MAE263F Midterm Presentation

Modeling a Soft Modular Adaptive Robotic Technology (SMART) Arm

Che Jin Goh and Agathiya Tharun

Overview

Goal:

- Simulate a modular soft robotic arm
- Develop a foundational framework for researchers to leverage and tweak to model their proposal

Method:

- Assign variable stiffness to each node
- Apply forces to “spawned joints” in a representative way to induce bending
    - Unstiffened nodes

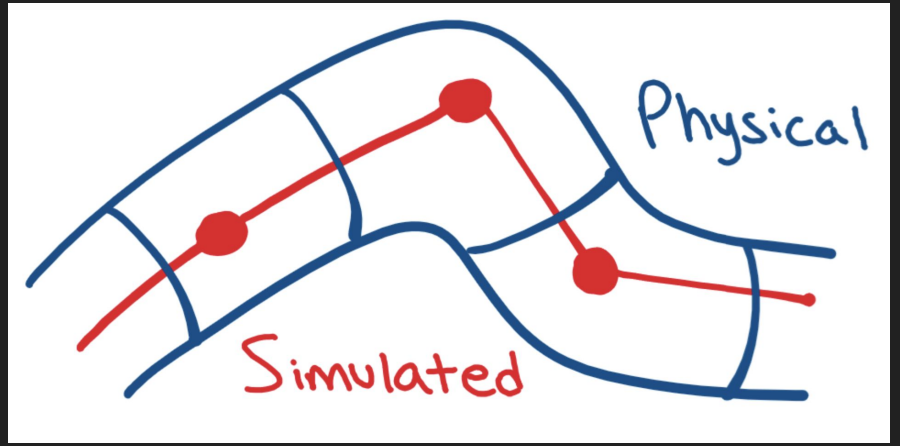
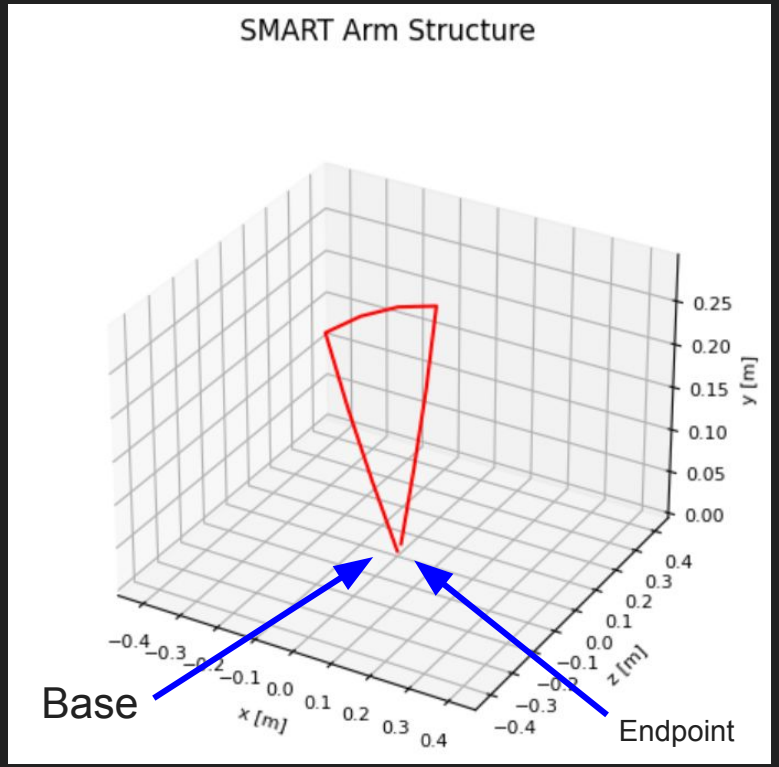


Figure 1: Simulated vs physical representation of soft arm

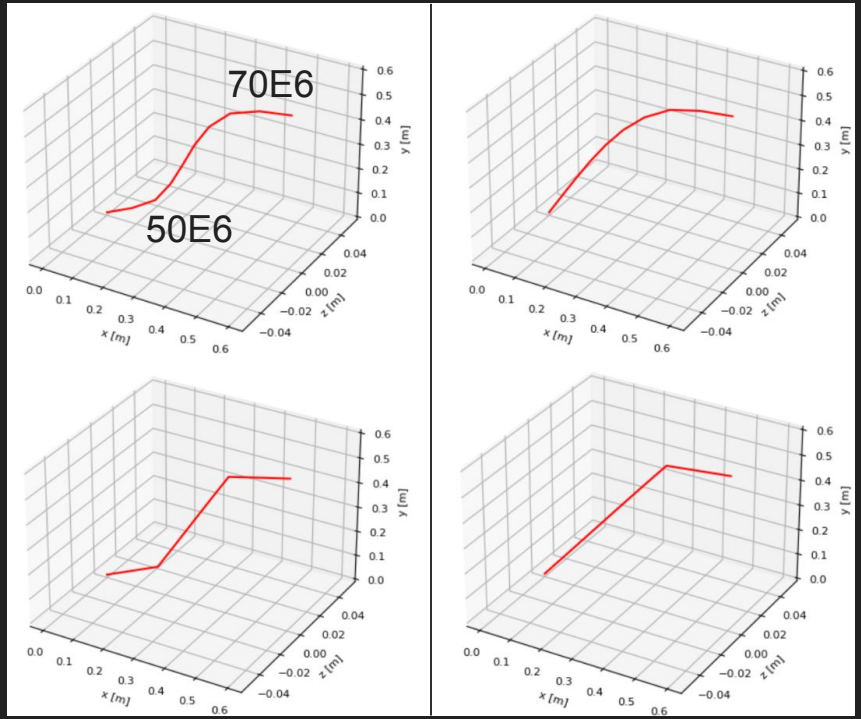
SMART Arm Capabilities

- User-defined number of nodes, lengths, and stiffnesses
- Applied 1-DOF forces to induce bending at “spawned joints”
  - Mimics physical contraction and rotational actuation
- SMART Arm can reach tight spaces near the base that traditional arms cannot; enhanced workspace



SMART Arm Capabilities

SMART Arm leveraging soft robotic capabilities and variable nodal stiffness



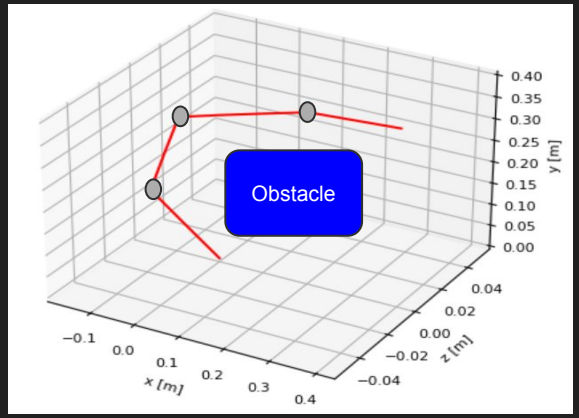
SMART Arm morphing to 1 DOF with variable nodal stiffness

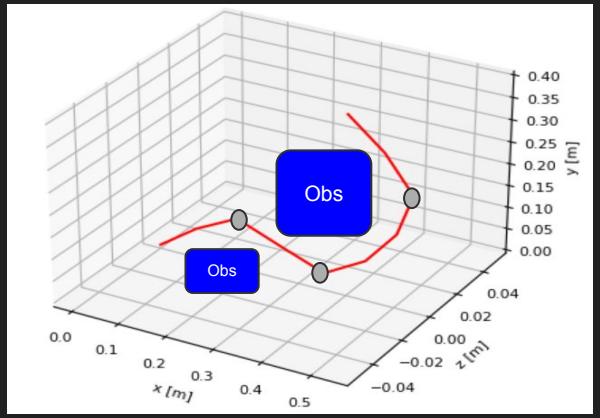
Traditional robotic arm with 2 DOF

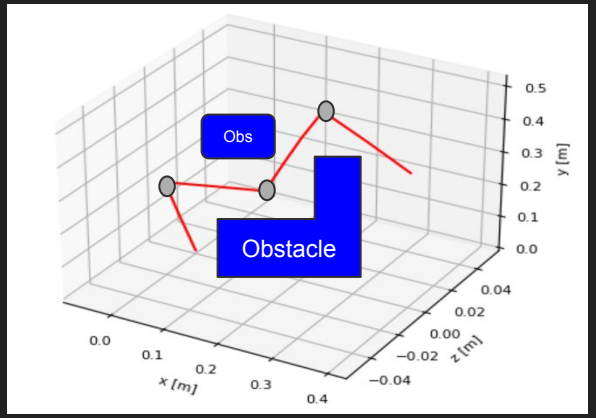
Traditional robotic arm with 1 DOF

Inverse Kinematics Solver

- SMART Arm can be used as an IK solver and produce the shape required to reach an endpoint.
- Manual force inputs can be used to dodge obstacles as needed.
- Variable stiffnesses are leveraged to vary arm fluidity/continuity







References

1) Hajiesmaili, E., & Clarke, D. R. (2021). Dielectric elastomer actuators. Retrieved from https://pubs.aip.org/aip/jap/article/129/15/151102/1025587/Dielectric-elastomer-actuators
2) (N.d.). Retrieved from https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8722799
3) Jiang, H., Wang, Z., Jin, Y., Chen, X., Li, P., Gan, Y., … Chen, X. (2021). *The International Journal of Robotics Research*, *40*(1), 411–434. doi:10.1177/0278364920979367
4) Liow, L., & Howard, D. (2024). *Frontiers for Young Minds*, *12*. doi:10.3389/frym.2024.1341887
5) Scalet, G. (2020). Two-Way and Multiple-Way Shape Memory Polymers for Soft Robotics: An Overview. Retrieved from https://www.mdpi.com/2076-0825/9/1/10