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Slithering on sand: kinematics and controls for success on granular media. PERRIN E SCHIEBEL, TINGNAN ZHANG, Georgia Institute of Technology, JIN DAI, CHAOHUI GONG, MIAO YU, Carnegie Mellon University, HENRY C ASTLEY, Georgia Institute of Technology, MATTHEW TRAVERS, HOWIE CHOSET, Carnegie Mellon University, DANIEL I GOLDMAN, Georgia Institute of Technology — Previously, we studied the *subsurface* locomotion of undulatory sand-swimming snakes and lizards; using empirical drag response of GM to subsurface intrusion of simple objects allowed us to develop a granular resistive force theory (RFT) to model the locomotion and predict optimal movement patterns. However, our knowledge of the physics of GM at the surface is limited; this makes it impossible to determine how the desert-dwelling snake *C. occipitalis* moves effectively (0.45+/-0.04 bodylengths/sec) on the surface of sand.We combine organism biomechanics studies, GM drag experiments, RFT calculations and tests of a physical model (a snake-like robot), to reveal how multiple factors acting together contribute to slithering on sandy surfaces. These include the kinematics—targeting an ideal waveform which maximizes speed while minimizing joint-level torque, the ability to modulate ground interactions by lifting body segments, and the properties of the GM. Based on the sensitive nature of the relationship between these factors, we hypothesize that having an element of force-based control, where the waveform is modulated in response to the forces acting between the body and the environment, is necessary for successful locomotion on yielding substrates.

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