Assessment on Slip Detection and Recovery on Quadruped Robots

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1. Resumo Estendido / Extended Abstract

Nowadays, mobile robots have greatly improved locomotion and dynamic balance skills. To achieve that, fixed-base and mobile robots have set the analytical and numerical basis for dynamics and control in most robotic applications for decades; in which most of these studies were developed for robotic manipulation with the purpose of moving and assembling objects in industrial lines. But to some extent, locomotion analytical heuristics like Raibert's works, showed that human intuition, with the right mathematical tools, enabled us understanding what is relevant for legged robotics locomotion. In addition, advanced dynamics and contact simulations were designed to aid with the costs of extensive and intensive testing in physical robots, due to energy consumption for autonomous control and hardware's wear; as well with the design of more advanced and affordable electronics and floating-base robots like recent legged robots (bipeds, quadrupeds, hexapods, many-legs) allowed our empirical knowledge to grow and opened new possibilities to improve robot locomotion.

However, slippery locomotion still faces some challenges regarding slip recovery and the dynamic resolution of its nonlinear nature in full-analytical solution attempts. An important observation is that slip recovery is still challenging due to the non-predictable nature of the slip event in the real world. On one hand, most recent works in legged robot locomotion have achieved impressive robustness to slippery scenarios through Deep Reinforcement Learning (DRL). On the other hand, most of these techniques focuses on DRL metrics, such as episodes, reward curve, batch size; however, many possible mechanical metrics could be used to allow a direct comparison between different techniques. Therefore, to solve such challenging problems it's mandatory to look for fair metrics for different methodologies: analytical heuristics, and learned policies. At the same time, using physically accurate simulated environments for experiments for different methodologies comparison should mitigate the replicability difficulties in the real world because the simulators capabilities of resetting all robot and environment states to an identical initial states.

Thus, it's believed that metrics could be created in terms of mechanical energy consumption, stability, how fast the slip recovery happens, and many others that should not be methodology-related. Using these metrics and replicable testing scenarios in simulated environments, many direct comparisons between these more complex controllers could be executed. In this work, we propose a set of comparison metrics and replicable testing scenarios with slippery scenarios on different methodologies.