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REAL-TIME OPTIMIZATION OF THE LIMBS ENERGETIC COST FOR A HEXAPOD ROBOT ACCORDING TO THE TERRAIN TOPOLOGY

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ABSTRACT

Autonomous mobile robots are essential to perform rescue and exploratory missions where the human access is problematic or even impossible. Bearing that in mind, at the University of Minho, the hexapod ATHENA (acronym for All-Terrain Hexapod for Environment Navigation Adaptability) has been developed aiming at autonomously adjusting its locomotion based on the terrain topology. The actuation of the robot legs is of paramount importance in complex environments, due to the instabilities in the torso posture associated with variable foot-force distribution. Besides that, the adaptive locomotion of hexapods must mimic the animals' locomotion, which adjust their gait with the type of terrain to reduce the overall energetic cost. For hexapods, this option implies changing their gait pattern within three possibilities - tripod, wave and ripple. Nonetheless, even the limbs trajectory needs to be adjusted to overcome obstacles caused by the terrain topology, which can significantly increase the energetic cost associated with of motion.

The main goal of this work is to energetically optimize the locomotion of ATHENA, based on its limbs trajectory through the simulation of an equivalent multibody model. For this purpose, four different trajectories for the swing phase are applied to the robot in four different scenarios – a flat surface, a flat surface with 0.02 m height blocks randomly displaced, a ramp, and an irregular ground. The dynamic simulations were performed in Gazebo, and the data related to the transportation cost, and the body oscillation is processed using Machine Learning. In all cases considered, the hexapod adopts a tripod gait, so the system stability differences induced by the utilization of different gait patterns does not influence the obtained results. Through an autonomous comparison of results for all case studies, a real-time estimation of the most adequate foot trajectory was obtained regarding the terrain topology the hexapod must walk across.

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