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Bipedal locomotion in granular media MARK KINGSBURY, TINGNAN ZHANG, DANIEL GOLDMAN, Georgia Inst of Tech — Bipedal walking, locomotion characterized by alternating swing and double support phase, is well studied on ground where feet do not penetrate the substrate. On granular media like sand however, intrusion and extrusion phases also occur. In these phases, relative motion of the two feet requires that one or both feet slip through the material, degrading performance. To study walking in these phases, we designed and studied a planarized bipedal robot (1.6 kg, 42 cm) that walked in a fluidized bed of poppy seeds. We also simulated the robot in a multibody software environment (Chrono) using granular resistive force theory (RFT) to calculate foot forces. In experiment and simulation, the robot experienced slip during the intrusion phase, with the experiment presenting additional slip due to motor control error during the double support phase. This exaggerated slip gave insight (through analysis of ground reaction forces in simulation) into how slip occurs when relative motion exists between the two feet in the granular media, where the foot with higher relative drag forces (from its instantaneous orientation, rotation, relative direction of motion, and depth) remains stationary. With this relationship, we generated walking gaits for the robot to walk with minimal slip.

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