

EGR 557 Presentation I

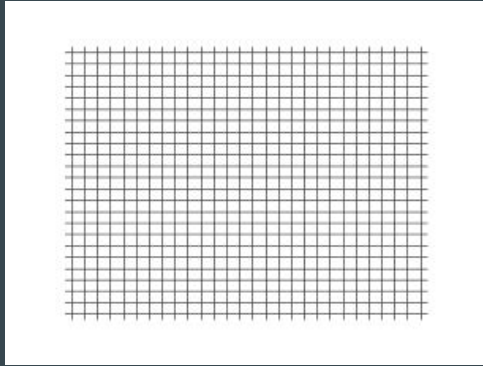
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Research Question: How can a snake-inspired biodegradable robot be created using foldable robotics principles?

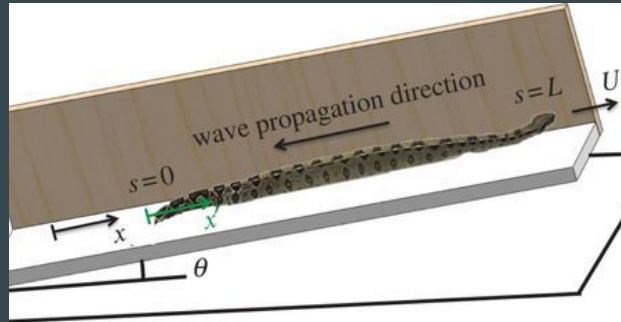
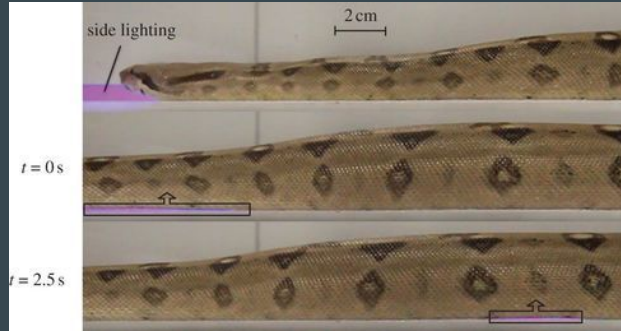
Biomechanics-driven Inspiration: Snake Rectilinear Motion

Rectilinear Motion & Longitudinal Wave [4]



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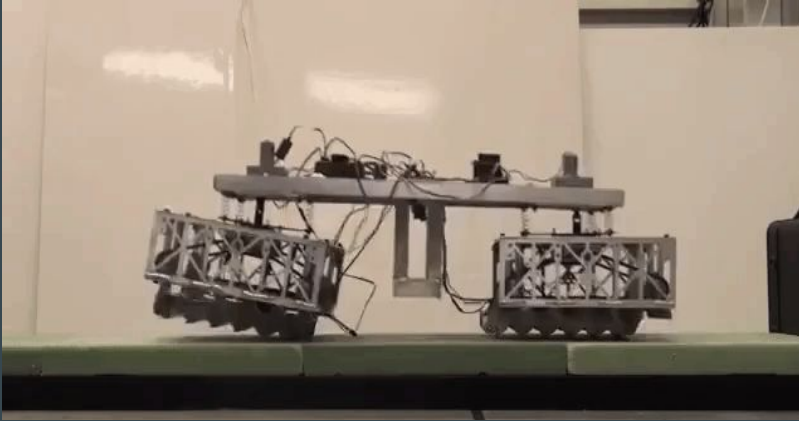
Rectilinear Locomotion [1] [3]



Biomechanics-driven Inspiration: Snake Rectilinear Motion

Previous Robots:

- Study on rectilinear locomotion by Georgia Tech [3]



Vertical and forward motion

Closed loop

Longitudinal wave

Biomechanics-driven Inspiration: Snake Rectilinear Motion

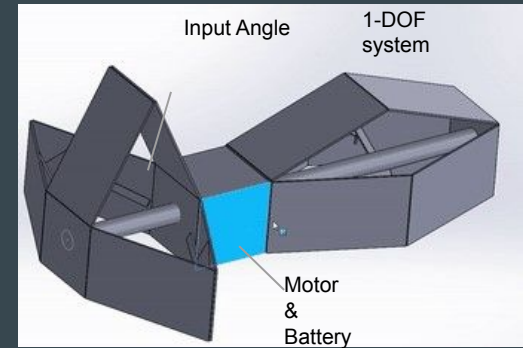
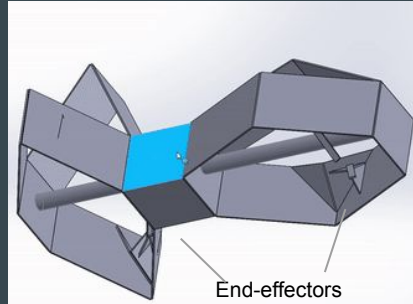
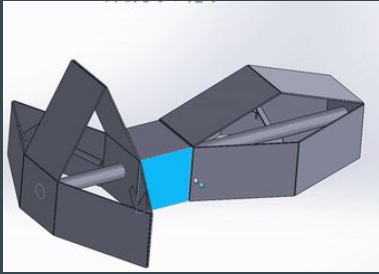
Parameter	Unit	Value Range
Total Mass	kg	.6±.1
Length	m	.3-.9
Average Speed	ft/s	0.33-0.197
Forward sliding friction coefficient	unitless	.3±.06 [1]
Backward Sliding friction coefficient	unitless	.42±.05
Cost of Working (partial energy cost of movement)	J/(kg*m)	.5-1
Ground Friction Reaction Force	N	2.4±.05

Key takeaways:

- Slow moving
- Closed loop needed to overcome forward and backward sliding friction

Proposed Mechanism: Snake-Inspired Biodegradable Robot

- Current Layout of Mechanism:



- Current Physical Prototype:

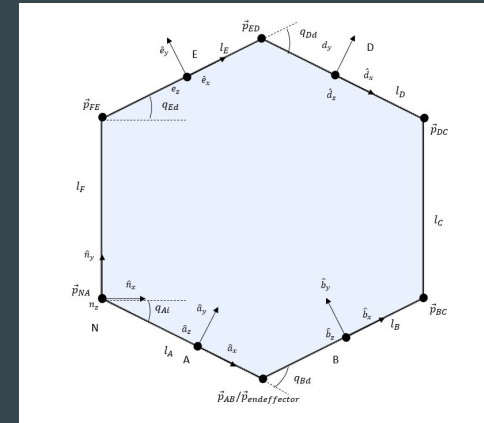
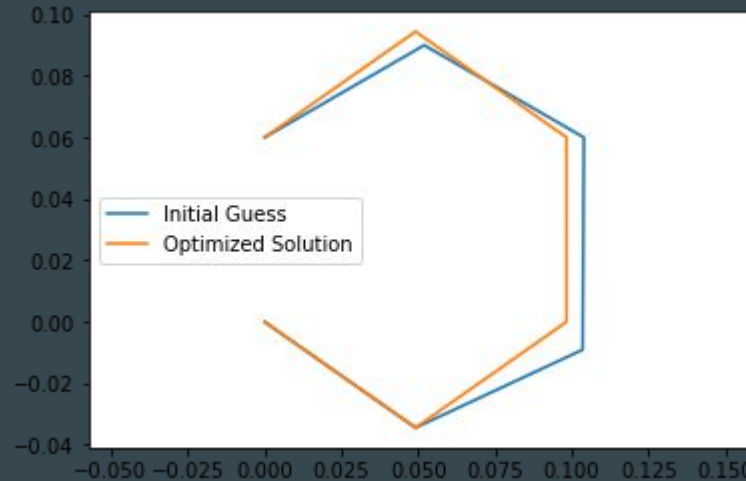
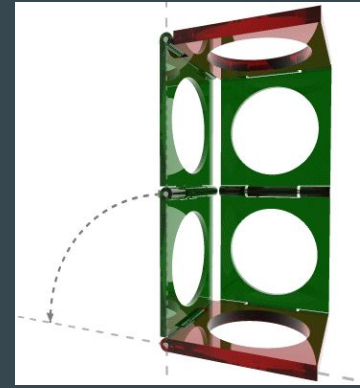


Current prototype:

- Vertical motion
- Horizontal motion
- Attempted longitudinal waves (2 links)

Kinematics: Sarrus Linkage

- 2-D model using two 2-bar linkages (AB and ED) with a constant distance at endpoint. Creating 1 independent state q_{Ai} and 3 dependant states q_{Bd} , q_{Dd} , q_{Ed} .
- The force at the end effector was estimated using recorded mass and acceleration to estimate ground reaction forces.
- This was then used with the external Jacobian to calculate the required input torque of 0.31 N*m



Future Plans:

- Implement closed loop
- Ensure longitudinal wave functionality
- Model kinematics and dynamics for additional actuators and design changes

Questions to be Answered:

- Are there biodegradable actuators and motors that will allow the robot to be fully biodegradable while achieving a desired result?
- How will the stiffness of the biodegradable material effect the robot's functionality?

Bibliography

1. H. Marvi, J. Bridges, and D. L. Hu, "Snakes Mimic Earthworms: propulsion using rectilinear travelling waves," The Royal Society, vol. 10, no. 84, Jul. 2013.
2. "Rectilinear motion," Merriam Webster, 2021. [Online]. Available: <https://www.merriam-webster.com/dictionary/rectilinear%20motion>. [Accessed: 21-Feb-2021].
3. E. Ackerman, "Full Page Reload," IEEE Spectrum: Technology, Engineering, and Science News, 20-Jan-2012. [Online]. Available: <https://spectrum.ieee.org/autoton/robotics/industrial-robots/georgia-tech-rescue-robot-moves-like-a-snake-doesnt-look-like-one>. [Accessed: 28-Feb-2021].
4. By Christophe Dang Ngoc Chan (cdang) - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=1386746>