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Robotics and Biology: Lets get Physical

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Our research group investigates the core fundamentals of locomotion as it exists in biology and as it applies to locomoting robotic systems. Initially, our work advanced techniques found in geometric mechanics to design cyclic controllers, often called gaits, for snake robots, highly articulated mechanisms that can thread through tightly packed spaces to access locations people cannot. We had considerable success in designing snake robot gaits, but found our systems stymied in terrains characterized by sandy substrates. Sandy terrains and other granular media pose a challenge to snake robots because it is unclear how the mechanism interacts with environment: we cannot simply assume the robot is on hard-ground nor in a fluid. Simulating granular interactions can prove to be computationally intractable for real-time use on the robots. Therefore, we developed experimental tools that allowed us to sieve out models of the locomoting systems operating on granular media. We were then able to bring these models into harmony with the elegant formulation of our geometric mechanics approach. This allowed us to derive adaptive controllers for our snake robots in sandy terrains, and enabled us to gain deeper insight into of how biological systems move over similar terrains as well.