Team 5- Project Update

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Refined Research Question:

"How can foldable techniques translate a small number of actuators into unique locomotion?"

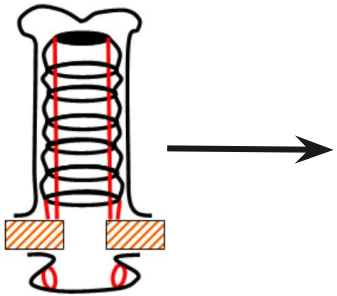


Figure 1: Tube foot (podia) bioinspiration [1]

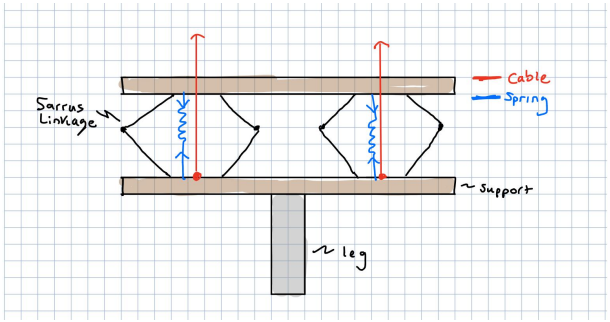


Figure 2: Conceptual device drawing

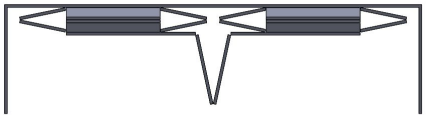


Figure 3: System motion concept

Current Specifications

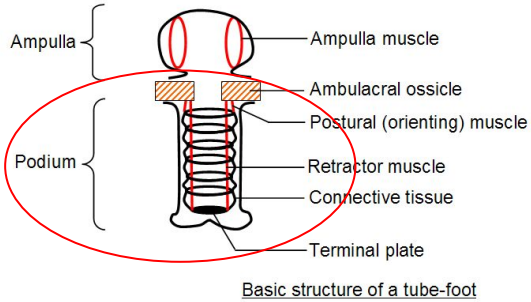


Figure 4: Basic structure of a tube foot [1]

- Bio-Inspiration change
  - Lumbricus Terrestris peristalsis → starfish tube foot (podia)
  - More interesting motion through foldable techniques.
- Spec Changes?
  - Cardstock still viable; can be layered for strength/stiffness.
  - Only need to support weight of actuator/power source/controller → Number of actuators remains the same.
    - More actuators → more complex motion achievable
  - Sarrus linkage properties able to be reused.

Dynamics

Figure 5: Device point and frame diagram

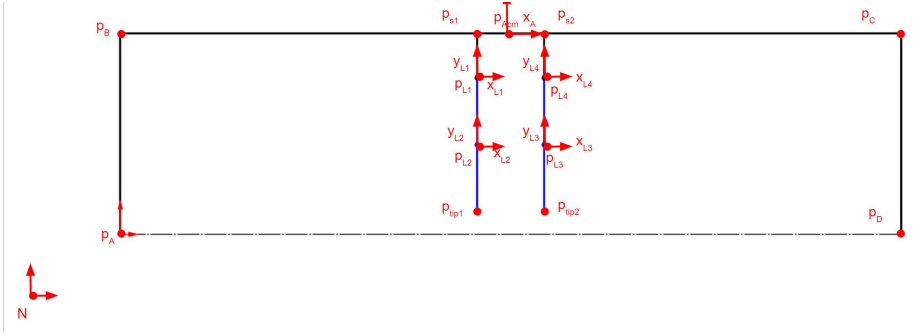
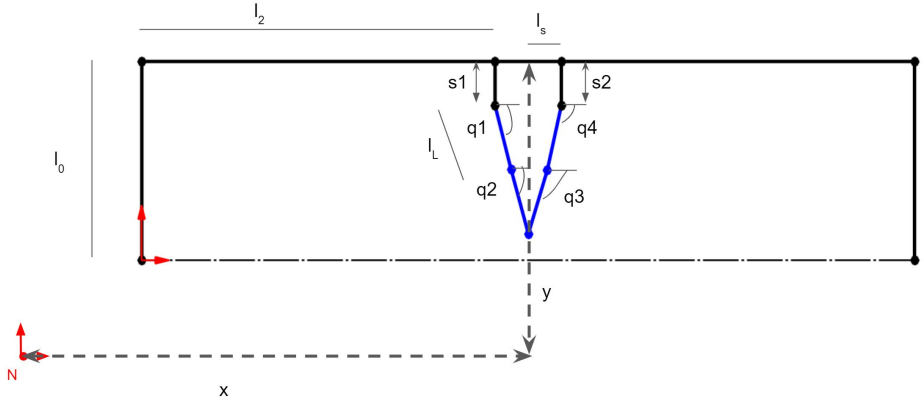
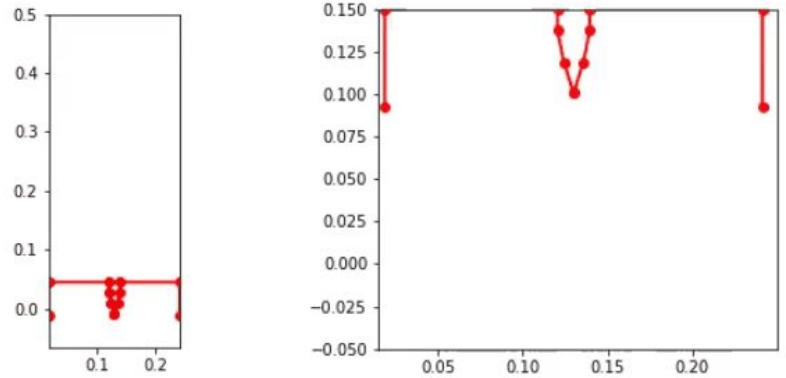


Figure 6: Device differentiable var and length diagram



- Forces Considered:
  - Gravity
  - Leg spring force
  - Sarrus Linkage force (sin wave)
  - Floor force (normal/friction)
- Justification:
  - Simplified sarrus linkages → variable lengths with spring preload
  - Single leg → needs outer frame for stability

Figure 7: System dynamics results



Data Collection, Parameter Id, and Model Fitting

Prototype and Motion

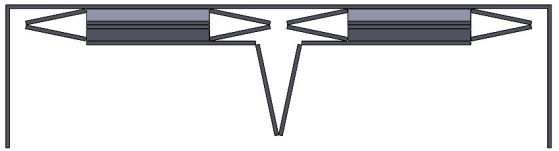


Figure 3: System motion concept

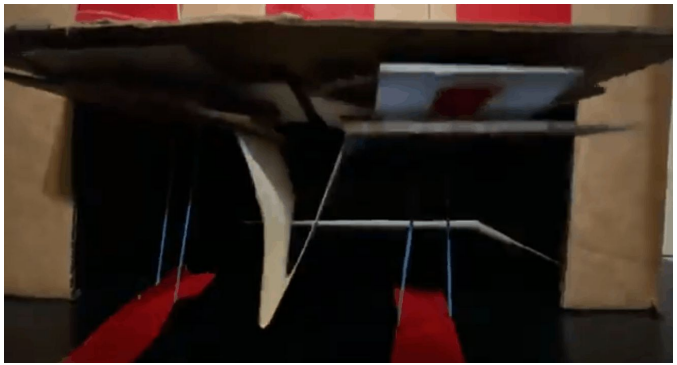


Figure 8: Prototype concept, up and down

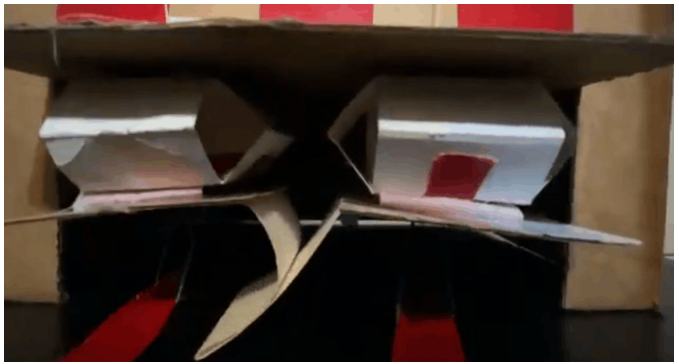


Figure 9: Prototype concept, walking

Data Collection, Parameter Id, and Model Fitting

Cantilever Beam and Stiffness

Figure 10: Stiffness Test

Table of deflections

Mass(g)	Deflection_Violet(cm)	Deflection_Red(cm)	Deflection_Green(cm)
100	2.0	2.0	1.5
200	4.0	6.0	2.5
300	6.5	8.0	4.0
400	7.5	9.0	6.0
500	8.0	9.0	7.5

Table 1: Deflections of Cardstock

E = 158MP a

k = 244530Nm^{-1}

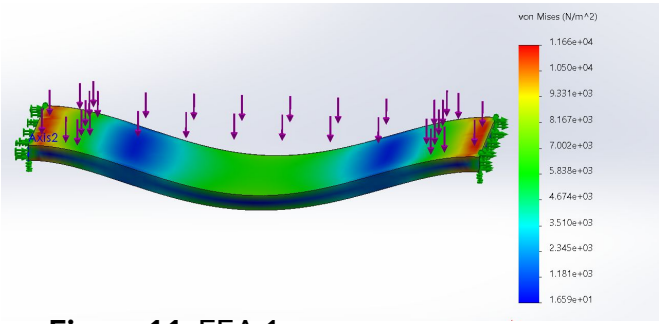


Figure 11: FEA 1

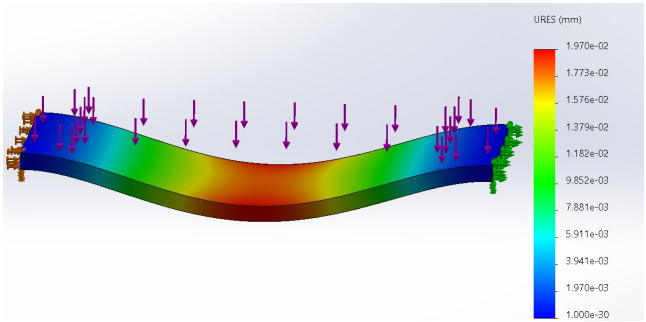


Figure 12: FEA 2

Motor Analysis and System Weight

Metric	Value
Voltage Range (VDC)	3-12
Max Current (A)	0.17
Max Torque (N-m)	0.002481
Pulley Radius (cm)	2.54
Force(mN)	97.68
Motor Weight (g)	50
System Weight (g)	57

Table 2: Motor Specifications

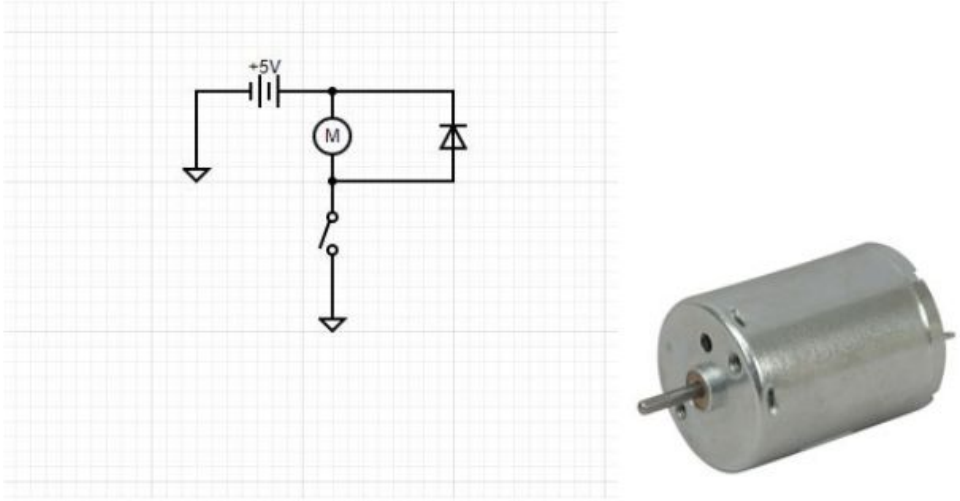


Figure 13: Motor circuit diagram and DC motor

Future Plans

- Finalizing dynamics
- Springs
- Buying materials
- Build full prototype

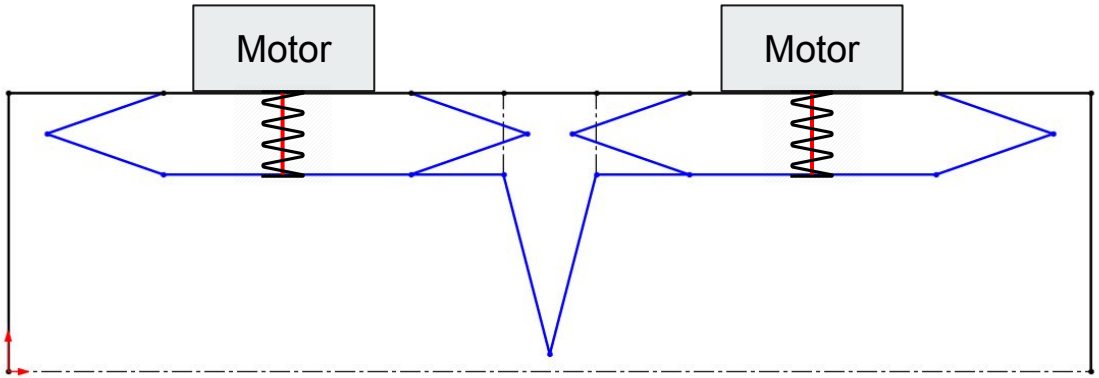
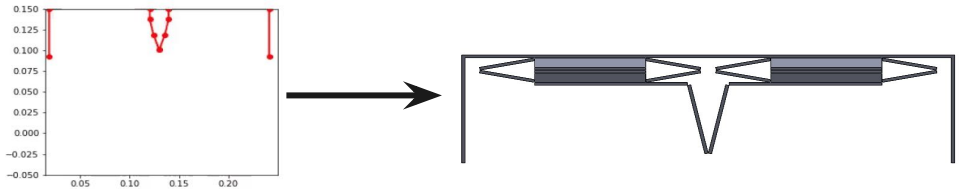


Figure 14: Future plans system prototype



References

[1] Cronodon BioTech, Asteroid mechanics, “Asteroids 2- Hydraulic systems” https://cronodon.com/BioTech/Asteroids_hydraulics.html