Slytherdrive

Soft Snake Robot

Group 24

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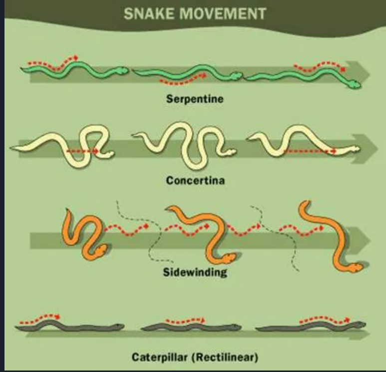
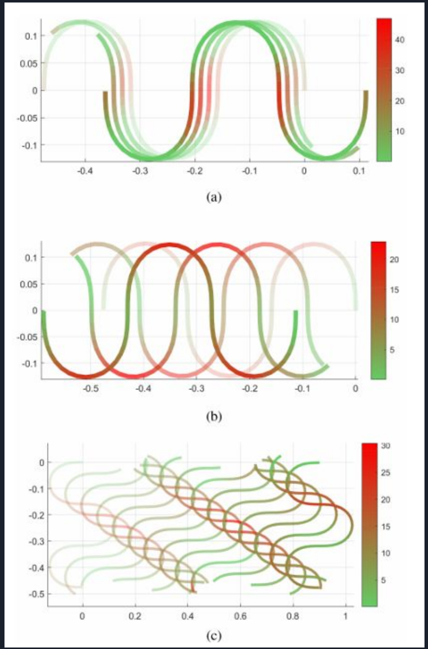
Our Project

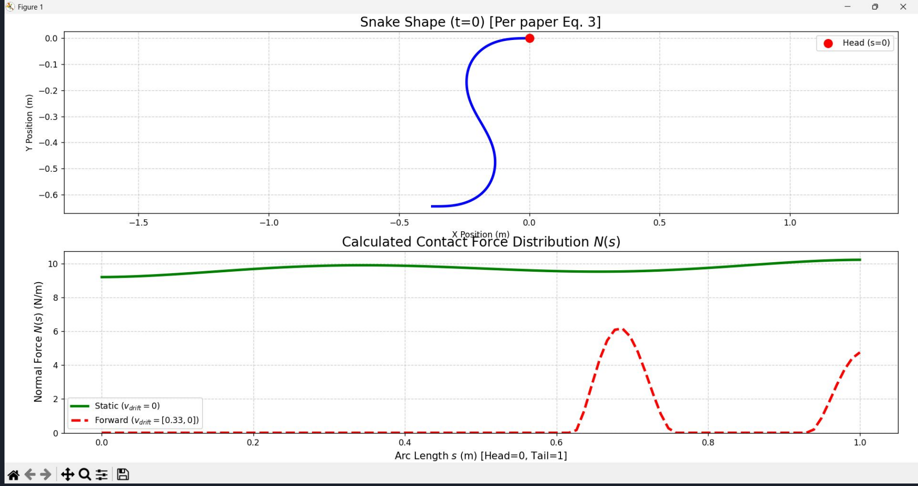
Our New Goal:

- Model and design a robotic snake that mimics the following natural snake movements:
  - Serpentine
  - Sidewinding
- We are currently approaching the modeling in two ways:
  - Simulation
  - Physics environment
- Body Tension → Ground Reaction Force Distribution → Motion
- Replicating: **Robotic Snake Locomotion Exploiting Body Compliance and Uniform Body Tensions by Junhyoung Ha**

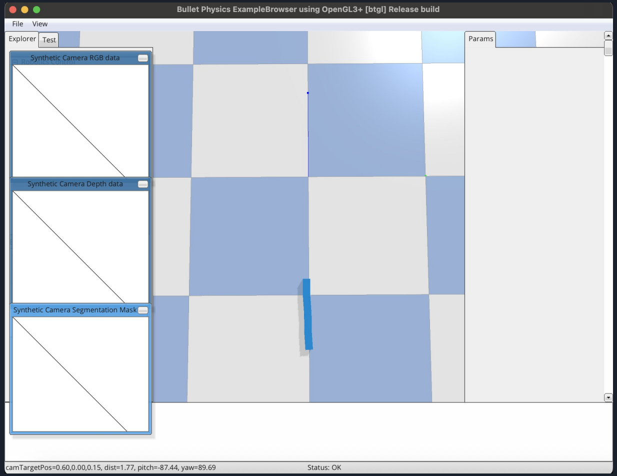




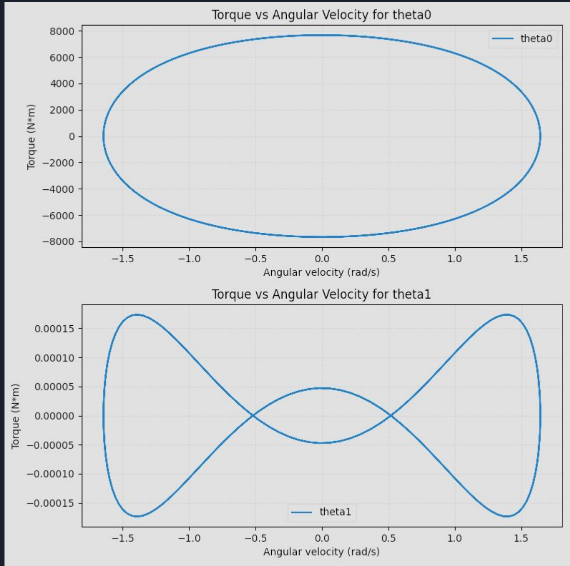
Simulations



Ground Contact Force Simulation



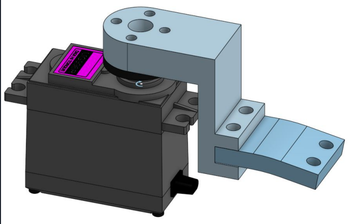
Dynamic 3D Simulation

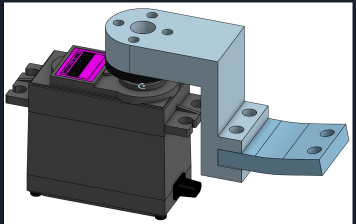


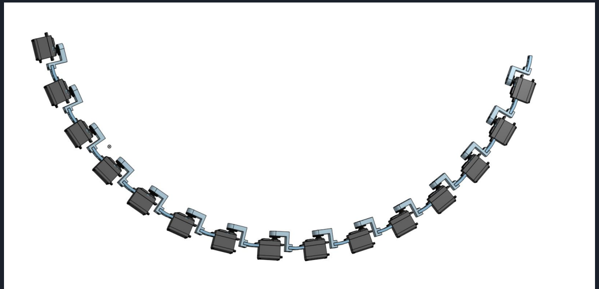
Initial derivation of required torque/speed curves (incomplete due to calculation times)

Hardware & Next Steps

- Developed a preliminary 3D CAD model to visualize and analyze the new robotic snake structure
- Implemented servo-based control for segment synchronization and cost efficiency
- Designed custom hinges and curved TPU blocks to replace rubber bands
- Plan to integrate simulation results with CAD model for motion and control refinement
- If time allows, will fabricate a physical prototype based on the finalized design

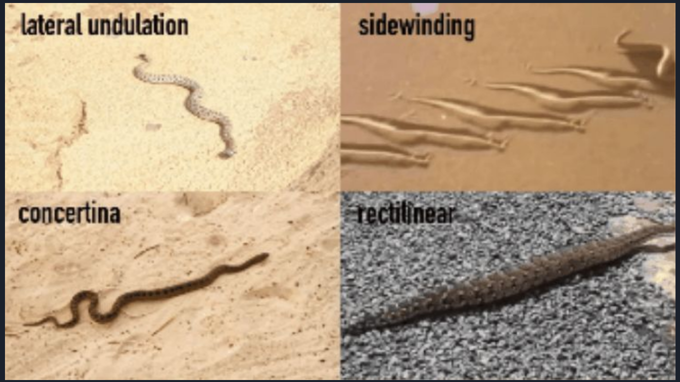


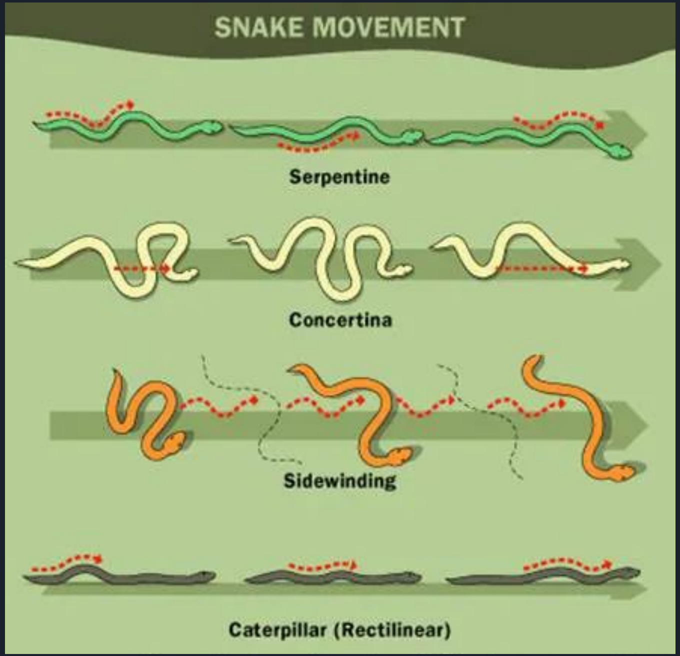




Project Introduction

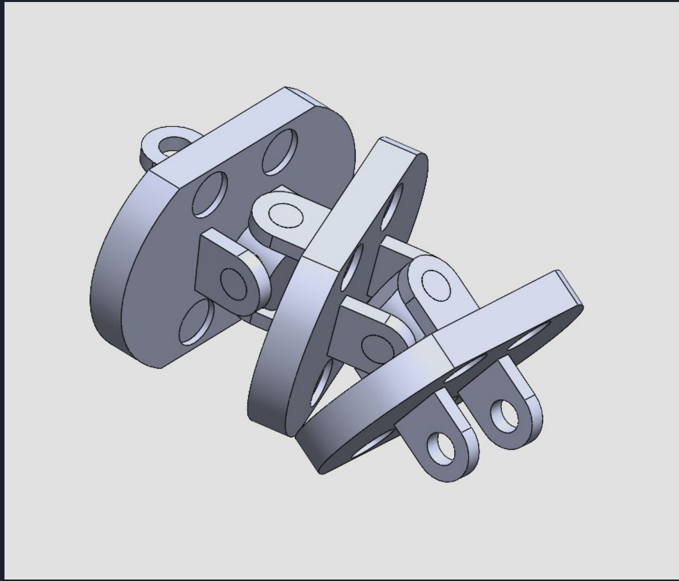
- Concept: **Pneumatic Snake Robot**
- 4 main modes of locomotion:
  - ***Serpentine*** (wave-like bends push along the surface)
  - ***Sidewinding*** (body segments lift off the ground and push the rest of the body diagonally)
  - Concertina (anchor body, bunch up, and stretch out)
  - Rectilinear (belly scales push back like legs of a millipede)
- Engineering Principles:
  - Rigid and continuum mechanics
  - Fluid dynamics for pneumatic controls
  - Control of a highly redundant robotic system





Implementation & Design

- Chain of rigid exoskeletal “vertebrae” connected by soft pneumatic actuators
- Hinges between vertebrae allow for pure rigid-body kinematics
- Risks/challenges:
  - Pressure tube management
  - Developing a high degree-of-freedom pneumatic control system
  - Measuring position of each joint
  - Developing an easy-to-manufacture scale-like surface with anisotropic friction



Semester Timeline

Week	Simulation/Control Development	Hardware Development
0 *(9/22)* [Presentation 1]	Research motion and gaits in literature	Purchase pneumatic control components
1 *(9/29)*		Complete CAD model & prototype a few vertebrae
2 *(10/6)*	Import CAD model, initial simulation setup	Integrate vertebrae prototype with pneumatic controls
3 *(10/13)*		Testing with prototype
3 *(10/20)*	Develop a variety of gaits for straight line motion, turning, and traversing obstacles	Iterate on vertebrae design & purchase rest of components
5 *(10/27)* [Presentation 2]		Complete manufacturing of all vertebrae
6 *(11/3)*		Complete robot assembly
7 *(11/10)*	Real-world testing	
8 *(11/17)*		
9 *(11/24)*	Testing & Finalization	
10 *(12/1)*	Final Presentation & Report	