Novel actuator for artificial muscles: Electro Permanent magnet-EPM

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Executive Summary

- An electro permanent magnet (EPM) features two adjacent cylindrical magnets, one characterized as the switchable magnet, the other as the fixed magnet.
- Future goal of being integrated into haptic technologies and artificial muscle by being downsized to mm range by using a bellows

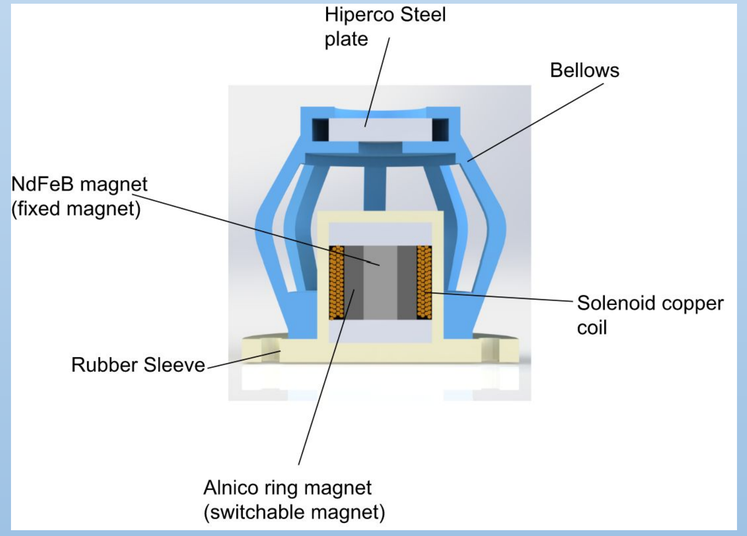
Design Process

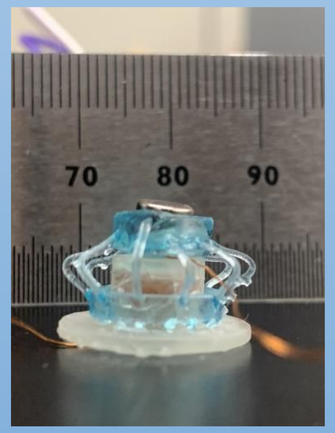
Design Requirements of Bellows

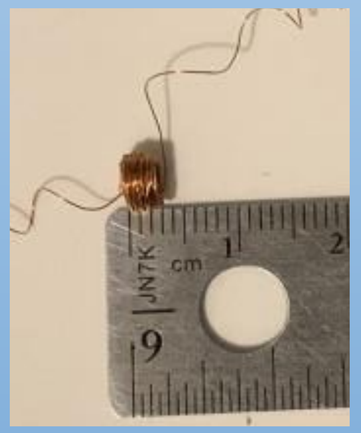
- Small form factor of ~100mm^3
- Able to hold weight of magnet
- Deflection with response to a change in the magnetic field
- Able to withstand stress from deflection

Design Requirements of Magnet

- Magnet parameters are mostly restricted by manufacturing availability.
- EPM consists of two cylindrical magnets, one inner(NdFeB), and one outer(alnico) with 34 gauge copper wire coiled around the larger one







Analysis

Analysis of Bellows

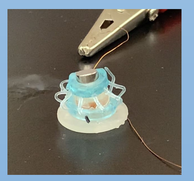
- Parameters Analyzed:
  - Corrugation height:x∝h
  - Stress-strain relationship for resin:x ∝ 1/E
  - Thickness of legs: x ∝ t
  - Number of legs: x ∝ 1/N(legs)

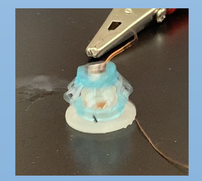
Analysis of Magnet and Multilayer solenoid

- Parameters Analyzed:
  - Coercivity of AlNiCo ~200mT
  - Current needed to actuate: ~12A

Performance

- Bellows successfully deflected
- Successful actuation at a given current
- Device turned ON/OFF





Future Improvements

- Look into using elliptical model for bellows.
- Use designed AlNiCo ring.
- Switch to magnet instead of steel plates
- Find a way to lower current and increase deflection
- Minaturize for haptic feedback

References and Acknowledgements

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