Modeling, Simulation and Implementation of Locomotion Patterns for Hexapod Robots

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***Abstract*—The legged robots can insert themselves in environments for which the robots with wheels are simply incapable of be inserted, as is the case of obstacles of large dimensions, terrain loose or steep slopes [1]–[5]. The objective of this work is to develop the modeling of hexapods robots and simulate them in a virtual environment of mechanical systems (according to Fig. 1), which makes possible performance analysis of several model criteria and determine the virtual path built by the robot [6]. The present work implemented the robot simulation in the Simulink simulation environment, using SimMechanics [7]. A computer program [8] was developed to make changes in the mechanical structure, in the simulation parameters, to evaluate the stability of the type of locomotion, the direct visualization of the position, speed, acceleration, and force applied to each foot of the robot. With the implementation of the stability determination algorithm, it was possible to verify that, for different locomotion patterns, there was an improvement in the stability, starting from the metachronal wave to tetrapod and tripod gaits, and there was also a consecutive decrease in the minimum torque required to the servo motors [9].**

***Index Terms*—Legged robots, Hexapods, SimMechanics, Modeling, Simulation, Locomotion.**

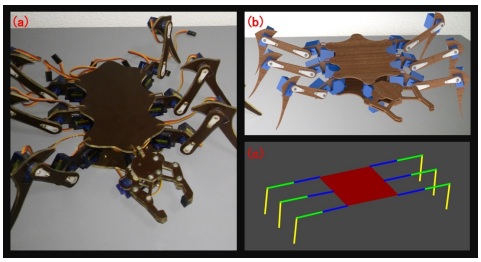

Fig. 1. Robot abstraction steps: (a) real model, (b) virtual model, (c) ideal model.

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REFERENCES

[1] K. Iagnemma and S. Dubowsky, *Mobile Robots in Rough Terrain*, 1st ed. Springer-Verlag Berlin Heidelberg, 2004, vol. 12.
[2] Gorner, Martin and Hirzinger, Gerd, "Analysis and Evaluation of the Stability of a Biologically Inspired, Leg Loss Tolerant Gait for Six- and Eight-Legged Walking Robots," *Robotics and Automation (ICRA), 2010 IEEE International Conference on*, pp. 4728–4735, 2010.
[3] Sorin, Mănoiu O. and Niţulescu, Mircea, "Hexapod Robot. Virtual Models for Preliminary Studies," *System Theory, Control, and Computing (ICSTCC), 2011 15th International Conference on*, pp. 1–6, 2011.
[4] M. F. S. Silva, "Sistemas robóticos de locomoção multipernas," Ph.D. dissertation, Faculty of Engineering of the University of Porto, Porto, Portugal, 2005.
[5] B. Siciliano and O. Khatib, *Springer Handbook of Robotics*, 1st ed. Springer, 2008, vol. 1.
[6] L. F. P. Oliveira, "Modelação, simulação e implementação de padrões de locomoção para robôs hexápodes," Master's thesis, Institute of Engineering of the Polytechnic Institute of Porto, Porto, Portugal, 7 2016.
[7] T. F. V. S. Castro, "Simulação de robôs quadrúpedes utilizando o simmechanics," Master's thesis, Institute of Engineering of the Polytechnic Institute of Porto, Porto, Portugal, 2012.
[8] L. F. P. Oliveira, L. T. Manera, M. F. Silva, and F. L. Rossini, "Software de simulação de robôs hexápodes," BR Patent BR 51 2020 000 582 9, Mar. 31, 2020.
[9] L. F. P. Oliveira and F. L. Rossini, "Modeling, simulation and analysis of locomotion patterns for hexapod robots," *IEEE Latin America Transactions*, vol. 16, no. 2, pp. 375–383, 2018.

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