue - prototype developed under the project FP7 ICARUS.
7-PRODUTECH – Robotic adaptive system for automatic shoes picking
8-PRODUTECH – AGV prototype for localization algorithms tests

3.3.5 Organization of Conferences (2000 ca.)
ROBÔTICA 2014 – 14º Festival Nacional de Robótica, que decorreu em Espinho, Portugal, de 19 a 21 de Maio de 2014.

3.3.6 Industry contract research (2000 ca.)
The Unit ROBIS has a very strong link with industry, regularly collaborating with technology suppliers for industry, on the design and development of new products they put on the market. For industrial companies the group supplies consulting services on innovation and industrial management. For industrial companies, the group also offers RTD services to meet specific requirements that cannot be answered by available commercial solutions. This section refers only to national contracts.
Contract research with industry referred to in the sections Internationalization and Government/Organization contracts, where projects with industry funded by QREN are listed.

Direct contract with industry
SCAN – Aquaculture Calibration System- aims to develop a robotic system for biomass and calibration of Pleuronectiformes species in underwater aquaculture tanks. The system works completely autonomous and its partially submerse, being the first non-intrusive and without fish injuries. It can be adjust dynamically and is built using laser and computer vision techniques to obtain underwater perception capabilities.
Consultancy
“Low cost ASV viability study”, 2014 for Marine Instruments, Vigo, Spain

3.3.7 Internationalization (2000 ca.)
Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

Joint Research
I3S, University of Nice, France: Information theory, adaptive sampling
University of Dundee, U.K.: Fluid mechanics
Georgia Institute of Technology, U.S.A.: Hydrodynamic dispersion models

Universidade Federal de Juiz de Fora: Mobile Robotics, Control

PhD student in Carnegie Mellon University, U.S.A.: cooperative robotics (CMU-Portugal program)

Research project (FCT) with Royal Institute of Technology, Stockholm

Co-supervision of PhD and student at Federal University of Juiz de Fora, Brasil: Mobile robotics

European Projects


Partners: Asociación de Investigación Metalúrgica del Noroeste (AIMEN), Spain; AALBORG UNIVERSITET (AAU), Denmark; ROBOTNIK AUTOMATION SLL (ROBOTNIK), Spain; C.A.T. Progetti srl (CAT), Italy; ATEIN NAVAL, S.A. (ATENASA), Spain.

FOCUS - Advances in FOestry Control and AUtoration Systems in Europe; 7th Framework Programme for Research;

Partners: Simosol Oy, SME, Finland; Bern University of Applied Sciences, RTD, Switzerland; Research Studios Austria FG – Studio iSPACE, RTD, Austria; Holzcluster Steiermark GmbH, RTD, Austria; University of Leuven, RTD, Belgium; VTT Technical Research Centre of Finland, RTD, Finland; HSM, SME, Germany; MHG Systems, SME, Finland; Kanton Luzern, SME, Switzerland.

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies.

Partners: AALBORG UNIVERSITET (AAU), Denmark; PSA - Peugeot Citroën Automobiles S.A. , France; BA Systèmes SAS, France; ALU-FR - Albert-Ludwigs-Universität Freiburg, Germany; UBO - Rheinische Friedrich-Wilhelms-Universität Bonn, Germany; UEDIN - The University of Edinburgh, United Kingdom.

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7: unmanned SAR technologies for detecting, locating and rescuing humans.

Partners: ECOLE ROYALE MILITAIRE - KONINKLIJE MILITAIRE SCHOOL (Belgium); SPACE APPLICATIONS SERVICES NV (Belgium); ESTUDIOS GIS S.L. (Spain); Aerospace Technology Centre (ASCAMM Foundation) (Spain); The Fraunhofer Institute for Reliability and Microintegration IZM (Germany); INSTYTUT MASZYN MATEMATYCZNYCH (Poland); JMDTHEQUE SARL (France); TECHNISCHE UNIVERSITAET WIEN (Austria); INTEGRASYS, S.A. (Spain); Skybotix AG (Switzerland); QUOBIS NETWORKS SL (Spain); INESC PORTO - INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES DO PORTO (Portugal); UNIVERSITE DE NEUCHATEL (Switzerland); Eidgenössische Technische Hochschule Zürich (Switzerland); ATOS SPAIN SA (Spain); TECHNISCHE UNIVERSITAET KAIERSLAUTERN (Germany); NATO Centre for Maritime Research and Experimentation (Italy); CALZONI SRL (Italy); METALLIANCIE SA (France); ESRI PORTUGAL - SISTEMAS E INFORMACAO GEOGRAFICA SA (Portugal); SPACETEC PARTNERS SPRL (Belgium); ESCOLA NAVAL (Portugal); BELGIAN FIRST AID AND SUPPORT TEAM (Belgium); ECOLE POLITECHNIQUE FEDERALE DE LAUSANNE (Switzerland);

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7: new tool for collecting real-time information in operational scenarios, capable of improving the effectiveness of the EU border monitoring.

Partners: BMT GROUP LIMITED, United Kingdom, METASENSING BV (Netherlands) Xenics nv (Belgium), QUEEN MARY UNIVERSITY OF LONDON (United Kingdom), FUNDACION TECNALIA RESEARCH & INNOVATION (Spain), INESC PORTO • INSTITUTO DE ENGENHARIA DE SISTEMAS E COMPUTADORES DO PORTO (Portugal), TECHNICAL UNIVERSITY OF CRETE (Greece), Ministério da Defesa Nacional (Portugal), "SPECIM, SPECTRAL IMAGING OY" (Finland), ALENIA AERMACCHI SPA (Italy), "TTI NORTE, S.L." (Spain), CENTER FOR SECURITY STUDIES (Greece), MARLO AS (Norway), Vitrociset spa (Italy), "NATIONAL CENTER FOR SCIENTIFIC RESEARCH
International papers in cooperation with foreign institutions:


3.3.8 Other national publications (6000 ca.)

3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

National programs – FCT: 2; QREN: 3; CONTRACTS: 1;
International programs - FP7:6
AUTOCLASS PROJECT - Automatic Classification and Quality Control for Car Tyres; Research Affiliate: CONTINENTAL – MABOR
PRODUTECH PTP – PPS4 - SISTEMAS E APLICAÇÕES PERIFÉRICAS PARA A ROBOTIZAÇÃO FLEXÍVEL E MÓVEL, QREN – Sistema de Incentivos à Investigaçao e desenvolvimento Tecnológico - Projectos Mobilizadores
TURTLE – Autonomous Support System for SubSea Operations.

FOCUS - Advances in FOestry Control and AUtomation Systems in Europe; 7th Framework Programme for Research; Funding Scheme,

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme: ICT – Information and communication technologies.

CLARiSSA - Cooperative Dual-Arm Robot for Structural Steel fAb0rication; 7th Framework Programme for Research; Funding Scheme SMERobotics;

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7;

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7;

SCAN – Aquaculture Calibration System- aims to develop an autonomous robot system for calibration and measuring biomass in fish production ponds of high added value.

FCT – RobArq - Robotic Technologies for Non-Standard Design and Construction in Architecture: robotic fabrication of complex geometries and variable customized assemblies employing Portuguese materials (e.g. cork, ceramics, wood);

FCT – OCHERA - Optimal Control: Health, Energy and Robotics Applications: analyze, simulate and solve numerically various problems modeling situations in areas as different as health, energy and robotics.
3.1 Group Description – HASLAB

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>HIGH ASSURANCE SOFTWARE LABORATORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Jorge Miguel de Matos Sousa Pinto</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
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</tbody>
</table>

3.2 Objectives & Achievements – HASLAB

3.2.1 Objectives (4000 ca.)

FOREWORD

The investigation of HASLab - High-Assurance Software Laboratory is focused on the design and development of software for critical systems, where a failure, either by surrounding factors, human error, or even attacks by hostile entities, can have catastrophic consequences.

Fit into this concept the essential services to actual society, in particular, the basic infrastructure, transport, health, communications, public administration and, in general, the service networks. These systems are controlled by computer programs whose correct operation, continued and safe is to ensure.

The coordinator of this unit during 2014 was Professor Rui Carlos Mendes de Oliveira.

OBJECTIVES

To achieve software reliability, the HASLab realizes research on three pillars of Information Technology: Software Engineering, the Distributed Systems and Cryptography and Information Security.

Software Engineering

With the ultimate goal of raising software engineering to the standards of other traditional engineering disciplines, the HASLab conducts research in methods, techniques and tools crucial for trustworthy software development. Our research covers all phases of the software development process, ranging from the requirements analysis and formal architecture and interface design, to the validation of the implemented solutions via advanced testing and code verification techniques.

Distributed Systems

In order to fight the poor performance, the occurrence of failures and the variability of the software system to be built, HASLab focus its research on reliable and scalable solutions for data management in cloud computing, scientific data environments and, also the dissemination of data and aggregation in distributed systems. The activity of HASLab aims to improve the reliability and criticality of these software components exploring properties inherent to the distribution and replication of computer systems.

Cryptography and Information Security

The control of access to information, of its integrity and authenticity are crucial aspects in the development of software applications for critical systems. The HASLab works to minimize the vulnerability to hostile attacks of...
each software component in modern computer systems, by providing theoretical specifications and practical implementations of cryptographic schemes and protocols whose security properties are formally proven.

### 3.2.2 Main Achievements (4000 ca)

The HASLab steadily produces fundamental and applied research that satisfies the quality standards of the top rated journal and conferences (rated A*, the best of the best in the popular computer science CORE venue ranking) in each of its areas of research. In 2014 we have published 30 journal articles and 75 full papers in international conferences rated at least B in the CORE ranking.

**Major outcomes of our research in 2014 were:**

- A detailed analysis and classification of Storage Deduplication Systems that has been published in the ACM Computer Surveys journal, followed by the design and implementation of a novel and highly efficient dependable and fully-decentralized deduplication system for cloud computing infrastructures.
- A new version of our open source framework to help validate, query, and refactor spreadsheets using model-driven software engineering principles. In 2014 this work was published in the IEEE Transactions on Software Engineering, the top journal in this research area, and several other highly ranked journals and conferences.
- An open source implementation of a domain-specific compiler for cryptography has been released and presented at Principles of Security and Trust 2014. The foundations of a verification tool for the same language have been published in Science of Computer Programming. In parallel, an optimisation of a classical construction of block-ciphers that provides stronger security under tampering has been proposed in Fast Software Encryption 2014.

**Projects**

- 2 ongoing EC-funded projects
- 1 EC-funded project kicked-off in 2014
- 1 IA-funded project kicked-off in 2014
- 5 ongoing FCT-funded projects
- 3 FCT-funded projects completed in 2014
- 1 IA-funded projects competed in 2014
- 4 ongoing CCDR-N (QREN) funded projects
- 1 ongoing IA funded project

**Publications**

- 30 papers in international peer-reviewed journals
- 75 papers in international conferences with peer reviewing
- 1 paper in national conference with peer reviewing
- 3 book chapters
- 2 PhD thesis
- 18 MsC thesis
- 4 others publications
Awards

HASlab postdoc researcher Alexandre Madeira was honored with the 2013 IBM Scientific Award.

Three best paper awards (SBCARS'2014, DX'2014 (2)).

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

3.3 Productivity - HASLAB

3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 30

The complete list can be consulted in: http://haslab.uminho.pt


5. BAQUERO, Carlos; D; H; D; J; D, L, Link Community Detection Using Generative Model and Nonnegative Matrix Factorization. PloS ONE 9 (1) (2014)


11. CAMPOS, José Creissac; GOMES, Tiago; ABADE, Tiago; HARRISON, Michael D.; SILVA, José Luís, A Virtual Environment Based Serious Game to Support Health Education. ICST Tran. Ambient Systems 3 (2014)


18. FERREIRA, João F.; GHERGHINA, Cristian; HE, Guanhua; QIN, Shengchao; CHIN, Wei- Ngan, Automated Verification of the FreeRTOS Scheduler in Hip/ Sleek. STTT 16: 381-397 (2014)


20. MADEIRA, Alexandre; MARTINS, Manuel; BARBOSA, Luis Soares, The Role of Logical Interpretations in Program Development. Logic in Computer Science 10 (1) (2014)

21. MADEIRA, Alexandre; MARTINS, Manuel; NEVES, Renato; BARBOSA, Luis Soares, A Dynamic Logic for Every Season. Lecture Notes in Computer Science 10 (2014)


23. OLIVEIRA, José Nuno; MACEDO, Hugo, A Linear Algebra Approach to OLAP. Formal Aspects of Computing (2014)


30. SILVA, Alexandra; BONCHI, Filippo; BONSANGUE, Marcelo M.; HANSEN, Helle Hvid; PANANGAEN, Prakash; RUTTEN, Jan JMM, Algebra- Coalgebra Duality in Brzozowski’s Minimization Algorithm. ACM Transactions on Computational Logic 15 (1) (2014)

3.3.2 Other International publications (6000 ca.)

Total number of publications: 75

The complete list can be consulted in: http://haslab.uminho.pt


4. ABREU, Rui; CARDOSO, Nuno, Enhancing Reasoning Approaches to Diagnose Functional and Non-Functional Errors. 25th International Workshop on Principles of Diagnosis (DX) (2014)

5. ABREU, Rui; HOFER, Birgit; PEREZ, Alexandre; WOTAWA, Franz, Generation of Relevant Spreadsheet Repair Candidates. ECAI: 1027-1028 (2014)


7. ABREU, Rui; PEREZ, Alexandre, A Diagnosis- Based Approach to Software Comprehension. ICPC: 37-47 (2014)

8. ABREU, Rui; MEDEIROS, José Carlos; ARCURI, Andrea; FRASER, Gordon, Continuous test Generation: Enhancing Continuous Integration With Automated Test Generation. ASE: 55-66 (2014)


10. ALMEIDA, José Bacelar; BARBOSA, Manuel; BARTHE, Gilles; DAVY, Guillaume; DUPRESSOIR, François; GRÉGOIRE, Benjamin; STRUB, Pierre- Yves, Verified Implementations for Secure and Verifiable Computation. IACR Cryptology ePrint Archive: 456 (2014)


13. BAQUERO, Carlos; SHOKER, Ali; ALMEIDA, Paulo Sérpio, Making Operation- Based CRDTs Operation- Based. DAIS: 126-140 (2014)


15. BAQUERO, Carlos; ALMEIDA, Paulo Sérpio; GONÇALVES, Ricardo; PREGUIÇA, Nuno; FONTE, Victor, Scalable ans Accurate Causality Tracking for Eventually Consistent Stores. DAIS: 67-81 (2014)


17. BARBOSA, Luis Soares; OLIVEIRA, Nuno; RODRIGUES, Flávia, ReCooPLa: a DSL for Coordination- Based Reconfiguration of Software Architectures. SLATE: 61-76 (2014)


21. BARBOSA, Luis Soares; MARTINHO, MH., Mathematical literacy as a condition for sustainable development. Lecture Notes in Computer Science: 64-77 (2014)

22. BARBOSA, Manuel; CASTRO, David; SILVA, Paulo F., Compiling CAO: From Cryptographic Specifications to C Implementations. POST: 240- 244 (2014)

23. BARBOSA, Manuel; FARSHIM, Pooya, The Related- Key Analysis of Feistel Constructions. IACR Cryptology ePrint Archive: 93 (2014)
24. CAMPOS, José Creissac; SILVA, Carlos Eduardo, Characterizing the Control Logic of Web Applications User Interfaces. ICCSA (6): 263-276 (2014)
25. CAMPOS, Filipe; MATOS, Miguel; PEREIRA, José Orlando; RUA, David, A peer-to-peer servisse architecture for the SmartGrid. P2P: 1-5 (2014)
29. CAMPOS, José Creissac; GOMES, Tiago; ABADE, Tiago; SILVA, José Luís, Design and Evaluation of Smart Library Using the APEX Framework. HCI (21): 307-318 (2014)
30. CAMPOS, José Creissac; ABADE, Tiago; GOMES, Tiago; HARRISON, Michael D.; SILVA, José Luís, Rapid Development of First Person Serious Games Using the APEX Platform: The Asthma Game. SAC: 169-174 (2014)
33. CASAL, J.; CLEDOU, G, Understanding students' mobility habits towards the implementation of an adaptive ubiquitous platform. ACM International Conference Proceeding Series: 67-72 (2014)
34. CUNHA, Alcino; SOUSA, NR; PACHECO, Hugo; MACEDE, Nuno, Bidirectional spreadsheet formulas. VL/ HCC – IEEE Symposium on Visual Language and Human- Centric Computing, Melbourne, Australia (2014)
35. CUNHA, Alcino, Bounded Model Checking of Temporal Formulas with Alloy. ABZ: 303-308 (2014)
37. CUNHA, Alcino; ANJORIN, Anthony; GIESE, Holger; HERMANN, Frank; RENSINK, Arend; SCHURR, Andy, BenchmarX. EDBT/ICDT Workshops, Athens, Greece: 82-8 (2014)
38. CUNHA, Alcino; MACEDE, Nuno; GUIMARÃES, Tiago, Target Oriented Relational Model Finding. FASE, Grenoble, France: 17-31 (2014)
39. CUNHA, Jácome; FERNANDES, João Paulo; PEREIRA, Rui; SARAIVA, João, Graphical Querying of Model- driven Spreadsheets. HCI 12: 419-430 (2014)
40. CUNHA, Jácome; COUTO, Marco; CARÇÃO, Tiago; FERNANDES, João Paulo; SARAIVA, João, Detecting Anomalous Energy Consumption in Android Applications. SBLP: 74-91 (2014)
41. CUNHA, Jácome; FERNANDES, João Paulo; MENDES, Jorge; PEREIRA, Rui; SARAIVA, João, Design and Implementation of Queries for Model-Driven Spreadsheets. CEFP – Central European Functional Programming School (2014)
42. CUNHA, Jácome; FERNANDES, João Paulo; SARAIVA, João, Spreadsheet Engineering. CEFP – Central European Functional Programming School (2014)
43. CUNHA, Jácome; FERNANDES, João Paulo; MENDES, Jorge; PEREIRA, Rui; SARAIVA, João, ES- SQL: Visually Querying Spreadsheets. Proceedings of the Symposium on Visual Languages and Human- Centric Computing (VL/ HCC) (2014)
44. CUNHA, Jácome; FERNANDES, João Paulo; MENDES, Jorge; PEREIRA, Rui; SARAIVA, João, Embedding Model-driven Spreadsheet Queries in Spreadsheet Systems. Proceedings of the Symposium on Visual Languages and Human-Centric Computing (VL/HCC) (2014)

45. CUNHA, Jácome; FERNANDES, João Paulo; MENDES, Jorge; PEREIRA, Rui; SARAIVA, João, MDSheet Model-Driven Spreadsheet. 1st Workshop on Software Engineering Methods in Spreadsheets (SEMS) (2014)

46. CUNHA, Jácome; MARTINS, Pedro; FERNANDES, João Paulo; PEREIRA, Rui; SARAIVA, João, Refactoring Meets Model-Driven Spreadsheets Evolution. Proceedings of the 9th International Conference on Quality in Model Driven Engineering (QUATIC) (2014)


48. CRUZ, Francisco; MAIA, Francisco; OLIVEIRA, Rui; VILAÇA, Ricardo, Workload-aware Table Splitting for NoSQL. SAC: 399- 404 (2014)


52. LOURENÇO, Cláudio Belo; FRADE, Maria João; PINTO, Jorge Sousa, A Bounded Model Checker for SPARK Programs. ATVA: 24-30 (2014)

53. MADEIRA, Alexandre; BARBOSA, Luis Soares; NEVES, Renato; MARTINS, Manuel, Introducing Hierarchical Hybrid Logic. Proceedings of AML – 10th International Conference on Advances in Modal Logic (2014)


55. MAIA, Francisco; PASQUET, Mathieu; RIVIÈRE, Etienne, SCHIAVONI, Valerio, Autonomous Multi-dimensional Slicing for Large-Scale Distributed Systems. DAIS: 141- 155 (2014)

56. MAIA, Francisco; MATOS, Miguel; VILAÇA, Ricardo; PEREIRA, José Orlando; OLIVEIRA, Rui; RIVIÈRE, Etienne, Dataflasks: Epidemic Store for Massive Scale Systems. 33rd IEEE International Symposium on Reliable Distributed Systems (SRDS) (2014)


60. MARTINS, Pedro; CARÇAO, Tiago, A Visual DSL for the Certification of Open Source Software. 14th of ICCSA (2014)


62. OLIVEIRA, Rui; COELHO, Fábio; CRUZ, Francisco; VILAÇA, Ricardo; PEREIRA, José Orlando, Ph1: A Transactional Middleware for NoSQL. 33rd IEEE International Symposium on Reliable Distributed Systems (SRDS) (2014)

63. OLIVEIRA, José Nuno, Preparing Relational Algebra for “Just Good Enough” Software. RAMICS 119-138 (2014)
64. PAULO, João; PEREIRA, José, Distributed Exact Deduplication for Primary Storage Infrastructures. DAIS: 52-66 (2014)


67. PINTO, Jorge Sousa; CARVALHO, Nuno; SOUSA, Cristiano da Silva; TOMB, Aaron, Formal Verification of kLIBC with the WP Frama-C Pug-in. NASA Formal Methods: 343-358 (2014)

68. RIBEIRO, António Nestor; CAMPOS, José Creissac; COUTO, Rui, Application of Ontologies in Identifying Requirements Pattern in Use Cases. 11th International Workshop on Formal Engineering Approaches to Software Components and Architecture (FESCA) (147): 62-76, Grenoble, France (2014)

69. RIBEIRO, António Nestor; CAMPOS, José Creissac; COUTO, Rui, The Modelery: A Collaborative Web Based Repository. 14th International Conference on Computational Science and its Applications (ICCSA) (2014)

70. RIBEIRO, António Nestor; CAMPOS, José Creissac Campos; COUTO, Rui, A Study on the Viability of Formalizing Use Cases. 9th International Conference on the Quality of Information and Communication Technology (QUATIC) (2014)


72. SARAIVA, João; MARTINS, Pedro; FERNANDES, João Paulo; WYK, Eric Van, Generating Attribute Grammar-Based Bidirectional Transformations From Rewrite Rules. PEPM: 63-70 (2014)

73. SILVA, Alexandra; BONCHI, Filippo; MILIUS, Stefan; ZANASI, Fabio, How to Kill Epsilons with a Dagger — A Coalgebraic Take on Systems with Algebraic Label Structure. CMCS: 53-74 (2014)

74. SILVA, Alexandra; GONCHAROV, Sergey; MILIUS, Stefan, Towards a Coalgebraic Chomsky Hierarchy. IFIP TCS: 265-280 (2014)

75. SILVA, Alexandra; OLIVEIRA, Nuno; BARBOSA, Luis Soares, Quantitative Analysis of Reo-Based Service Coordination. SAC: 1247-1254 (2014)

3.3.3 Ph. D. thesis completed (3000 ca.)

1. MACEPO, Nuno Filipe Moreira, A Relational Approach to Bidirectional Transformations (2014)


3.3.4 Patents/prototypes (2000 ca.)

( void )

3.3.5 Organization of Conferences (2000 ca.)

ICEGOV - 8th International Conferences on Theory and Practice of Electronic Governance
HCl Engineering 2014 - Charting the Way towards Methods and Tools for Advanced Interactive Systems
SAC 2014 - Computer Security Track
INForum 2014
COST Summer School on Cryptographic Attacks
Workshop on Middleware for Next Generation Internet Computing (MW4NG)
W-PSDS 2014
First Workshop on Molecular Logic (with U Aveiro, U Chile and INRIA)

3.3.6 Industry contract research (2000 ca.)

Portugal Telecom Inovação – Operation Support Systems as a Service

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

The UNU-EGOV unit is expected to become a full-fledged research institute within two years, fostering collaboration between a number of international research institutions, and high profile international forums and committees. A number of HASLab members have been playing and are expected to keep playing a vital role in the planning and operation of this Operational Unit, contributing in this way to further internationalisation of HASlab theoretical and applied research.

European projects:
CoherentPaaS – A Coherent and Rich PaaS with a Common Programming Model (FP7 611068)
PRACTICE: Privacy-enhanced and Secure Computations on Potentially Malicious Clouds (FP7 609611)
LeanBigData - Ultra-Scalable and Ultra-Efficient Integrated and Visual Big Data Analytics (FP7 619606)

Other projects:
European Networks:
European Network of Excellence in Cryptology II ICT-2007-216676 (associated membership)

International contracts:
Verificação e Validação de Sistemas Software para Projetos Espaciais [consulting for Instituto de Aeronáutica e Espaço / AEB, 2011-2014]

Working Group memberships:
IFIP Working Group 1.3 on Foundations of System Specification
IFIP working group 2.7 / 13.4 on User Interface Engineering
IFIP Working Group 2.1 on Algorithmic Languages and Calculi
IFIP Working Group 6.1 on Architectures and Protocols for Distributed Systems

Publications in cooperation:
16 journal papers and 26 other papers were published in 2014 in cooperation with authors from foreign institutions.

3.3.8 Other national publications (6000 ca.)

1. CAMPOS, Filipe; MATOS, Miguel, PEREIRA, José Orlando, Coordenação de Serviços Web Heterógeneos Com Tolerância a Faltas. INFORUM (2014)

3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice

Research projects funded by FCT:
APEX - Prototipagem Rápida de Experiência de utilização [2011 – 2014]
FATBIT: Fundamentos, Aplicações e Ferramentas para Transformação Bidireccional [2012 – 2014]
QAIS: Análise quantitativa de sistemas reactivos: fundamentos e algoritmos [2012 – 2015]
Testes de Interfaces gráficas com o utilizador baseado em padrões (PBGT) [2012 – 2015]
Análise e Verificação de Programas Concorrentes Críticos (AVIAAC) [2012 – 2015]
NASONI - Coordenação de Software heterogéneo: fundamentos, métodos e ferramentas [2013 – 2015]

Research projects funded by Agência da Inovação:
PROVA - Platform for Software Verification and Validation [2012 – 2014]
GreenSSCM - Framework de Poupança de Energia para Software Aeroespacial [2013 -2015]

Research projects funded by CCDR- N:
Network Sensing for Critical Systems Monitoring (Best Case - RL3) [2013- 2015]
Smartgrids (Best Case - RL5) [2013 – 2015]
Cooperation and Perception for Augmented Autonomy (Best Case - RL4) [2013- 2015]

Research projects funded by EC:
PRACTICE: Privacy-Preserving Computation in the Cloud [2013- 2016]

Research projects funded by industry:
3.1 Group Description – UGEI

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>UNIDADE DE GESTÃO E ENGENHARIA INDUSTRIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Bernardo Sobrinho Simões de Almada Lobo</td>
</tr>
<tr>
<td>Research Area</td>
<td>Mechanical Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
</tr>
</tbody>
</table>

3.2 Objectives & Achievements – UGEI

3.2.1 Objectives (4000 ca.)

FOREWORD

The on-line form does not maintain fixed the Unit Coordinator names, allowing permanent updating with the effect of changing past reports. The Coordinator of this Unit during 2011 was Prof. José António Sarsfield Cabral.

This Unit is an autonomous Associate Unit of INESC TEC.

OBJECTIVES

UGEI aims to produce problem driven knowledge focusing on three main fields: Service Engineering and Design, Decision Support and Intelligent Systems, and Performance Management and Business Intelligence. UGEI focuses on the areas where engineering, management and social sciences meet, at the cutting edge between theory and practice, around multidisciplinary projects mainly in Health, Retail, Mobility and Manufacturing.

Unit members are encouraged to carry out research projects based upon real-world problems. This application / problem solving attitude - which obviously encompasses the development of innovative theoretical work - is specially valued by the Unit, which has a strong and long lasting connection with both Portuguese and foreign organizations.

Moreover, it aims to establish direct links with renowned foreign research groups and to promote the dissemination of research in leading international journals and conferences.

The UGEI research objectives encompass the following dimensions:

Service Engineering and Design

a) Design Complex Service Systems with multiple stakeholders (e.g. Health)

b) Service Design for sustainability: developing new service design methods that explicitly incorporate sustainability concerns into the design of new services

c) Design for the Customer Experience: Designing services and products service systems for the customers experience, involving a human-centered design approach that feeds the design process with customer experience input.

d) Human-machine interaction: Understanding the influence of pervasive mobile devices, social networks and increasingly dynamic information and payment models on behavior of people; Proposing new frameworks, models and systems for improving quality of interaction and service, both in business and
in social responsibility areas; Identifying medium and long term trends and needs for multidisciplinary research involving ICT.

Decision support and Intelligent Systems

a) Solution Approaches: Mathematical modeling and programming (combine new stronger models and valid inequalities based on the polyhedral structure of these problems to tighten linear relaxations and speed up the solution process); Robust and efficient optimization algorithms to produce resilient solutions, adaptable to frequent changes in the operating conditions; Matheuristics: Exploiting mathematical programming techniques in (meta)heuristic frameworks; Simulation-based Optimization: integrating optimization techniques into simulation analysis

b) Intelligent Systems and Agent-Based Modeling and Simulation: Design and development of systems that integrate massive (often real time) data, optimization tools and visualization techniques to support decisions in tactical and operational levels.

c) Agent-Based Modeling and Simulation (ABMS): ABMS approach to model business elements in supply chains. Developing each agent as an independent microscopic simulator, and Designing a framework to integrate independent agents. The framework provides network communication and language support for exchanging business messages using XML.

Performance Management and Business Intelligence

a) Performance assessments: Performance assessments exploring Data Envelopment Analysis, econometric and statistical techniques; Developing new efficiency and productivity measurement models, that can identify the drivers of good performance in companies; Enhancing Organizational Performance in different sectors (e.g. Health, Construction industry) and Promoting Robust benchmarking; Exploring new methodologies to assess and improve quality of life, livability and attractiveness of urban areas, as they are essential to the development of countries given their role in the attractiveness of human capital.

b) Data Mining, Data Analysis and Statistical methods: Data Mining applied to companies management. In order to address the needs of business to extract knowledge from data that could be leveraged to increase revenues, new analytical techniques are required. The challenges placed by large data sets lead to a redefinition of the process of data analysis to find patterns and relationships between data elements in large and noisy data sets.

c) Demand Planning: Predicting the future as accurately as possible given all the information available: time series (exponential smoothing, Box-Jenkins) and explanatory models (neural networks).

3.2.2 Main Achievements (4000 ca)

In 2011, twelve papers related with the main research topics of UGEI have been published in international peer-review leading journals (10 of have ISI) and four ISI Proceedings. The number (twelve) of published proceedings of important international conferences is of worth note. Moreover, three special issues in international peer-review journals have been edited by members of UGEI, namely in the International Journal of Production Research, the Journal of Service Design and the Managing Service Quality Journal.

The members of UGEI Unit also contributed with two book chapters and three proceedings in national conferences. They were invited to review over a dozen of papers in seven different top journals.

They were members of the scientific and programme committee of over 10 international conferences and members of the organizing committee of 1 international conferences.
Members of UGEI unit were enrolled in seven industry contract research projects. Throughout 2011, researchers of UGEI have also coordinated and participated in sixteen (16) research projects funded by QREN, FCT, ADI and European Commission.

The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

### 3.3 Productivity - UGEI

#### 3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 12

List can be consulted in: http://profile.inescporto.pt


#### 3.3.2 Other International publications (6000 ca.)

Total number of publications: 38
The complete list can be consulted in: http://profile.inescporto.pt

Due to the limited space made available in this form, only selected papers are listed.

15. Deisemara Ferreira, Alistair Clark, B. Almada-Lobo, Reinaldo Morabito, Comparação entre duas estratégias de eliminação de subtours para um modelo de dimensionamento e sequenciamento de lotes baseado no modelo ATSP in Proceedings of XLII SBPO - Simpósio Brasileiro de Pesquisa Operacional, pp.1-10, 2011

3.3.3 Ph. D. thesis completed (3000 ca.)

1. Paulo Teixeira de Morais, Evaluation of Performance of European Cities With the Aim of Increasing Quality of Life, Industrial Engineering and Management Doctoral Program, Supervisors: Ana Camanho e José A. Cabral., 2011
2. Maria Gabriela Beirão dos Santos, Exploring Attitudes in Travel Behaviour, Industrial Engineering and Management Doctoral Program, Supervisors: José A. Cabral., 2011

3.3.4 Patents/prototypes (2000 ca.)
(void)

3.3.5 Organization of Conferences (2000 ca.)

Program Committee of 9th workshop on intelligent techniques for web personalization & recommender systems (ITWP 11) Barcelona, 2011
15º APDIO Congress, Coimbra, 2011.04
Associate-chair INTERACT 2011-13th Conference on Human-Computer Interaction, Lisbon, 2011.09
Steering Committee IWLS’11–International Workshop on lotsizing, Istanbul, Turkey, 2011.08
Chair, IEMS’11-2nd Symposium on Industrial Engineering and Management, Porto, 2011.01
Reviewer Computer Human Interaction CHI Conference 2011, Vancouver,Canada, 2011
Reviewer Services Marketing Track, European Marketing Academy Conference (EMAC), Ljubljana, 2011

Scientific Committee of 14th EWGT Conference “Transportation/Logistics”. Poznan, Poland, 2011.09
13th IEEE Conference on Commerce and Enterprise Computing Luxembourg, 2011.09
TEAR 2011-6th Trends in Enterprise Architecture Research Workshop; in conjunction with the EDOC’2011, 15th International Enterprise Computing Conference, Helsinki, Finland, 2011.08
SoEAAEE’2011–3rd Workshop on Service Oriented Enterprise Architecture for Enterprise Engineering; in conjunction with the EDOC’2011, 15th International Enterprise Computing Conference, Helsinki, 2011.08
JISBD 2011, XVI Jornadas de Ingeniería del Software y Bases de Datos, A Coruña,Espanha, 2011.09
IESS1.1,2nd International Conference on Exploring Services Sciences, Genebra,Switzerland, 2011.02
ICSOB’2011,2nd International Conference on Software Business, Brussels, Belgium, 2011.06
ICSEM’11,2nd International Conference on Services in Emerging Markets, Mumbai, India, 2011.09
FSTI-2011, 1st First International Workshop on Frontiers in Service Transformations and Innovations, Tirana, Albania, 2011.09
CIbSE’11, XIV Conferencia Iberoamericana en Software Engineering, Rio de Janeiro, Brasil, 2011.04
CAISE’11, 23rd Conference on Advanced Information Systems Engineering, London, 2011.06
3.3.6 Industry contract research (2000 ca.)

Analysis of Retail Store Atmospherics for Customers behaviour.
Funded by InovRetail (2011.03.01-2011.12.31); Areas of Science: Performance Management and Business Intelligence; Areas of Technology Transfer: Retail.

Replenishment Algorithms for Wholesale WIPRO RETAIL Framework
Funded by Wipro Retail (2010.05.01-2011.02.28); Area of Science: Decision Support and Intelligent Systems; Area of Technology Transfer: Retail.

Replenishment Algorithms for Wholesale WIPRO RETAIL Framework
Funded by Transdev and CaetanoBus (2007.01.09-2012.03.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Mobility and Manufacturing.

Designing the Mobile Service Experience
Funded by Cardmobil (2008.03.01-2012.03.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Mobility.

Towards the development of communities oriented to services
Funded by Sonae (2008.06.01-2012.12.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Retail.

Designing a sustainable Electronic Health Record: from Service Ecosystem to Information Architecture
Funded by Ministry of Health (2010.09.01-2013.09.01); Area of Science: Service Engineering and Design; Area of Technology Transfer: Health.

Segmented Promotion Monitorization System
Funded by Sonae MC (2010.05.04-2013.07.31); Area of Science: Performance Management and Business Intelligence; Area of Technology Transfer: Retail.

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

8 papers (75% of the total) in international peer-review journals and 8 proceedings in international conferences (50% of the total) with authors from foreign institutions, namely: Imperial College London Northwestern University, University of West of England, University of Vienna, University of São Paulo, Europa-Universitat, Texas State University, University of Canterbury, Technical University of Berlin, Technical University of Darmstadt and Universidade Federal do Triângulo Mineiro.

Visiting Researchers at UGEI
Christian Almeder, Europa-Universität, Frankfurt (Oder), Germany, June 2011
Maristela Oliveira Santos, University of São Paulo, Institute of Mathematics and Computer Sciences, Brazil. January-February 2011
Sophie Parragh, Department of Business Administration, University of Vienna, Austria January - June 2011.
Franklina Toledo, Institute of Mathematics and Computer Sciences, University of São Paulo, Brazil, February – July 2011
Alysson Costa, Institute of Mathematics and Computer Sciences, University of Sào Paulo, Brazil, June – July 2011
3.3.8 Other national publications (6000 ca.)


3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice.

(void)
3.1 Group Description – CISTER

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>CENTRO DE INVESTIGAÇÃO EM SISTEMAS CONFIÁVEIS E DE TEMPO REAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Eduardo Manuel de Médicis Tovar</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC Porto</td>
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</tbody>
</table>

3.2 Objectives & Achievements – CISTER

3.2.1 Objectives (4000 ca.)

This Unit is an autonomous Associate Unit of INESC TEC.

OBJECTIVES

CISTER (Research Centre in Real-Time and Embedded Computing Systems) is a Research Centre based at the School of Engineering (ISEP) of the Polytechnic Institute of Porto (IPP), Portugal and autonomous Associate Unit of INESC TEC. Since it was created, CISTER has grown to become one of the leading European research units in the area, contributing with seminal research works in a number of subjects: real-time communication networks and protocols; wireless sensor networks (WSN); cyber-physical systems (CPS); real-time programming paradigms and operating systems; distributed embedded systems; cooperative computing and QoS-aware applications; scheduling and schedulability analysis (including multiprocessor systems). CISTER was, in 2004 and 2007 awarded the classification of Excellent by FCT evaluation.

Monitoring and controlling the behaviour of embedded computing systems, (systems where computers are part of other systems) is one of the strategic research areas in Europe. This area has an impact in very important sectors such as industrial automation, automotive, aerospace, consumer electronics, communication system or medical systems. Europe is seen as an international outstanding example for many of these are sectors, which is, however, not the case for general-purpose computing systems, which are traditionally dominated by non-European organisations. Embedded computing systems is one of the areas with higher growth in ICT, where > 95% of the current processors are embedded (embedded systems are everywhere: cars, aeroplanes, factories, electrical networks, mobile phones, keys, smart cards, electronic games or PDA’s).

The global market for embedded processors was worth €125 billion in 2014 with future annual growth rates higher than 6% up to 2020 when it is expected to reach € 190 billion. As these computer systems become pervasive and ubiquitous, due to being embedded everywhere, they are also becoming inherently distributed and interconnected. These systems are thus the nervous system of our society, and it is no coincidence that they always appear when a smart environment is put forward. Nevertheless, and being transversal to smart-* topics, these embedded computing systems present their own research challenges which are independent of particular application areas or domains. Furthermore, in the vast majority of its applications, the adequacy of the system depends not only on the logical result of computation, but also on the time at which the results are produced; thus adequacy and performance are very tightly interrelated. This has makes real-time very significant and it is indiscernibly connected to the existing research challenges.

Future research activities will reflect the experience gained in recent years and the key competences of the Research Group, but it will also strategically explore some new, emerging lines of research. These activities will focus on the following themes.
PROGRAMMABILITY

Next generation of Real-Time Embedded Systems will be based on heterogeneous parallel architectures, and will need to consider multiple dimensions of complexity such as performance, energy efficiency, time-criticality, dependability, cost-effectiveness, etc. It is thus necessary to research new paradigms of programming that can increase productivity and robustness, whilst reducing complexity. CISTER has a proven record of impactful work in real-time and embedded programming models, and is working with a special focus on real-time parallel programming, seamless programming of WSN and new approaches for verification.

MODELLING AND ANALYSING THE TEMPORAL BEHAVIOUR

CISTER has an international reputation in the field of real-time scheduling. We are addressing new problems resulting from the integration of distributed, and many-core architectures in today’s platform. CISTER is working on scheduling of parallel tasks in distributed, multi- and many-core platforms, the sharing of resources (memories, communication networks, etc.), the use of dedicated computing accelerators such as GPGPUs, and task-to-processor mapping. Investigated solutions also include probabilistic approaches to provide efficient results where classical analyses yield pessimistic results.

MIXED-CRITICALITIES

Today, industry faces a new challenge with the integration of multiple applications with different levels of criticality in the same system. CISTER is building upon previous results obtained for the problem of mixed-criticality systems in two ARTEMIS projects (CONCERTO and EMC2), and developing scheduling techniques to respect timing constraints of high criticality tasks and to recover from unexpected behaviours. Work is also undergoing on the analysis and design tools that enable a safe integration of applications of different criticalities in the same computing platform, eventually facilitating their certification.

ENERGY-AWARE COMPUTATION

Europe has a strong leadership in energy-aware embedded computing, thus it is not a surprise that low-power is one of the objectives of its research agenda. Now that multi-core platforms are becoming mainstream there is a need to facilitate heterogeneous multi-cores, which perform operations in a low-cost and efficient manner. On the one hand energy consumed in peripherals has become on par with that of cores. On the other hand, this needs to be paired with mechanisms for temporal isolation. CISTER addresses these challenges in a holistic manner, based on a proven track record in the area.

UBIQUITOUS SENSING AND ACTUATION

CISTER has been leading international research in ubiquitous/networked embedded systems, with a special emphasis on quality of service (QoS) in low-power & low-cost wireless networks. We are focused on the QoS properties that make these networks and systems more dependable, functional and scalable. Studying properties such as timeliness, reliability, energy-efficiency and mobility, under stringent application requirements and environmental conditions is one of the areas of this work. The focus is currently on designing efficient, reliable and real-time mechanisms, particularly in the unlicensed and over-populated ISM band.

CO-DESIGN APPROACHES FOR CPS

CISTER has research expertise in relevant fields such as scalable data aggregation, low power and embedded communication, and analysis of temporal behaviour of complex systems. CISTER is well positioned to continue to tackle Cyber-Physical Systems (CPS)-related challenges, namely dealing with the massive increase in sensor data. At CISTER, researchers have adopted innovative co-design approaches to address scalable data aggregation in large-scale CPS, and is currently further exploring these concepts to propose novel distributed algorithms for CPS.

RESOURCE AND QOS MANAGEMENT

The notion of Quality of Service (QoS) contracts and Service Level Agreements (SLA) is essential in order to handle the reliable and safe management of embedded distributed systems resources. Our focus is in the context of guaranteeing that the applications are able to get their desired resources, specified on SLA. Architectures/mechanisms being proposed and/or analysed range from complex distributed systems (e.g. middlewares for the Internet of Things) to resource constrained nodes (e.g. sensor nodes).
3.2.2 Main Achievements (4000 ca)

Calls:
CISTER has successfully participated in the recent ECSEL JU calls and participated in the submission of nine proposals. The proposals are on various CPS-related topics including, smart city infrastructure and applications, safety assurance, security, maintenance and testing. CISTER’s intended research contributions include issues in runtime monitoring, timing, schedulability, verification and testing, communication, security, middleware and various pilot demonstrators. The proposal MANTIS (Management of critical knowledge to support maintenance decision making) was submitted in collaboration with INESC-TEC CESE, and proposal GUARD (Guaranteed Security verification for connected intelligent critical systems) with INESC-TEC HASLab.

In the scope of the European R&D program H2020, in the topic “New ICT-based solutions for energy efficiency”, CISTER participated in the project proposal EnerGAware (Energy Game for Awareness of energy efficiency in social housing communities), which has been selected for a grant.

In 2014, the ARTEMIS projects EMC2 (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) and DEWI (Dependable Embedded Wireless Infrastructure) were initiated. CISTER hosted the general assembly project meetings from P-SOCRATES, DEWI, ENCOURAGE, CarCoDe, with more than 150 participants in total from all over Europe.

Events:
CISTER organized CiWork 2014 that aims to bring together researchers and practitioners from the industry and academia and provide them with a platform to report on recent advances and developments in the newly emerging areas of real-time and embedded technologies, as well as actual and potential applications to industrial systems.

A new 3-month BIC internship program for students of FEUP and ISEP was started. During this time frame, the students contributed to a set of practical challenging multi-disciplinary projects under the supervision of CISTER researchers.

CISTER will host the 12th edition of the highly reputed European Wireless Sensor Network conference (EWSN). Being one of the leading international conferences in this area, EWSN has played a prominent role in the dissemination of innovative research and provides a high quality discussion forum. In 2015 CISTER will also host the 28th GI/ITG International Conference on Architecture of Computing Systems (ARCS’15) in Porto. The ARCS series of conferences is one of the most important and oldest scientific events for computer architecture research in Europe. The focus of the 2015 conference will be on reconciling, in mixed-critical systems, the parallel execution paradigm borrowed typically from the high-performance computing world and the time-predictability requirement peculiar to the embedded computing market segment.

CISTER was visited by representatives of Embraer, one of the world’s leading aircraft manufacturers with its headquarters in Brazil. CISTER seized the opportunity offered by this visit to organize a workshop day during which CISTER gave an overview of the projects and international efforts in which the team is involved.

Smart-Cities:
Within the objectives of the Arrowhead project CISTER, together with Aalborg University and Neogrid, successfully demonstrated the flex-offer framework software in two pilots. CISTER also completed with great success the ENCOURAGE project, in which we were the main responsible for the design and development of the middleware.

Analysis of energy saving by smart grids on a prototype installed in Terrassa campus, analysis of feasibility and regulations of smart grids. New approach to mobility models for simulations of vehicular communications.

Confirmed in the editorial boards of Research Journal Social Technologies (Mykolas Romeris University) and of Transactions on Emerging Telecommunications Technologies (Wiley).

Invited paper in plenary session (similar to keynote speech) of International Academic Conference on Social Technologies in Vilnius, Lithuania, regarding how social intelligence emerges out of smart grid approaches.
Multi/Many-Core Processors:
José Augusto Santos-Jr, PhD student of Prof. George Lima (UFBA, Brazil) visited CISTER for 6 months, under Brazilian scholarship, in order to work with CISTER co-supervisor.

Strengthen the usage of the multi/many-core processors in the industry and provide the analysis for Network-on-Chip (NoC) technologies in order to ensure time predictability. Specifically, the challenge of time-predictability in modern many-core architectures has been investigated and a framework to compute the worst-case communication delay for many-cores using a Limited Migrative Model has been proposed. The latter contribution was selected among the best papers at RTCSA’14 and was invited to the Journal of Signal Processing Systems (JSPS).

Proposed a new algorithm to tightly estimate the maximum end-to-end latency of a packet transmission over a Network-On-Chip, which is the de facto mainstream communication fabric in modern many-core architectures. We have also proposed a new framework to budget the execution of a real-time task and manage all these pre-assigned task execution budgets at runtime. The proposed framework allow tasks to preempt each other only if the preemting task is able to compensate for the damage caused to the preempted task. That is, the preemption is allowed only if the amount of time corresponding to the maximum delay incurred by the preempted task can be transferred from the execution budget of the preemting task to that of the preempted task. Transactions between tasks budgets turned out to be a very flexible mean that also allow tasks to (sometimes) violate the constraint imposed on their minimum inter-arrival time. We then focused on parallel applications and studied how to deal with control-flow information when computing their response time on a multicores. This led us to study the WCET of such parallel applications when deployed on a multicores, an activity that we are still pursuing today.

Invited speaker to the 14th International Workshop on Worst-Case Execution Time Analysis (WCET 2014), held in Madrid, to give a recap of the main challenges of time-predictability in modern many-core architectures.

Wireless Sensor Networks:
CISTER presented XDense, an architecture for large interconnected wireless sensor networks, developed for the application to turbulence analysis in aircraft wings, where a network of embedded sensors embedded exchange information in a nearest neighbor manner to perform in-network image processing and data aggregation.

We proposed to batch the transmissions together by defining a harmonizing period to align the transmissions from multiple applications at periodic boundaries. This harmonizing period is then leveraged to design a protocol that coordinates the transmissions across nodes and provides real-time guarantees in a multi-hop network. This protocol, which we call Network-Harmonized Scheduling (NHS), takes advantage of the periodicity introduced to assign offsets to nodes at different hop- levels such that collisions are always avoided, and deterministic behavior is enforced. NHS is a lightweight and distributed protocol that does not require any global state-keeping mechanism.

3.3 Productivity - CISTER

3.3.1 Publications in peer review Journals (6000 ca.)


3.3.2 Other International publications (6000 ca.)


(posts & demo)


### 3.3.3 Ph. D. thesis completed (3000 ca.)


David Pereira, Towards Certified Program Logics for the Verification of Imperative Programs, PhD thesis, April 2013 (supervisors: Nelma Moreira, Simão Melo de Sousa)


**inished in 2015:**

- Many-Core Platforms in the Real-Time Embedded Computing Domain, Borislav Nikolic
- Real-time Limited Preemptive Scheduling, José Marinho
- Reliable Mobility Support in Low-Power Wireless Networks, Hossein Fotouhi

**Ongoing PhD work:**

- Dynamic Contracts for Verification and Enforcement of Real-Time Systems Properties, André Pedro
- Real-Time Software Transactional Memory, António Barros
- Resource Abstraction via a Real-Time Interface, Artem Burmyakov
- Reliability and Time Bounded Delays in Wireless Sensor Networks, Claro Noda
- Dynamic Parallel Real-Time Embedded Systems in Multiprocessor Platforms, Cláudio Maia
- Integrating Dataflow and Non-Dataflow Real-Time Application Models on Multi-Core Platforms, Hazem Ali
- Networked Embedded Systems for Active Flow Control in Aircraft, João Loureiro
- Efficiency and Time-Driven Mapping and Scheduling Techniques for Many-Core Architectures, José Fonseca
Analysis of General-Purpose Graphics Processing Units for Real-Time Systems: Models and Analyses, Kostiantyn Berezovskyi
Computing Aggregate Quantities in Large-Scale and Dense Sensor Networks, Maryam Vahabi
A Framework for the Development of Parallel and Distributed Real-Time Embedded Systems, Ricardo Garibay-Martínez
Improving QoS for Large-Scale Wireless Sensor Networks, Ricardo Severino

3.3.4 Patents/prototypes (2000 ca.)
(void)

3.3.5 Organization of Conferences (2000 ca.)
Organizing Committee:
CiWork 2014, Porto, Portugal
INForum 2014, Porto, Portugal
ISCIT 2014, Incheon, South Korea
Conference / Program / Track Chair:
RTSS 2014, Rome, Italy
RSC 2014, Niagara Falls, Canada
RTAS 2014, Belin, Germany
DATE 2014, Desden, Germany
ARCS 2014, Luebeck, Germany
Special Session Organizer:
ETFA 2014 – SS04, Barcelona, Spain
Tutorial/Workshop Chair:
IEEE CAMAD 2014, Athens, Greece
JRWRTC 2014, Versailles, France
WMCIS’2014, Paris, France
Program Committee:
WMC 2014, Rome, Italy
HILT 2014, Portland, USA
RTNS 2014, Versailles, France
3.3.6 Industry contract research (2000 ca.)

(Void)

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the International level

International Projects:
EMC² (Embedded multi-core systems for mixed criticality applications in dynamic and changeable real-time environments) JU grant nr. 621429 | ARTEMIS/0001/2013
DEWI (Dependable Embedded Wireless Infrastructure) JU grant nr. 621353 | ARTEMIS/0004/2013
Arrowhead (Ahead of the future) JU grant nr. 332987 | ARTEMIS/0001/2012
P-SOCRATES (Parallel SOftware framework for time-CRitical mAnycore systEmS) FP7-ICT-611016
CONCERTO (Guaranteed Component Assembly with Round Trip Analysis for Energy Efficient High-integrity Multi-core Systems) JU grant nr. 333053 | ARTEMIS/0003/2012
CarCoDe (Platform for Smart Car to Car Content Delivery) ITEA2 Nº 11037, QREN Nº 30345
ENCOURAGE (Embedded iNtelligent COntrols for bUildings with Renewable generAtion and storaGE) JU grant nr. 269354 | ARTEMIS/0002/2010

International educational programs:
Active participation in the CMU Portugal Program (CMU-PT), namely in the doctoral programs in Electrical and Computer Engineering.

International Associations:
Member of HiPEAC 3 (European Network of Excellence on High Performance and Embedded Architecture and Compilation)

3.3.8 Other national publications (6000 ca.)
3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice.

National Programs:

CISTER (13-14) (Projeto-Estratégico | Unidade de Investigação) FEDER (COMPETE) / FCT
BEST-CASE (New frontiers on embedded ICT & applications) NORTE-07-0124-FEDER-000063
PATTERN (Programming AbsTracTions for wireless sensor Networks) FCOMP-01-0124-FEDER-028990 | PTDC/EEI-SCR/2171/2012
V-SIS (Sistema de Validação de Sistemas Críticos) QREN - SI I&DT Nr. 38923
AVIACC (Analysis and Verification of Concurrent Critical Programs) FCOMP-01-012244-FEDER-020486 | PTDC/EIA-CCO/117590
REGAIN (Real-time scheduling on general purpose graphics processor units) FCOMP-01-0124-FEDER-020447 | PTDC/EIA-CCO/118080/2010
SMARTS (Slack Management in Hierarchical Real-Time Systems) FCOMP-01-0124-FEDER-020536 | PTDC/EIA-CCO/121904/2010
Smartskin (Densely Instrumented Physical Infrastructures) FCOMP-01-0124-FEDER-020312 | PTDC/EEA-ELC/121753/2010
MASQOTS (Mobility mAnagement in wireless Sensor networks under Quality-of-service constraints using standard and Off-The-Shelf technologies) FCOMP-01-0124-FEDER-014922 | PTDC/EEA-TEL/112220/2009
VipCore (Virtual Processor-based Multicore Scheduling) FCOMP-01-0124-FEDER-015006 | PTDC/EIA-CCO/111799/2009
RePoMuC (Real-time Power management on partitioned MultiCores) FCOMP-01-0124-FEDER-015050 | PTDC/EIA-EIA/112599/2009
3.1 Group Description – C-BER

<table>
<thead>
<tr>
<th>Research Group Title</th>
<th>Center for Biomedical Engineering Research</th>
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<tr>
<td>Principal Investigators</td>
<td>A. Campilho; J. Paulo Cunha</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
<tr>
<td>Home Institution</td>
<td>INESC TEC</td>
</tr>
</tbody>
</table>

3.2 Objectives & Achievements

3.2.1 Objectives (4000 ca.)

FOREWORD

In 2013, INESC TEC created the group BRAIN - Biomedical Research And INnovation. The research herein developed had contributions of other INESC centers or units. The researchers in this area had strong contributions in the period of 2008-2012, particularly in Brain Imaging, Movement Quantification in Neurological Diseases and Wearable Wireless Vital Signs Monitoring. They participated in several projects at national and international level and also were co-founders of an international company.

In 2014, INESC TEC created a new Centre for Biomedical Engineering Research (C-BER), where researchers coming from the Bioimaging group from INEB – Biomedical Engineering Institute. joined researchers from the BRAIN and other INESC TEC researchers from the Bioinstrumentation field. The INEB Bioimaging group had strong contributions in image analysis and classification methodologies for lesion detection, segmentation and identification, useful for aiding the diagnosis process in several diseases, as retinal, genetic, pulmonary and vascular diseases. The Bioinstrumentation researchers developed expertise in Hyperspectral Single-pixel Imaging, Body Motion Characterization, and Bio-inspired Visual perception. They participated in several projects and also were co-founders of an international company, integrating knowledge and technology developed in the institute. In the mid of 2014, other researchers from UTAD Universidade de Trás-os-Montes e Alto Douro) integrated C-BER, opening the cooperation with an University of the North Region of Portugal.

This Centre benefits, furthermore, from the INESC TEC environment and from the active interaction with other research groups, namely in the areas of the cluster NIS – Network Intelligent Systems.

OBJECTIVES

The mission of C-BER is to promote knowledge through applied research, advanced training and innovation in Biomedical Engineering. The major goals of C-BER are:

1) to create interdisciplinary knowledge enabling the innovation and technology transfer with economic impact; the interdisciplinary aspect is intrinsic to BME (Biomedical Engineering) by the cooperation among engineers, physicists, medical doctors and other healthcare professionals; the interdisciplinary component is reinforced within INESC TEC environment through high level expertise in engineering, physics and mathematics domains.

2) to develop technological products, tools and methods for the prevention and early detection of different types of diseases, such as cancer (lung, breast), major prevalent diseases (diabetes, hypertension, cardiovascular), aging related impairments (Alzheimer, Parkinson or macular degeneration), or for human rehabilitation, physiotherapy or functional assessment.

4) to contribute to the development of advanced neurotechnologies at the frontier of engineering and neurology.
5) to promote strategic partnerships with: a) other centers of INESC TEC; b) clinical partners, from the main hospitals in the region; c) research institutes, particularly INEB and I3S; d) and with other international institutions.

Supported by the previous experience of the researchers of C-BER and aiming at achieving the goals above, the objectives of the 3 Labs are:

   - Wearable Monitoring Systems - To develop methods and technologies for human rehabilitation and physiotherapy, active and independent living and sport performance by using advanced embedded and wearable technologies for personalized healthcare and long-term daily use.
   - Embedded Visual Sensing - To develop new methods for human visual perception modelling, bioinspired vision sensors for human behaviour analysis, visual aids for human impairments or mobile robotics.

   - Retina CAD – To design innovative methods and tools for the early detection/characterization of prevalent eye pathologies, supported by the detection of characteristic features and lesions in fundus layers, as retina and choroid, and the combination of data from distinct modalities (retinography, angiography, OCT – Optical Coherence Tomography)
   - Carotid CAD: To measure macrovascular markers of arteriosclerosis as the intima-media thickness and plaque burden from carotid ultrasound images. The relation of these markers to the presence of cerebral small vessel diseases will be studied.
   - Lung CAD – To create CAD and content-based image retrieval systems for pulmonary pathologies, relying on previous experience in lung nodule (particularly subtle nodules or non-solid nodules as ground glass opacities) detection and characterization of interstitial lung disease.

3) NeuroEngineering Lab

The NELab is organized in the following teams:

   - NeuroImaging – Brain imaging multimodal analysis and fusion (MRI, EEG, etc.); Reinforce the National Brain Imaging Research Network (http://www.brainimaging.pt), of which we constitute the UPorto node; Image guided and evaluation of neurosurgery procedures; neuro-prosthetics and brain stimulation devices; New optogenetics imaging systems for living neural tissues; Confocal neural imaging analysis (KP: Neuroimage, 84, pp. 435-42, 2014)
   - Brain-Computer Interfaces (BCI) – new interaction paradigms based on EEG and other biosignals; wearable mobile interfaces; (KP: IEEE Trans. Intelligent Transportation Systems, 2015 (in Press)).

Common to the three research labs, there is a line of research to develop methods and tools for patient rehabilitation at home for the recovery of the motor function and the automatic assessment of functional abilities.

3.2.2 Main Achievements (4000 ca)
2014 is the first year of activity of C-BER. Naturally, it has an impact on the achievements herein reported, some of them being a result of activities developed in a different environment.

During 2014 the following important achievements can be highlighted in different areas of activity as in publications, in supervision, projects and others.

PUBLICATIONS

High-Impact papers of C-BER:


Aurélio Campilho authored 1 book and co-edited 3 books:

- Aurélio Campilho, Mohamed Kamel, Image Analysis and Recognition, Lecture Notes in Computer Science 2014, LNCS 8814, Part I, 2014
  http://link.springer.com/book/10.1007/978-3-319-11758-4
  http://link.springer.com/book/10.1007/978-3-319-11755-3

Researchers of C-BER co-authored the following book chapters:


Researchers of C-BER received a best poster award for the presentation:
SUPERVISION

C-BER researchers are supervising the two Post-doctoral grants:

Researcher: José Rouco Maseda  
Starting date: 1-Jan-2012; End date: 31-Dec-2014

Title: “3D detection and segmentation of pulmonar nodules in computerized tomography images”, Bolsa de pós-doutoramento da FCT, com o contrato DFRH - SFRH/BPD/85663/2012.  
Investigator: Jorge Novo Buján  
Researcher: Bolsa Pos-doutoramento  
Starting date: 1-April-2013; End date: 31-Oct-2014.

C-BER researchers are supervising fifteen (15) PhD students and supervised eleven (11) M.Sc. students who concluded their thesis in 2014.  
One of the PhD students engaged is a joint FEUP/CMU dual degree U.S. citizen student. He is currently at the Robotics Institute of CMU, Pittsburgh, PA.

PROJECTS

A CMU-Portugal grant of $1.2m was leaded by a C-BER member and started in 2014.

OTHER

Aurélio Campilho is Associate Editor of the Machine Vision and Applications Elsevier Journal and is a member of Editorial Advisory Board of JTACS - Journal of Theoretical and Applied Computer Science, Polish Academy of Science. [http://www.jtacs.org/sciboard](http://www.jtacs.org/sciboard).

“RetinaCAD – Retinal Computer-Aided Diagnosis System” was presented in the competition iUP25K – and it was selected as one of the 10 best ideas for business (presented by Behdad Dashtbozorg, Ana Maria Mendonça, and Aurélio Campilho).

During the year, several initiatives have been launched to strengthen the interaction with other research groups within the INESC TEC universe. It worths mentioning the participation of several C-BER research groups in the INESC TEC Health Open Day.

3.3 Productivity

3.3.1 Publications in peer review Journals (6000 ca.)

Total number of publications: 11


3.3.2 Other international publications (6000 ca.)

Total number of publications: 24

1 Book and 2 Proceeding volumes by major international publishers


http://link.springer.com/book/10.1007/978-3-319-11758-4

http://link.springer.com/book/10.1007/978-3-319-11755-3
2 Book Chapters by major international publishers


19 full paper articles and 3 abstracts in international conferences


3.3.3 Ph.D. thesis completed (3000 ca.)

Title: Wearable sensors systems for human motion analysis: sports and rehabilitation
Student: Ana Sofia Matos Silva
Degree: Doctoral Program in Biomedical Engineering
Supervisor: Miguel Velhote Correia
Conclusion date: 25-JUL-2014
On-going PhD work: 13
Title: Content Based Image Retrieval in Biomedical Images
Student: José Ricardo Ferreira de Castro Ramos  
Degree: Doctoral Program in Electrical and Computer Engineering  
Role: Aurélio Campilho (Supervisor)

Title: Advanced Image Analysis for the Assessment of Retinal Vascular Changes  
Student: Behdad Dasht Bozorg  
Degree: Doctoral Program in Electrical and Computer Engineering  
Role: Ana Maria Mendonça (Supervisor) Aurélio Campilho (Co-supervisor)

Title: Segmentação e Classificação de Imagem Médica: Caracterização de nódulos pulmonares não sólidos e parcialmente sólidos  
Student: Daniela Marisa da Silva Campos  
Degree: Doctoral Program in Electrical and Computer Engineering  
Role: Aurélio Campilho (Supervisor)

Title: Advanced Methods for Optical Coherence Tomography Choroidal Image Analysis  
Student: Raul de Medina Prata Pinheiro  
Degree: Doctoral Program in Electrical and Computer Engineering  
Role: Ana Maria Mendonça (Supervisor) Jorge Silva (Co-supervisor)

Title: Computational algorithms for image analysis: Applications on human vocal tract and silhouette  
Student: Maria João Medeiros de Vasconcelos  
Degree: Doctoral Program in Informatics Engineering  
Co-supervisor: Miguel Velhote Correia  
Conclusion date: 23-MAR-2015

Title: Mixed-signal Test and Measurement Framework for Wearable Monitoring System  
Student: António José Salazar Escobar  
Degree: Doctoral Program in Electrical and Computer Engineering  
Supervisor: Miguel Velhote Correia  
Conclusion date: 07-JAN-2015

Title: On-chip vision processing based on sparse coding and dictionary learning  
Student: Hugo Daniel Rodrigues Gonçalves  
Degree: Doctoral Program in Electrical and Computer Engineering  
Supervisor: Miguel Velhote Correia
Title: Wearable fall assessment and prediction system  
Student: Mario Rodolfo Sáenz Espinoza  
Degree: Doctoral Program in Biomedical Engineering  
Supervisor: Miguel Velhote Correia

Title: Motion recognition: a biologically inspired approach  
Student: Daniel Monteiro Basso  
Degree: Doctoral Program in Electrical and Computer Engineering  
Supervisor: Miguel Velhote Correia

Title: Movement patterns of the upper limb in human subjects using accelerometry and electromyography  
Student: Carla Mariana Borges da Silva  
Degree: Doctoral Program in Biomedical Engineering  
Supervisor: Miguel Velhote Correia

Title: The exaltation of a sense - haptic art  
Student: Sandra Mónia Couto Coelho  
Degree: Doctoral Program in Digital Media  
Supervisor: Miguel Velhote Correia

Title: Detection, characterization and evaluation of posture, and upper-limbs movements in stroke patients by means of sensor fusion  
Student: Pedro Filipe Pereira da Fonseca  
Degree: Doctoral Program in Biomedical Engineering  
Supervisor: Miguel Velhote Correia

Title: Bio-signal analysis for neuromuscular control assessment: application to the stretch-shortening cycle in the human locomotion system  
Student: Carlos Manuel Barbosa Rodrigues  
Degree: Doctoral Program in Biomedical Engineering  
Supervisor: Miguel Velhote Correia

Title: Motor impairment assessment in TTR Familial Amyloid Polyneuropathy  
Student: Maria do Carmo Sousa Cardoso Vilas-Boas  
Degree: Doctoral Program in Biomedical Engineering  
Supervisor: João Paulo Silva Cunha
Title: Personalized stress and fatigue monitoring with wearable human sensing
Student: Dustin Axman
Degree: Dual degree in ECE, CMU-Portugal (ECE PhD program CMU, Pittsburgh / Doctoral Program in ECE, FEUP)
Supervisor: João Paulo Silva Cunha

3.3.4 Patents/prototypes (2000 ca.)

• List of Patents

• List of Prototypes
  - RetinaCAD – Retinal Computer-Aided Diagnosis System
  - Wivern – A clinical framework for advanced data analysis in vascular research
  - Developed under the project: Vascular Image Analysis in Carotid and Retinal Images
  - Plaque Segmentation
  - Reduction of false candidates in nodule detection in CT lung images
  - Vital Responder platform
  - KinectEpil – RGB-D Epileptic Seizure Movement Quantification
  - NeuroKinect - RGB-D Neurological Diseases Movement Quantification
  - ABrIL – Advanced Brain Imaging Lab
  - NeuronDyn - Live Neurotransmitter Vesicle Movement Dynamics in Living Neurons
  - SenseMyHeart – HRV and cardiac intensity webservice

3.3.5 Organization of Conferences (2000 ca.)

• Aurélio Campilho, VI Jornadas de Bioengenharia, Faculdade de Engenharia da Universidade do Porto, 21-22 November 2014 (Scientific Committee, Session Chair of Tech in Health: from Substitution to Diagnosis).
• Aurélio Campilho, ICIAR 2014 - International Conference on Image Analysis and Recognition, Vilamoura, Portugal, 22-24 October 2014 (General Chair).
  http://www.aimiconf.org/iciar14/index.php
• Aurélio Campilho, ICPR 2014 – International Conference on Image Analysis, Track: Biomedical Image Analysis – Area Chair
• Aurélio Campilho, Bioimaging 2014 | 3rd International Symposium in Applied Bioimaging | Life in a Pixel, 16-17 outubro, 2014. (Scientific Committee)

- Jorge Silva,ICIAR 2014 - International Conference on Image Analysis and Recognition, Vilamoura, Portugal, 22-24 October 2014 (Organizing Committee & Scientific Committee)

Other program Committees

- CIARP 2014 19 th Iberoamerican Congress on Pattern Recognition

3.3.6 Industry contract research (2000 ca.)

National direct RTD contracts: 2
EcoDrive, Card4B SA
Hermes, Tech4Home Lda

3.3.7 Internationalization (2000 ca.)

Collaborative publication, Research, Graduate Training Networks or other forms of participation of the Research Group at the international level

International projects: none; International consultancy: none

International educational programs
Active participation in the Carnegie Mellon | Portugal Program (MPP), namely in the doctoral program on Electrical and Computer Engineering. This participation is an important opportunity for the exchange of information and experiences.
Aurélio Campilho is the Director of the Doctoral Program in Electrical and Computer Engineering, one of the degrees integrated in the dual doctoral program under the Carnegie Mellon | Portugal Program.
João Paulo Cunha is serving as “Scientific Director” of the Carnegie Mellon | Portugal program.

International Associations
Vice-President da AIMI – Association for Image and Machine Intelligence, Canadá, since October, 2006.
Senior Member of IEEE – Institute of Electrical and Electronics Engineers.

Number of books in cooperation with authors from foreign institutions: 03
Number of papers in journals in cooperation with authors from foreign institutions: 03 in 2014

3.3.8 Other national publications (6000 ca.)

3.3.9 Government/Organization contract research (2000 ca.)

Include here work carried out by the group that resulted in a publication or report. Of particular importance are those involved in public policy advice.

National programs – FCT:

QREN:

Participation in sectorial initiatives
4 RESEARCH LINES

In this section you can see the individual Research Lines reported in the last form as well as the Research Groups involved in each RL. They can be accessed by clicking the Research line’s name or its unique identifier.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Research Line Title</th>
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</thead>
<tbody>
<tr>
<td>RL-FIS-LA14-182</td>
<td>Networked Multimedia Systems and Services in Scenarios of Convergence</td>
</tr>
<tr>
<td>RL-EEI-LA14-183</td>
<td>Photonics for Life Sciences: Optical Biochemical Sensing and Imaging</td>
</tr>
<tr>
<td>RL-EEI-LA14-184</td>
<td>Sustainable Energy Systems and the Smart Grid</td>
</tr>
<tr>
<td>RL-FIS-LA14-187</td>
<td>Robotics, Intelligent and Autonomous Systems for Complex Environments</td>
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<td>RL-EEI-LA14-188</td>
<td>Intelligent and Adaptive Systems and Mathematical Modeling in Decision Support</td>
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<td>RL-EEI-LA14-189</td>
<td>Architectures, Languages and Systems for Advanced Computing</td>
</tr>
<tr>
<td>RL-EEI-LA14-190</td>
<td>Real-Time Embedded Systems for Smart Environments</td>
</tr>
<tr>
<td>RL-EGE-LA14-192</td>
<td>Technology and Innovation Management</td>
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<tr>
<td>RL-EME-LA14-193</td>
<td>Industrial Engineering and Service Management</td>
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4.1 General Description (RL-FIS-LA14-182)

Research Line Title

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>NETWORKED MULTIMEDIA SYSTEMS AND SERVICES IN SCENARIOS OF CONVERGENCE</th>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>Manuel Alberto Pereira Ricardo</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
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</table>

4.2 Objectives and Achievements (RL-FIS-LA14-182)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

This Research Line (RL) envisions a lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content. The RL defines as its mission the development of advanced systems and technologies enabling high capacity, efficient, and secure communications, media knowledge extraction, and immersive ubiquitous multimedia applications. This mission will be accomplished by directing the research activities towards (a) the extraction and processing of knowledge from media, (b) the development of pervasive multimedia applications by combining context-aware technology with creative skills and empowering social engagement, (c) the development of self-manageable, scalable, secure, and context-aware wireless networks, and (d) the development of technologies for optical and wireless communication systems, supported in signal processing techniques, radio devices, design and test of circuits, and reconfigurable digital systems.

4.2.2 Main Achievements (2000 ca.)

RESEARCH GROUP INTERACTION AND CROSS-RG COOPERATION

This RL is tied to the research activities carried out by the Centre for Telecommunications and Multimedia Unit (CTM). Interaction with other Units was achieved in the following projects that required cooperation among several RG:

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL3 - NETWORK SENSING FOR CRITICAL SYSTEMS MONITORING, cooperation with CAP

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL4 - Cooperation and perception for augmented autonomy, cooperation with CROB

BEST CASE - Better Science Through Cooperative Advanced Synergetic Efforts, RL5 – Smartgrids, cooperation with CPES

SUNNY - Smart UNattended airborne sensor Network for detection of vessels used for cross border crime and irregular entry, cooperation with CROB

CNG – Content for Next Generation Networks, with USIG

Escolinhas Criativas – Creative Spaces for Creative Kids, with USIG

PGlobal - Publico Global, with USIG

MAIN RESULTS – just a few examples are given, selected from projects mentioned above:

SUNNY - specification of SUNNY communications architecture and functional model based on information flows for maritime surveillance employing different sensors onboard unmanned aerial vehicles (UAVs).
CNG - a client-server prototype for personalised immersive environments. A system that presents 3D multi-view video content to users, transparently adapting the perspective of the scene according to the focus of attention of the viewer, using eye-gaze and head tracking information.

Escolinhas Criativas - a collaborative tool for annotating multimedia content based on the concepts of Game With a Purpose.

### 4.3 Research Line Output (RL-FIS-LA14-182)

This section allows you to provide the productivity of the Research Line during the reporting period.

#### 4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language.

The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter and intra-Centre.


Pedro Silva, Maria Teresa Andrade, Pedro Carvalho, Jorge Mota, A Structured and Flexible Language for Physical Activity Assessment and Characterization, journal of sports medicine, pp.-, 2013.


#### 4.3.2 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language.

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

**TEIXEIRA, F., FREITAS, P., PESSOA, L., CAMPOS, R., RICARDO, M., Evaluation of IEEE 802.11 Underwater Networks Operating at 700 MHz, 2.4 GHz and 5 GHz, in Proc. of WUWNet’14, Rome, Italy, Nov. 2014.**

**MÓNICA, P. et al., TEC4SEA - A Modular Platform for Research, Test and Validation of Technologies Supporting a Sustainable Blue Economy, in Proc. of OCEANS’14, St. John’s, Canada, Sep. 2014.**
LOPES, M., TEIXEIRA, F., MAMEDE, J., CAMPOS, R., Wi-Fi Broadband Maritime Communications Using 5.8 GHz Band, in Proc. of UComms'14, Sestri Levante, Italy, Sep. 2014.


4.3.3 PhD thesis completed (3000 ca.)
Co-supervision or clearly multidisciplinary projects are allowed here.

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative theses within the framework of the RL.


4.1 General Description (RL-EEI-LA14-183)

Research Line Title          | PHOTONICS FOR LIFE SCIENCES: OPTICAL BIOCHEMICAL SENSING AND IMAGING
Principal Investigator       | Paulo Vicente Silva Marques
Research Area                | Physics

4.2 Objectives and Achievements (RL-EEI-LA14-183)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 Objectives (1000 ca.)

Coordinator in 2013 and 2014: Prof. Paulo Marques.

Optical sensing and imaging technologies have been the main activity of UOSE throughout the last decade resulting in the creation of an advanced dedicated infrastructure and trained human resources with great expertise in material science, optical fibre, integrated optics technology and imaging systems. The strategic goal of this RL is to optimise these multidisciplinary assets, directing them towards research and technology valorisation, in the following areas:

SENSORS DEVELOPMENT
- Novel sensing mechanisms
- Extreme environments applications
- Biochemical sensing
- OPTICAL IMAGING
  - Development of Differential Optical Coherence Tomography
  - Compressive imaging and Hyper-spectral analysis

MICROFABRICATION & INTEGRATED OPTICS
- Direct writing with femtosecond laser pulses.

TECHNOLOGY TRANSFER

While the main focus of the activity of the RL is upstream in the knowledge production chain, nevertheless strategic partnerships with national and international companies will be pursued.

4.2.2 Main Achievements (2000 ca.)

New FDTD based theoretical models for the study and evaluation of new optical fiber tweezers geometries and the manipulation of complex cell shapes
Test and comparison of the polymer tweezers with tweezers fabricated by chemical etching
Fabrication of new fiber micro structures using focused ion beam suitable for trapping and transfer of angular
momentum to the cells (introducing the ability to spin the cells).

Preliminary results were obtained indicating the ability to combine trapping with sensing using the same fibre probe. Such results are an important step towards single cell analytics.

Two different systems for femtosecond laser processing of materials were assembled: one for laser direct writing on planar substrates and the other for device fabrication on optical fibers. The devices fabricated include first order Bragg gratings written by point by point in both in planar and fiber formats. A full characterization of the process was done (pulse frequency, power, writing velocity, focal point depth).

Optical fiber sensor for hydrogen and metals

Microstructured fiber for vapour and liquid sensing

4.3 Research Line Output (RL-EI-LA14-183)

This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language


36. Perez-Rivero, A., Ricote, J., Bretos, I., Calzada, M., Cruz, J., Fernandes, J.R., Jimenez, R., "Morphotropc phase boundary in solution derived (Bi0.5Na0.5)1-xTi03 thin films: Functional properties II.", Journal of the American Ceramic Society, April 2014, vol.97, no.4, p.1276-1282.


4.3.2 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language


32. Balogh, K., Jesus Gouveia, C., Queirós, R.B., Kovacs, B., Pereira, C.M., Borges, M.T., Jorge, P., "Optical fiber dissolved CO2 sensor for application in aquaculture industry", XII EUROPTRODE - EUROPT(R)ODE - XII Conference on Optical Chemical & Biosensors, April 2014, Athens, Greece.


4.3.3 PhD thesis completed (3000 ca.)

Co-supervision or clearly multidisciplinary projects are allowed here


4.1 General Description (RL-EEI-LA14-184)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>SUSTAINABLE ENERGY SYSTEMS AND THE SMART GRID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Manuel António Cerqueira Costa Matos</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EEI-LA14-184)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 Objectives (1000 ca.)

Coordinator in 2011: Prof. Manuel Matos.

The aim of the research line is to address the issue of sustainability, namely through the Smart Grid paradigm. EU goals require the development of knowledge and tools to support the massive integration of renewable energy into the electric power system, new control strategies for large scale integration of DER and off-shore wind farms and forecasting and decision support tools.

Through the Smart Grid paradigm, new organisation schemes for power system emerge, including smart metering, load response, microgrids, integration of Electric Vehicles and dispersed storage. This requires new models, control mechanisms and communication architectures. Knowledge extraction from newly available information and testing of prototypes in laboratorial environments and pilot sites is also an objective.

RESEARCH GROUP INTERACTION

The Power Systems Unit is the core research group for this research line.

An objective of the RL is to achieve a high degree of multidisciplinary and RG interaction.

4.2.2 Main Achievements (2000 ca.)

Development of models to simulate the operation of electricity markets using Nash Equilibria concepts (collaboration with UESP) – in the framework of OIL (Optimisation Inter-Unit Line)

A complete approach to Electric Vehicles integration in electric networks, including a smart charging procedure that allows EV to participate in the provision of primary and secondary frequency control, the development of the concept of aggregator

Contribution on general requirements for EV charging stations, namely through the impacts of having EV participating in primary frequency control on standard IEC61851-1.

Advances in Cross-entropy Method applied to generation capacity reliability evaluation

New methodology for reconfiguration and voltage Var Control of distribution networks using the EPSO and graph theory

New solution to the problem of recomposing missing information at the SCADA of energy/distribution management systems (EMS/DMS), through the use of offline trained autoencoders.

RESEARCH GROUP INTERACTION AND CROSS-RG COOPERATION

This RL is tied to the research activities carried out by the Power Systems Unit (USE). Large interaction with other Units was achieved.

Projects carried out in cooperation among several RG:
SIMULESP - System to support the operation of electric power sub-transmission grids in contingency situations of ELECTROPAULO, Brazil, UNISANTA, Brazil [collaboration LIAAD]

NER 300 - Specification of the Control Centers of Non-Interconnected Greek Islands, Greek Operator of the Non Interconnected Islands, 2010-2011 [collaboration USIG]

REIVE - Smart electrical grids with electrical vehicles, FAI [collaboration UTM]

MARTIFER CV - Studies regarding large scale renewable energy sources integration in Cape Verde Islands up to 2020 and specification of advanced SCADA systems. GeSto Energy, 2010-11 [collaboration USIG]

INOVGRID - Development of an advanced smart metering project for EDP Distribuição [collaboration UTM]

4.3 Research Line Output (RL-EEI-LA14-184)

This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.


4.3.2 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.


4.3.3 PhD thesis completed (3000 ca.)

Co-supervision or clearly multidisciplinary projects are allowed here

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative thesis projects within the framework of the RL.

Theses supervised by members of the research line:

Approved


Submitted


4.1 General Description (RL-EGE-LA14-185)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>Enterprise Collaborative Networks, Operations Management and Decision Support System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Jorge Manuel Pinho de Sousa</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-185)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

Coordinator in the period: Prof. J. Pinho de Sousa.

This RL aims at contributing for the performance improvement of industrial companies, through R&D projects, consultancy, technology transfer and training; and at promoting high quality research initiatives in specific areas.

Research is structured around 4 main vectors: Operations Management and Logistics; Collaborative Networks; Decision Support and Business Analytics; Enterprise Information Systems.

The first research vector covers a broad set of topics such as operations strategy, operations management, performance management, layout design, supply chain management, logistics, and transportation systems. The second of these vectors forms a strong interdisciplinary research area that covers topics such as networked business models, supply-chain management, virtual organizations or organizational networks, collaboration and network governance, or collaborative performance management.

The third research vector deals with methods and techniques such as structuring of decision-making problems, mathematical programming, multi-criteria decision analysis, combinatorial optimization and meta-heuristics, simulation, decision support systems, business intelligence, and data mining. The fourth vector plays an important role on the research activities of the centre, particularly in what concerns the design of advanced information systems, the design of information systems supporting new organisational paradigms, systems integration and inter-operability.

4.2.2 Main Achievements (2000 ca.)

During the period 2013/2014, 13 PhD theses were successfully finished, 26 papers were published in peer review journals, and 56 in international conference proceedings subject to a refereeing process. Moreover several papers have been accepted for publication in peer review journals, and some out of these were published or are expected to be published during 2015. Due to a significant increase of PhD students in recent years, there are currently 26 on-going doctoral projects, with 13 concluded or expected to be concluded during 2015.

The centre has a strong tradition of participation in large European research projects. These projects have highly contributed to achieving critical mass in the fields of Enterprise Collaborative Networks and Operations Management and to strengthening partnerships with leader research organisations in Europe. During this period the group has participated in 11 projects, representing a total funding of about 900 K Euro.

The very active participation in the MANUFUTURE and Footwear European Technology Platforms led to the establishment of important partnerships at a European level. These partnerships have played an important role in the preparation and set-up of several European projects that strongly contributed to the results of the group.
In total, 11 European projects were active during 2013/2014. An important critical mass has been achieved in the fields of Enterprise Collaboration Networks and Operations Management.

A large number of projects has also been pursued at a national level, including research projects funded by FCT, RTD projects in partnership with technology based companies and consultancy firms funded by the QREN programme. A total of 15 projects were executed, representing a total funding of 959 K Euros.

During the period under analysis a total of 18 research and technology transfer projects directly contracted by companies were active, representing a total income of 815 k Euros.

A number of relevant outcomes should be highlighted:

- a new framework was designed to support the definition and implementation of hierarchic and compound performance measurement systems (VFF - Virtual Factory Framework, European project), and this framework was implemented at VW Autoeuropa plant with quite good results.
- within several projects with IKEA, a new simulation system has been developed to represent production lines and evaluate different scenarios according to multiple perspectives. This framework was used to support decisions concerning layouts, lot sizes, sequencing, etc., and the good results achieved so far are motivating the design of new projects.
  - Innovative business analytics, recommender systems and software to manage market trends, using information from social networks, were designed in projects such as Creative Retail, Corenet and PT21.
  - Research and developments on the multi-objective optimisation “scheduler” have been pursued, leading to an innovative up-graded software tool that has been integrated with several ERP systems, with a considerable commercial success (more than 30 licences have already been sold internationally).
  - In the European projects FOCUS (Advances in Forestry Control and Automation Systems in Europe) and MOFSS (Make to Order Fast and Smart Scheduler), both having started in January 2014, new innovative approaches are being developed, to exploit the integrated use of simulation and optimization techniques in advanced production and logistic systems.

During these 2 years, several initiatives have been launched to strengthen the interaction with other research groups within the INESC TEC universe, as reported in other points of this document.

In this context, a special reference should here be made to the BEST CASE project (research line “Smart Manufacturing and Logistics”) coordinated by CESE, but integrating multiple research teams at INESC TEC.

This 30-month project (“NORTE-07-0124-FEDER-000057”) is financed by the North Portugal Regional Operational Programme (ON.2 – O Novo Norte), started in January 2013 and went on in 2014. The main objective of this initiative was to establish an innovative framework for research in various relevant topics on production management and logistics, with the development of new models, techniques and applications.

The project was structured around 6 work-packages on: Advanced Design and Strategies for Manufacturing Systems; Collaboration and Knowledge Management in Manufacturing Networks; Scheduling and Planning for Manufacturing Systems; Logistics and Robotics; Improved Manufacturing through Optimized Cutting and Packing; Modelling, Optimization and Simulation

Significant developments in terms of mathematical programming models and heuristics were achieved, and interesting results and innovative approaches in hybrid implementations were obtained. Some successful applications of these techniques took place in planning problems in production and operations scheduling (“scheduling”), or problems of cutting and packing. The integration of simulation to optimization in their multiple variations was also deeply explored.

The other INESC TEC groups strongly involved in these joint research activities were: CEGI, CROB, LIAAD and CSIG.
4.3 Research Line Output (RL-EGE-LA14-185)

This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

Include only if more than one Research Group of the LA is involved. Give title and full citation in original language


4.3.2 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language
Simon Fischer, Ingo Mierswa, João Mendes Moreira, and Carlos Soares, editors. Proc. of the 4th RapidMiner Community Meeting And Conference (RCOMM 2013) 2013


Filipe Ferreira, Ahm Shamsuzzoha and Americo Azevedo, “Predictive industrial maintenance: a collaborative approach”, 7th International Conference on Interoperability for Enterprise Systems and Applications, At Albi, France


4.3.3 PhD thesis completed (3000 ca.)

Co-supervision or clearly multidisciplinary projects are allowed here

Reza Fazeli, A combined multi-criteria and system dynamics methodology for mid-term planning of light duty vehicle fleets, PhD thesis, Programa Doutoral em Sistemas Sustentáveis de Energia, March 2013 (supervisors: Jorge Pinho de Sousa, Vitor Leal)


Vitor Santos, Human and Technological Dynamics in Complex Research and Development Projects, PhD thesis, Programa Doutoral em Sistemas e Tecnologias de Informação (U Minho), April 2013 (supervisors: João Álvaro Carvalho, António Lucas Soares)

André Rossi, Meta-aprendizado aplicado a fluxos contínuos de dados PhD thesis, Programa Doutoral em Ciências de Computação e Matemática Computacional (U São Paulo), December 2013 (supervisors: André Carvalho, Carlos Soares)


4.1 General Description (RL-EGE-LA14-186)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>DIGITAL SOCIETY – SOFTWARE, INFORMATION AND INTERACTION TECHNOLOGY, SERVICES AND POLICIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Gabriel David</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-186)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

Coordinator in 2013: Prof. Gabriel David.

This research line is the focus of the USIG/INESC TEC unit.

The ability to organize, manage, and retrieve useful information plays a crucial role in today’s digital society. This line of research addresses complex and difficult multidisciplinary problems faced by industry requiring expertise in the analysis, design and implementation of large software systems, using best software engineering practices for design, development and testing, as well as visual and user interaction components to enable their widespread use. The addition of researchers in the Special Purpose Computing Systems area and Accessibility and Support Technologies area expands the competences to the ability to incorporate embedded components in the system and to use inclusive technologies that enlarge the potential audience. Our focus is on major application areas with high social impact, namely e-Government, e-Health, and transport systems that, together with other groups, enable INESC-TEC to successfully achieve strong industrial partnerships and technology transfer.

Coordinator in 2014: Prof. Gabriel David.

This research line is the focus of the USIG/INESC TEC unit.

The ability to organize, manage, and retrieve useful information plays a crucial role in today’s digital society. This line of research addresses complex and difficult multidisciplinary problems faced by industry requiring expertise in the analysis, design and implementation of large software systems, using best software engineering practices for design, development and testing, as well as visual and user interaction components to enable their widespread use, the ability to incorporate embedded components in the system and to use inclusive technologies that enlarge the potential audience. Our focus is on major application areas with high social impact, namely e-Government, e-Health, and transport systems. Our results, together with other groups, enable INESC-TEC to successfully achieve strong industrial partnerships and technology transfer.

4.2.2 Main Achievements (2000 ca.)

MAIN RESULTS – a few examples:
ERAS - 3D Reconstruction of historic buildings based on textual descriptions and geospatial data.
OnlineGYM – Online gymnasium implemented with avatars representing personal trainer and trainees, animated using movement captured by KINECT cameras at their homes and synchronised in a virtual world displayed in their PCs.

The 3D modelling know-how of ERAS, the interaction techniques of OnlineGYM and the gaming background of CNG can be combined into effective serious games with a rich interface, ready to be tried in innovative educational, e-learning, and training environments.

RAIA.co – Final version of sensor observation service and catalog service for a web based oceanographic georeferenced sensor network.

This project, together with the other research data management and data preservation projects are building the expertise to deal with Open Data Government projects.

RESEARCH GROUP INTERACTION

This RL is closely tied to the research activities developed by the Information Systems and Computer Graphics Unit (USIG), taking advantage of this group expertise in handling large software systems from end to end. This is demonstrated by the extended interaction with other INESC groups in several projects:

- With UTM: networking services, signal processing and new digital educational content in projects CNG, SARA, AAL4ALL;
- With ROBIS: ICARUS – robotics for unmaned search and rescue;
- With CRACS: SIBILA - information retrieval, research data management and digital preservation.

Actually, a collaboration pattern is emerging in several proposals (ICARUS, TEC4SEA, OMAN) among USIG, ROBIS, UTM and UOSE, where each has a clear role:

- USIG - graphical interfaces, information processing and visualization, software integration;
- ROBIS - robotics;
- UTM - communications;
- UOSE - sensors.

MAIN RESULTS – a few examples:

LEANBIGDATA – Spatial-temporal data retrieval algorithm based in RB-interval trees and visualization prototypes.

ONLINEGYM – Final version of an online gymnasium.

ICARUS – Serious game for training of search and rescue.

MASSIVE – Laboratory of virtual multisensorial experiences.

The competences on visualization, interaction and serious games already displayed in ONLINEGYM and ICARUS will be expanded in the MASSIVE laboratory.

Several successful projects demonstrate the proven experience in the public sector:

- GIE-GNP – Public presentation of new interregional collaborative Portal (Galicia/Northern Portugal).
- OASRN – Deployment of IS for the Portuguese Architects professional association.

A similar statement can be made for the transports sector:

- MIELE – Multimodal multicriteria e-logistics marketplace simulator.
- SIGAP2 – Deployment of first module of 3PORT port management IS at APDL.
- TICE-Mobilidade- Successful demonstration of application for on-demand car insurance.
- SARA – Demonstration of road management system.
Finally, in the health sector:
- AAL4ALL – Deployment of pilot supporting the trials of the Portuguese AAL eco-system composed by 30 partners.
- APDIC – Project on the preparation of a digital preservation plan for a hospital.

RESEARCH GROUP INTERACTION
This RL is closely tied to the core research activities of USIG but also represents extended interaction with other INESC groups:
- UTM - SARA, AAL4ALL, VCARDID, PGLOBAL
- ROBIS - ICARUS
- UOSE – EYEFRY
- HASLAB – LEANBIGDATA, VCARDID
- UESP – CAP@CIDADE
- CRACS – APDIC, VCARDID.

In 2014, a new collaboration trend started to get shape among the computer science groups at INESC TEC, as can be seen, for instance, in projects VCARDID, LEANBIGDATA, and APDIC:
- USIG - graphical interfaces, information processing and visualization, software integration;
- HASLAB – distributed systems;
- CRACS - security;
- LIAAD – data mining.

4.3 Research Line Output (RL-EGE-LA14-186)
This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)
Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language
(void)

4.3.2 Collaborative Other Publications (2000 ca.)
Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language


4.3.3 PhD thesis completed (3000 ca.)
Co-supervision or clearly multidisciplinary projects are allowed here
(void)
4.1 General Description (RL-EGE-LA14-187)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>ROBOTICS, INTELLIGENT AND AUTONOMOUS SYSTEMS FOR COMPLEX ENVIRONMENTS</th>
</tr>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>António Paulo Gomes Mendes Moreira</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-187)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

This research line is the focus of the ROBIS/INESC TEC unit.

The activity of ROBIS addresses research on fundamental and applied scientific principles and practices with the aim of developing innovative intelligent and robotic solutions. Research activities focus on aerial, land and marine robotics, industrial robotics and intelligent systems and sensors.

NAVIGATION AND OPERATION

Innovative approaches for navigation and positioning of autonomous vehicles.

Tools to assist the operation of autonomous robots (automatic configuration of navigation and mission). Human/Robots interaction, including rapid teaching of manipulators; Hyper-flexible cells; Co-working;

CONTROL AND COORDINATION

Multi-robot systems with approaches for coordination, control and perception for complex and cluttered environments applications.

Intelligent control and smart sensors, adaptive sampling strategies.

TECHNOLOGY TRANSFER

As Robotics is an area of intensive knowledge integration and with direct impact in its application, RG will develop an intensive effort in technology transfer and completing projects.

4.2.2 Main Achievements (2000 ca.)

This RL is tied to the research activities carried out by the Robotics and Intelligent Systems Unit (ROBIS). Large interaction with other Units was achieved.

Projects carried out in cooperation among several RG:

FOCUS - Advances in FOestry Control and AUtomanation Systems in Europe; 7th Framework Programme for Research; Funding Scheme : SME-targeted collaborative projects: advancing forestry control and automation through the development of an integrated technological solution that combines predictive control with
processing and planning processes. The CESE unit is the coordinator of the project, and is also responsible for the research in planning for the FOCUS project.

STAMINA - Sustainable and Reliable Robotics for Part Handling in Manufacturing Automation; 7th Framework Programme for Research; Funding Scheme : ICT – Information and communication technologies: CESE unit participates in the STAMINA project developing the vertical integration of the fleet of robots in the IT system of the end-user.

ICARUS - Integrated Components for Assisted Rescue and Unmanned Search operations; FP7: unmanned SAR technologies for detecting, locating and rescuing humans. (CTM???)

SUNNY - Smart UNmanned aerial vehicle sensor Network for detection of border crossing; FP7: new tool for collecting real-time information in operational scenarios, capable of improving the effectiveness of the EU border monitoring.

4.3 Research Line Output (RL-EGE-LA14-187)

This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

Include only if more that one Research Groups of the LA is involved. Give title and full citation in original language.

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.

4.3.2 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language.

4.3.3 PhD thesis completed (3000 ca.)

Co-supervision or clearly multidisciplinary projects are allowed here.

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative thesis projects within the framework of the RL.


Luís André Freitas da Rocha, Programação de Robôs Industriais em Células Robotizadas Flexíveis, Programa Doutoral em Engenharia Electrotécnica e de Computadores da Faculdade de Engenharia da Universidade do Porto. (Orientador em co-orientação do Prof. Vítor Manuel Ferreira dos Santos, Departamento de Engenharia Mecânica da Universidade de Aveiro, concluída em Abril de 2014)


4.1 General Description (RL-EGE-LA14-188)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>INTELLIGENT AND ADAPTIVE SYSTEMS AND MATHEMATICAL MODELING IN DECISION SUPPORT</th>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>Alípio Mário Guedes Jorge</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-188)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

This research line is the focus of the LIAAD/INESC TEC unit.

It is our aim to produce both fundamental and applied research, developing new methods and techniques in the areas of data mining, artificial intelligence, statistical data analysis, operations research, optimization and mathematical modelling and use these for decision support. Many of the activities are carried out by postgraduate students thus contributing to their training.

A considerable part of our work is to develop and enhance algorithms and methodologies, contributing to the state of the art in our research areas.

We aim to apply some of our research results in projects with companies that can benefit from them. We are interested in the areas of power systems, web industry, urban transports, and water supply, among others.

It is also our aim to pursue cooperation with researchers from other national and foreign institutions, namely the University of São Paulo from Brazil.

RESEARCH GROUP INTERACTION

An objective of the RL is to achieve a high degree of multidisciplinary and interaction among several RG.

CRACS - participation in joint proposals for projects; joint MSc student on recommender systems with a GPU approach; development ILP/relational methods in bioinformatics.

CESE – a business intelligence solution has been deployed at Universidade do Porto; joint papers published; joint supervision of students; collaboration in the smart manufacturing effort; optimisation and decision support; data mining in industrial applications; modelling industrial networks; metalearning and transfer learning; recommender systems.

CEGI - joint papers published.

CPES - collaboration in the smart grids effort; co-supervision of an MSc dissertation.

Haslab - joint project proposals.

CTM - joint effort for promoting knowledge transfer in the area of smart media.

4.2.2 Main Achievements (2000 ca.)

In 2014 the group had a high number of publications (34) in international journals. We also counted 24 articles in highly ranked conferences (CORE>=B), including CIKM, ECAI, IDA and UMAP. Overall the group published more...
than 100 articles in journals, conferences and books. A special highlight to the publication in 2014 of 2 articles in the high impact journal ACM Computing Surveys.

Researchers from the group have participated in the organization of many international conferences, as organization committee members, track chairs, area chairs and program committee members
1 new book was published with a collection of articles.
13 PhD theses and 54 MSc dissertations with supervision or co-supervision of LIAAD members were concluded and defended last year.
Paula Brito continued her presidency of IASC - International Association for Statistical Computing (http://www.iasc.isi.org/node/54).
Many of our researchers participate as members of editorial boards of scientific journals and scientific committees of international conferences.

COOPERATION WITH OTHER UNITS
CRACS - joint MSc student on recommender systems with a GPU approach;
CESE – a business intelligence solution has been deployed at Universidade do Porto; joint papers published; joint supervision of students;
CEGI - joint papers published.
CPES - co-supervision of an MSc dissertation.

4.3 Research Line Output (RL-EGE-LA14-188)
This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)
Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language

4.3.2 Collaborative Other Publications (2000 ca.)
Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language

Several Units at INESC TEC are already multi-disciplinary. The following lists multi-disciplinary collaborative publication effort within the framework of the RL, both inter- and intra-Unit.


4.3.3 PhD thesis completed (3000 ca.)
Co-supervision or clearly multidisciplinary projects are allowed here
Co-supervision or clearly multidisciplinary projects are allowed here
PhD Thesis co-supervised with members of other INESC groups


MSc Dissertations co-supervised with members of other INESC groups

1. André Valente Rodrigues, Paralelização de algoritmos de fatorização de matrizes para recomendação usando GPU, Tese de Mestrado em Ciência de Computadores, Dezembro 2014. (LIAAD / CRACS)
7. Simão José Batista Ferreira, O Comportamento dos Consumidores Adolescentes e a Sua Evolução no Facebook, Mestrado em Gestão Comercial, Supervisor: Pedro Quelhas Brito, November 2014.
4.1 General Description (RL-EGE-LA14-189)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>ARCHITECTURES, LANGUAGES AND SYSTEMS FOR ADVANCED COMPUTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Fernando Manuel Augusto Silva</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-189)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

The core of our work stems from our expertise in high-level languages design and implementation, secure systems development, as well as in parallel and distributed systems and frameworks. In the last few years, we have been able to both maintain a strong position in our foundational areas and leverage our expertise to open new directions of research in competitive areas such as Information Mining and Web-based Systems. In the next step, our goal is to achieve a balance between Computer Science research and challenging multidisciplinary applications arising from the life sciences, engineering, the Web, and the broad area of social networking.

The effort in the last years has only been possible through support from a network of international collaborators. As a case in point, our contributions in Security and health Informatics, started with international collaboration, have led to strong publications, and have raised high interest outside academia, with INESC TEC providing the ideal vehicle to establish the necessary bridges.

4.2.2 Main Achievements (2000 ca.)

MAIN RESULTS – a few examples:

New competitive funding raised within this RL totaled over 500,000€ with three new projects funded:
- ABLe: Advice-Based Learning for Health Care (PTDC/EEI-SII/2094/2012), FCT, (2013/15)
- HYRA: Crowd-Sourcing Mobile Devices to Develop Edge Clouds (CMUP-ERI/FIA/0048/2013), FCT, CMU-Portugal, (2014/17)

New research contracts with industry and QREN within this RL totaled over 950,000€ with 5 contracts with QREN ON.2, 1 with INCM, 1 with FCT/FCCN.

The publication record of CRACS was maintained at a high standard with a significant increase in journal publications. In 2013/14, CRACS has published 27 refereed journal papers, 2 technical books, 10 book proceedings, 7 book chapters, and 76 conference papers, 51 of which in proceedings with international diffusion (Springer, ACM, or IEEE), and mostly indexed by ISI and Scopus. This corresponds to circa 5 publications on average per senior researcher.

International collaboration is a strong commitment of this RL, achieving 24 joint publications with international collaborators. Some of the most important collaborations are with CMU, UT-Austin, Wisconsin-Madison, UT-Dallas in the US, Amsterdam, Leuven, Imperial College, York, Newcastle, UPM in Europe, Tokyo IT in Japan, and COPPE in Brazil.
A considerable number of software systems developed within this RL are available online for download and at least three of the systems, Yap Prolog, Logtalk, and Mooshak, are very mature and used worldwide by a large community of users, both academic and industrial.

4.3 Research Line Output (RL-EGE-LA14-189)
This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)
Include only if more that one Research Groups of the LA is involved. Give title and full citation in original language

With LIAAD:

1. T. Loureiro, R. Camacho, J. Vieira and N. A. Fonseca, "Improving the performance of Transposable Elements detection tools", in Journal of Integrative Bioinformatics, vol. 10, November 2013

4.3.2 Collaborative Other Publications (2000 ca.)
Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language

With LIAAD:


With CAP:


4.3.3 PhD thesis completed (3000 ca.)
Co-supervision or clearly multidisciplinary projects are allowed here

Ph.D. theses with LI AA D:

1. Carlos Manuel Abreu Gomes Ferreira, Exploring Temporal Patterns from Multi-relational Databases, PhD in Computer Science, FCUP, Supervisor: João Gama (LIAAD); Co-supervisor: Vitor Santos Costa (CRACS), June 2014
2. Mário Amado Alves, Adaptive Hypertext. The shattered documents approach, PhD in Computer Science, FCUP, Supervisor: Alípio Jorge (LIAAD); Co-Supervisor: José Paulo Leal (CRACS), July 2013
M.Sc. dissertations with LIAAD:

1. André Valente Rodrigues, Paralelização de algoritmos de fatorização de matrizes para recomendação usando GPU, MSc in Computer Science, FCUP, Supervisor: Alípio Jorge (LIAAD); Co-supervisor: Inês Dutra (CRACS), December 2014

2. Diogo André Rocha Teixeira, A Computational Platform for Gene Expression Analysis, MSc in Informatics and Computing Engineering (MIEC), FEUP, Supervisor: Rui Camacho (LIAAD), Co-Supervisor: Nuno Fonseca (CRACS), Concluded in July 2014

3. Daniela Filipa Neves Cardeano, Data Mining em aplicações de Desenho Racional de Fármacos, MSc in Informatics and Computing Engineering (MIEC), FEUP, Supervisor: Rui Camacho (LIAAD), Co-Supervisor: Nuno Fonseca (CRACS), Concluded in July 2014
4.1 General Description (RL-EGE-LA14-190)

Research Line Title
REAL-TIME EMBEDDED SYSTEMS FOR SMART ENVIRONMENTS
Principal Investigator
Eduardo Manuel de Médicis Tovar
Research Area
Electrical and Computer Engineering

4.2 Objectives and Achievements (RL-EGE-LA14-190)
This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

Coordinator in 2015: Prof. Eduardo Tovar.
This research line is the focus of the CISTER/INESC TEC associate unit.
Embedded computing systems (ECS) is a strategic research area in Europe, incorporating > 98% of the processors.
ECS are also becoming inherently distributed and interconnected, paving the way for smart-* applications.
The main objective of this RL is to address the challenges related to guaranteeing the logical and temporal correctness of ECS for smart environments and cyber-physical systems, addressing topics such as real-time networks/protocols (e.g. sensor/actuator networks, real-time software (e.g. languages and operating systems), adaptive real-time systems (e.g. power management), multicore systems (e.g. scheduling).
This RL is tied to the research activities carried out by the Research Centre in Real-Time and Embedded Computing Systems (CISTER), an LA Associate Unit, but it broadens its scope by integrating other specific competences of the Research Group as well as strengthening synergies and incorporating the skills available in other Research Groups, such as: ROBIS – on the real-time issues and platforms for robotic applications; CRACS – on the fundamental theory of real-time languages and operating systems; HASLab – on the verification of embedded software.

4.2.2 Main Achievements (2000 ca.)

(Void)

4.3 Research Line Output (RL-EGE-LA14-190)
This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)
Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language

With HASLAB:

4.3.2 Collaborative Other Publications (2000 ca.)
With HASLAB:


4.3.3 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language

(Void)

4.3.4 PhD thesis completed (3000 ca.)

Co-supervision or clearly multidisciplinary projects are allowed here

(Void)
4.1 General Description (RL-EGE-LA14-191)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>CRITICAL INFORMATION SYSTEMS – DEPENDABLE SOFTWARE, DEVELOPMENT METHODS AND TOOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Investigator</td>
<td>Rui Carlos Oliveira</td>
</tr>
<tr>
<td>Research Area</td>
<td>Electrical and Computer Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-191)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

Coordinator in 2014: Prof. Rui Carlos Mendes de Oliveira.

This research line is the focus of the HASLab/INESC TEC unit.

Some of the pillars of our society are currently based on information systems that are expected to be trustworthy. Paradoxically, it is widely accepted that these information systems, many of which support critical infrastructures, will fail from time to time. The focus of this line of research is the production of high-assurance software for trustworthy systems: software whose adequacy, responsiveness, predictability, robustness and security have been carefully considered during development.

This is clearly a hard problem that, with the increasingly asymmetric and unstable nature of environments, requires looking at previously disjoint scientific fields as a whole. This RL exploits synergies between competencies in three main aspects of trustworthy systems: rigorous software development, data and systems dependability, and information security. The RL focuses on safety-critical systems, cloud computing, and smartgrids, as application areas in which trustworthiness is particularly relevant.

4.2.2 Main Achievements (2000 ca.)

The HASLab steadily produces fundamental and applied research that satisfies the quality standards of the top rated journal and conferences (rated A*, the best of the best in the popular computer science CORE venue ranking) in each of its areas of research. In 2014 we have published 30 journal articles and 75 full papers in international conferences rated at least B in the CORE ranking.

Major outcomes of our research in 2014 were:

- A detailed analysis and classification of Storage Deduplication Systems that has been published in the ACM Computer Surveys journal, followed by the design and implementation of a novel and highly efficient dependable and fully-decentralized deduplication system for cloud computing infrastructures.

- A new version of our open source framework to help validate, query, and refactor spreadsheets using model-driven software engineering principles. In 2014 this work was published in the IEEE Transactions on Software Engineering, the top journal in this research area, and several other highly ranked journals and conferences.

- An open source implementation of a domain-specific compiler for cryptography has been released and presented at Principles of Security and Trust 2014. The foundations of a verification tool for the same language have been published in Science of Computer Programming. In parallel, an optimisation of a classical construction of block-ciphers that provides stronger security under tampering has been proposed in Fast Software Encryption 2014.
Projects
2 ongoing EC-funded projects
1 EC-funded project kicked-off in 2014
1 IA- funded project kicked-off in 2014
5 ongoing FCT-funded projects
3 FCT-funded projects completed in 2014
1 IA- funded projects completed in 2014
4 ongoing CCDR-N (QREN) funded projects
1 ongoing IA funded project

Publications
30 papers in international peer-reviewed journals
75 papers in international conferences with peer reviewing
1 paper in national conference with peer reviewing
3 book chapters
2 PhD thesis
18 MsC thesis
4 others publications

Awards
HASlab postdoc researcher Alexandre Madeira was honored with the 2013 IBM Scientific Award.

Three best paper awards (SBCARS'2014, DX'2014 (2)).
The Unit established large cooperation with other Units through projects and proposal submission as well as participation in other cross-Unit activities. This is reported in the Research Lines report sections.

4.3 Research Line Output (RL-EGE-LA14-191)
This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)
Include only if more that one Research Groups of the LA is involved. Give title and full citation in original language

4.3.2 Collaborative Other Publications (2000 ca.)
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4.3.3 PhD thesis completed (3000 ca.)
Co-supervision or clearly multidisciplinary projects are allowed here
4.1 General Description (RL-EGE-LA14-192)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>TECHNOLOGY AND INNOVATION MANAGEMENT</th>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>Joao Alberto Vieira de Campos Pereira Claro</td>
</tr>
<tr>
<td>Research Area</td>
<td>Economics and Management</td>
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</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-192)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

Coordinator in 2013-2014: Prof. João Claro.

This research line is the focus of the UIIT/INESC TEC unit.

The Innovation and Technology Transfer Unit is the core RG for this RL. The RL explores research opportunities in Technology and Innovation Management, mainly associated with INESC TEC role at the university-industry interface, and collaborations with COTEC and UT Austin|Portugal in technology commercialization:

- Technology Entrepreneurship, focusing on early stages of academic new ventures;
- Innovation Management, studying practices, tools, and metrics, and multidisciplinary approaches to the Front End of Innovation;
- Innovation Networks, specifically Open Innovation and technology transfer;
- Technology Strategy, concentrating on roadmapping and the interface of technology and operations;
- Engineering Systems Design, focusing on flexibility and the integration of management and social concerns;
- Science and Technology policy, examining the economics of knowledge.

4.2.2 Main Achievements (2000 ca.)

Unit researchers are co-advising several PhD students with researchers from UESP. The first of these co-advised PhD students graduated in 2013, and three more are expected to graduate in 2015.

A collaboration with UESP, C-BER, Instituto de Telecomunicações, and CMU, in a CMU Portugal Program-funded Entrepreneurial Research Initiation, VR2MARKET, is on-going since 2014.

The unit has also been instrumental in the reorganization of the infrastructure services of INESC TEC, in particular in the creation of a Technology Licensing Office and an Industry Liaison Office, and the definition of key instruments to strengthen INESC TEC's activity in science based innovation, such as its policies for Intellectual Property, Spin-offs, Conflicts of Interest and Commitment, Ethics, or Entrepreneurial Testbeds, a new mechanism for interaction with companies.
4.3 Research Line Output (RL-EGE-LA14-192)
This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)
Include only if more than one Research Groups of the LA is involved. Give title and full citation in original language.

4.3.2 Collaborative Other Publications (2000 ca.)
Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language.

4.3.3 PhD thesis completed (3000 ca.)
Co-supervision or clearly multidisciplinary projects are allowed here.
4.1 General Description (RL-EGE-LA14-193)

<table>
<thead>
<tr>
<th>Research Line Title</th>
<th>INDUSTRIAL ENGINEERING AND SERVICE MANAGEMENT</th>
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<tbody>
<tr>
<td>Principal Investigator</td>
<td>Bernardo Sobrinho Simões de Almada Lobo</td>
</tr>
<tr>
<td>Research Area</td>
<td>Mechanical Engineering</td>
</tr>
</tbody>
</table>

4.2 Objectives and Achievements (RL-EGE-LA14-193)

This section allows you to provide the Objectives and Achievements of the Research Line during the reporting period.

4.2.1 General Objectives (1000 ca.)

Coordinator in 2011: Prof. José António Sarsfield Cabral.

This research line is the focus of the UGEI/INESC TEC associate unit.

This Associate Unit, the Unit of Management and Industrial Engineering (UGEI) is the core research group for this line of research.

UGEI aims to produce problem-driven knowledge focusing on three main fields, as reported in the RG section:

1. Service Engineering and Design
2. Decision Support and Intelligent Systems
3. Performance Management and Business Intelligence

The objective of this RL is to promote a high degree of multidisciplinary and RG interaction. This RL broadens the scope of UGEI activity by integrating other specific competences of the Research Group as well as strengthening synergies and incorporating the skills available in other Research Groups.

Its research projects are based upon real-world problems: Application / problem solving oriented stance - which obviously encompasses the development of innovative theoretical work leading to multidisciplinary projects mainly in Health, Retail, Mobility and Manufacturing, not only within UGEI research team, but also across different INESC TEC units.

4.2.2 Main Achievements (2000 ca.)

MAIN COLLABORATIVE RESULTS

Within the Decision Support and Intelligent Systems research dimension applied to mobility, members from UGEI and UESP have worked on the dial-a-ride problem with split requests and profits. Demand responsive transportation systems are a means to complement standard transportation networks. For the first time in literature, routing problems have been optimized with pickups and deliveries, time windows, request splitting and selection.

A PhD work on “Integrated Vehicle and crew scheduling based on Multiobjective metaheuristics” supervised my members of UGEI and UESP was completed.

Members of UGEI and UESP have launched and co-ordinated Optimization Interunit Line (OIL), an inter-unit line created at INESC Porto LA to promote and cross-fertilize research on optimization. The main activities of the OIL during this period were: the organization of the Weekly Optimization Workshop (WOW); the promotion of joint multidisciplinary project proposals and publications; the joint supervision of graduate students by researchers from different Units.
UGEI has also collaborated with UESP on the research project ShoeID related to supply chain management in the shoe industry. The contribution of UGEI was focused on demand forecasting and planning.

Moreover, members from LIAAD have participated in the UGEI multidisciplinary research project related to the optimization of operating room planning and scheduling and on the proposal that was approved “Solving Management Decision Problems by Genetic Programming”.

Projects carried out in cooperation among several RG:

An integrated framework for operating room capacity planning and scheduling Funded by FCT (FCT, PTDC/EGE-GES/102681/2008): UGEI, LIAAD

PPExt—Industrial Extensions to Production Planning and Scheduling, UGEI, UESP Funded by European Commission – call FP7-PEOPLE-2009-IRSES, Proposal nº 24688

Industrial Extensions to Production Planning, Funded by FCT/CAPES 4.4.1.00, UGEI, UESP

Solving Management Decision Problems by Genetic programming. Funded by FCT (FCT, PTDC/EGE-GES/117692/2010): LIAAD, UGEI, UESP

ShoeID

4.3 Research Line Output (RL-EGE-LA14-193)

This section allows you to provide the productivity of the Research Line during the reporting period.

4.3.1 Collaborative Publications in peer review Journals (2000 ca.)

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4.3.2 Collaborative Other Publications (2000 ca.)

Include only if more than one group is involved and only include here Books, chapters or full papers published in conference proceedings. Give title and full citation in original language.


4.3.3 PhD thesis completed (3000 ca.)

Co-supervision or clearly multidisciplinary projects are allowed here