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Paper title:

Design Guidelines for Bioinspired Adaptive Foot for Stable Interaction with the Environment

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Abstract:

Robotic exploration in natural environments requires adaptable, resilient, and stable interactions with uncertain terrains. Most state-of-the-art legged robots utilize flat or ball feet that lack adaptability and are prone to slip due to point contact with the ground. In this paper, we present guidelines to design an adaptive foot that can interact with the terrain to achieve a stable configuration. The foot is inspired by goat hoof anatomy that incorporates roll and yaw rotations in Fetlock and Pastern joints, respectively. To ensure adaptability with stability in physical interaction and to prevent the foot from collapsing, we provide a lower bound on each joint's stiffness. Additionally, we also render an upper bound to conform to the high force exchange during interactions with the ground consisting of certain roughness. Based on these guidelines, we design the hoof and experimentally validate the theoretical results with a loading test setup in lab settings. We use four different friction materials with various triangular, rectangular, and semi-circular extrusions to simulate common ground features. We observe that hooved pads require more load for the system to be unstable. Any anatomical-inspired foot can be designed based on the guidelines proved analytically and experimentally in this article.

Citation:

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