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Proprioceptive Actuation Design for Dynamic Legged locomotion[1] SANGBAE KIM, PATRICK WENSING, MIT, BIOMIMETIC ROBOTICS LAB TEAM — Designing an actuator system for highly-dynamic legged locomotion exhibited by animals has been one of the grand challenges in robotics research. Conventional actuators designed for manufacturing applications have difficulty satisfying challenging requirements for high-speed locomotion, such as the need for high torque density and the ability to manage dynamic physical interactions. It is critical to introduce a new actuator design paradigm and provide guidelines for its incorporation in future mobile robots for research and industry. To this end, we suggest a paradigm called proprioceptive actuation, which enables highly- dynamic operation in legged machines. Proprioceptive actuation uses collocated force control at the joints to effectively control contact interactions at the feet under dynamic conditions. In the realm of legged machines, this paradigm provides a unique combination of high torque density, high-bandwidth force control, and the ability to mitigate impacts through backdrivability. Results show that the proposed design provides an impact mitigation factor that is comparable to other quadruped designs with series springs to handle impact. The paradigm is shown to enable the MIT Cheetah to manage the application of contact forces during dynamic bounding, with results given down to contact times of 85ms and peak forces over 450N. As a result, the MIT Cheetah achieves high-speed 3D running up to 13mph and jumping over an 18-inch high obstacle.

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