Proposal for a Master internship

Locomotion in granular media

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Many living species have evolved to move within granular environments such as sand. Examples include snakes that slither across deserts, lizards that swim beneath sandy surfaces, and razor clams that burrow into the seabed (Fig. 1a) [1]. Locomotion in such environments is highly challenging because granular materials are heterogeneous, strongly dissipative, and exhibit complex mechanical behavior, transitioning between solid- and fluid-like states. Animals provide remarkable sources of bioinspiration for identifying efficient strategies to move through granular media. Such bio-inspired approaches could ultimately enable the design of robots capable of exploration and rescue operations in deformable granular terrains.

(a) (b)

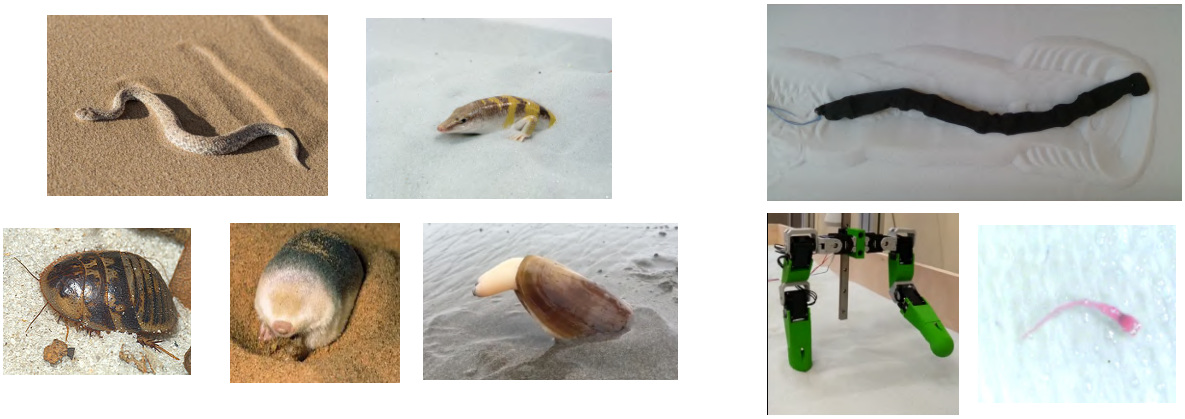

Figure 1: (a) Examples of species adapted to granular environments. (b) Robots and active systems studied at FAST: a snake robot slithering on a granular substrate; a legged robot walking on sand; and magnetic swimmers in wet grains.

At the FAST laboratory, we experimentally investigate the strategies animals use to move through sand and assess their effectiveness and robustness. To this end, we design bio-inspired robots and active systems and study their behavior in controlled granular environments. Our main sources of inspiration are the locomotion modes of snakes, beetles, worms, and moles in sand and soil, as well as legged locomotion on granular substrates (Fig. 1b). The objective of these experiments is to uncover the physical principles governing interactions between moving bodies and granular materials [2, 3]. Ultimately, this research aims to establish a physics-based framework both for protecting desert fauna and for developing robots capable of navigating sandy environments.

We welcome inquiries from anyone interested in locomotion, granular mechanics, or robotic design and control- free to reach out to us.

[1] AE Hosoi and Daniel I Goldman. Beneath our feet: strategies for locomotion in granular media. *Annual review of fluid mechanics*, 47:431–453, 2015.

[2] Baptiste Darbois Texier, Alejandro Ibarra, and Francisco Melo. Propulsion by reciprocal motion into granular media. *Physical Review Fluids*, 6(3):034604, 2021.

[3] Antoine Seguin, Yann Bertho, and Baptiste Darbois Texier. Penetrating a granular medium by successive impacts. *Physical Review E*, 106(5):054904, 2022.