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EFFECTIVE USE OF FORCE FEEDBACK IN HEXAPOD WALKING

Abstract

Legged systems have shown the potential for use in tasks aligned with space exploration missions. Unfortunately, they have not yet been useful for search and rescue nor exploration missions even here on Earth due to unreliable operation. The purpose of this work is to quantify the effectiveness of force feedback on an experimental legged system, and demonstrate its benefits on the efficiency and adaptability of the system to complex terrain.

Experimental results were gathered using a six-legged system with three different control algorithms: traditional position control, Simple Force Threshold (SFT) control, and the novel Force Threshold Position (FTP) control developed by the authors. The system was presented with four complex terrains and allowed to take 20 walking steps; the distance traveled after these 20 steps was recorded. This process was repeated ten times for each controller on each terrain. The same process was also repeated for configurations where SFT and FTP were used on only the front and middle legs and again on only the front legs. In both cases, the remaining legs used position control.

For all terrains, the force-based controllers outperformed the traditional position control, traveling further and doing so more consistently. FTP also outperforms SFT on all terrains tested, but to a smaller degree. This difference was attributed to fewer instances where the system's body conflicted with the terrain and impeded forward progress. The results also showed that as fewer legs utilized force feedback, the efficiency in terms of both distance traveled and consistency of results decreased with each leg pair lost.

The application of force feedback principles to the walking process of a hexapod robot has demonstrated positive benefits for the traversal of rough terrain. Roughly the size of a skateboard and standing at approximately 10.5 cm at its tallest, the system used in this study realizes the effectiveness of the FTP algorithm. Despite a relatively small stature, the system is able to overcome a large variety of obstacles, including tall grass, rocks, curbs, and stairs up to 18 cm.