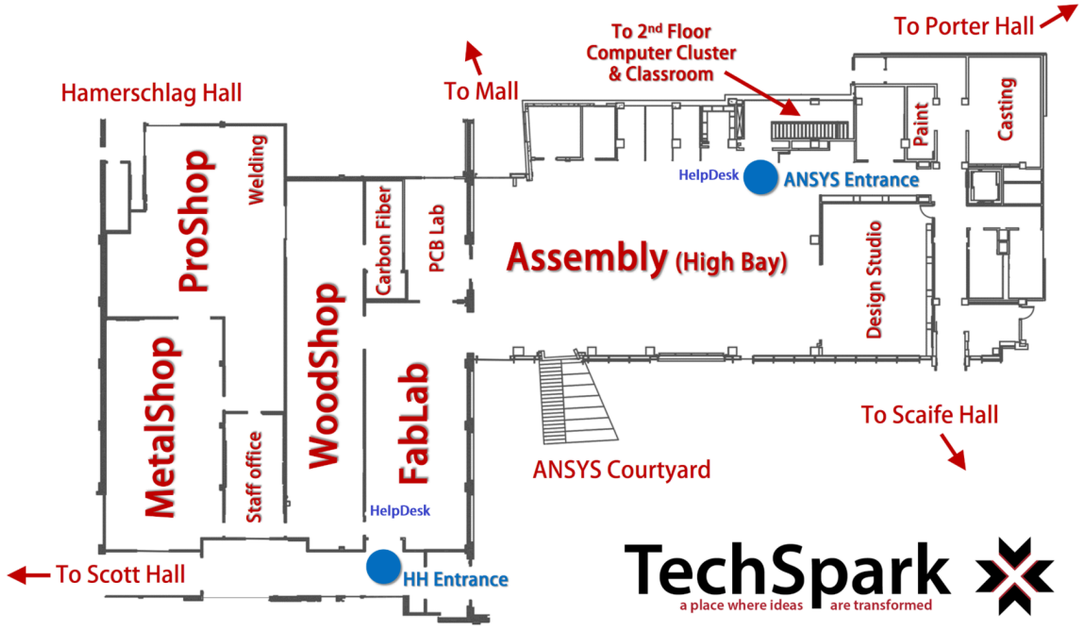
Final Projects

- Find something that fits your specific interests and strengths

- We may be able to help you find resources https://engineering.cmu.edu/techspark/index.html

Facilities layout



Tech Spark facilities layout

Example Projects

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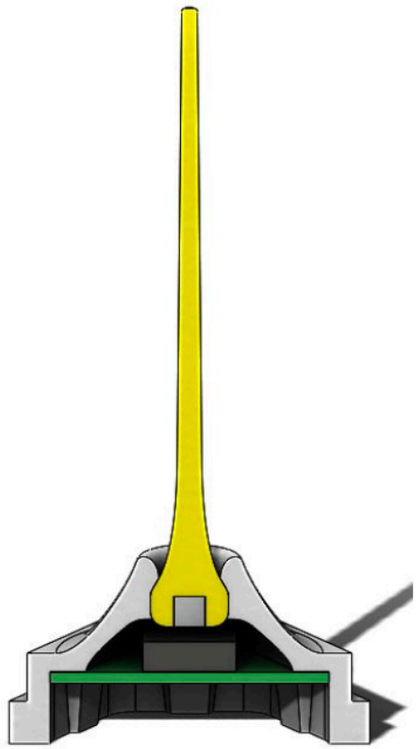
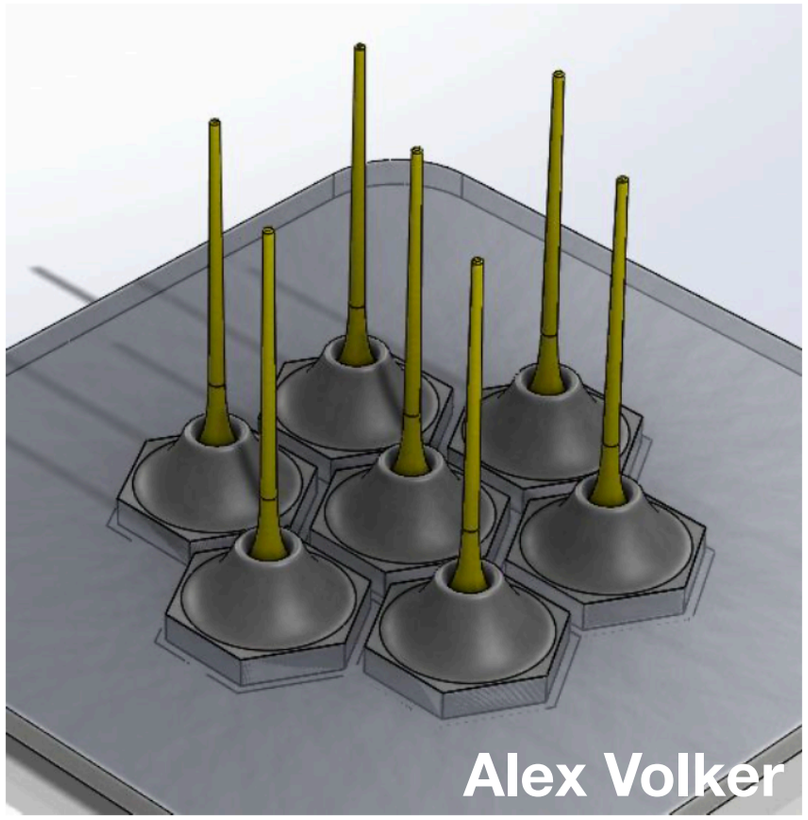
Approach: Mechanical Design





Here are some CAD renderings of the present whisker design. A multi-material casting approach is taken in order to simplify the mechanical structure. The left figure shows a cutaway view of an individual whisker element. For reference, the cross-sectional width of the base (grey) is approximately 10 mm.

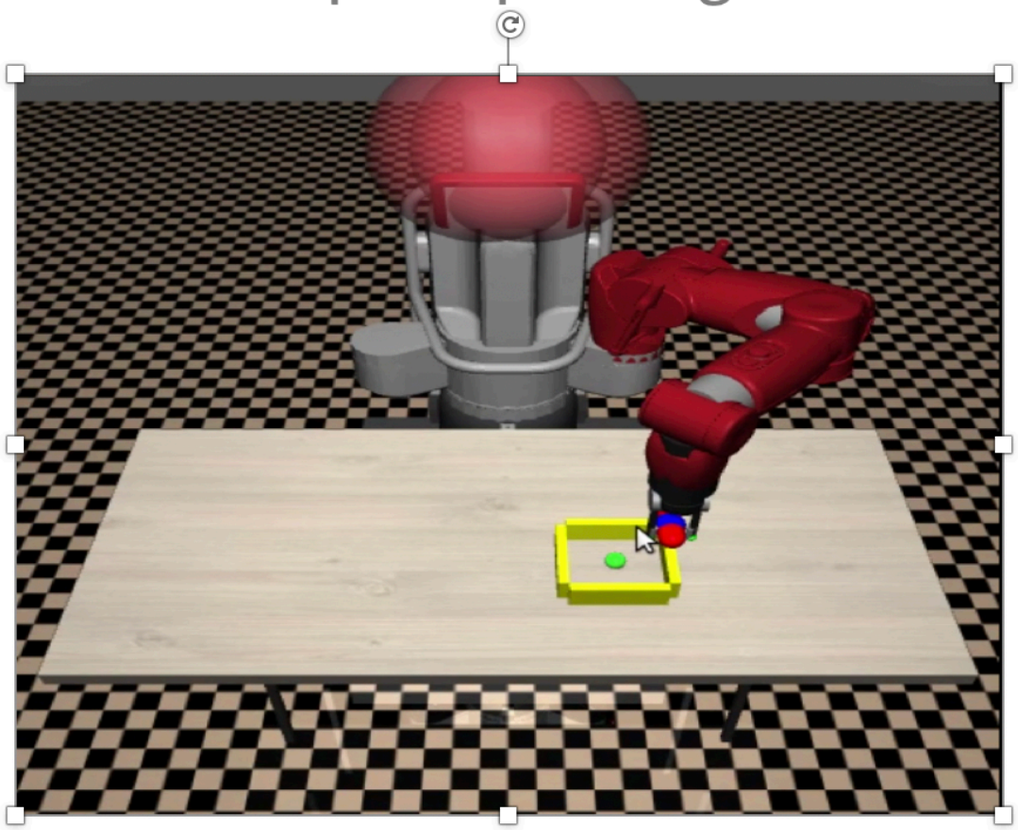
The stem (yellow) is composed of a stiff rubber material, at least 60A, approximately 1 mm in diameter. The base (grey) is a more compliant rubber, at most 40A. A small, 1 mm diameter by 1 mm thick, neodymium (N42 grade or better) magnet is embedded at the lower end of the stem, just above the 3-DoF hall sensor (black), mounted on a pcb (green).

The figure on the right shows a cluster of seven such whiskers.

Objective

Learn hierarchical policy: Learn **parameterized policy** where parameters correspond to meta-parameters of skills.

Long term running example: put an object inside a box which requires pressing a button to open the box.



Plan could be

1) Move to box(goal position),
2) Push the button(goal, direction),
3) Move to cup(goal position, direction)
4) Grasp the cup(goal position),
5) Move the the cup above the box(goal position)
6) Ungrasp the cup

The coffee ground hand solidly adheres to the wrist as hoped, with high lifting capability. The 600g mug is shown being lifted with the hand in the cupped position. Weights as high as 5kg were successfully lifted in similar configurations.

… a few more

- measuring success of canonical grasps on benchmark tasks (David Butterworth)
- building a hand with nonlinear passive compliant joints (Reuben Aronson)
- building a hand for supporting large weights (Mark Martone)
- learning to push with a soft hand (Dominik and Cornelia Bauer)
- optimizing hand design for robust translation / rotation (Andre Meixner)
- grasping scanned objects in the real world (Puneet Puri)
- comparing controller response to noise (Sherman Lam)
- labelling human manipulation tasks (Yuzi Nakamura)

Other Ideas / Themes

Make a hand

- Yale OpenHand project https://www.eng.yale.edu/grablab/openhand/
- Soft Robotics Toolkit https://softroboticstoolkit.com/
- follow a published paper

- One of our soft hands
- Work with Charlie to build a sensor mitten
- Work with our simulator to design a better 3D hand design and tendon routing to perform specific manipulations (Michelle)
- Improve our contact model

Simulation ideas

- Simulation model of the human index finger (muscles, tendons, bones…)
- Manipulation in simulation (Caroline?)
- Manipulation learning with OpenAI Gym https://gym.openai.com/envs/HandManipulatePen-v0/
- Soft hand simulation
- Improve our contact modeling

Simulators to check out

- SynGrasp http://sirslab.dii.unisi.it/syngrasp/
- MuJoCo Haptix https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7363441 http://www.mujoco.org/book/haptix.html
- SOFA https://www.sofa-framework.org/
- Klamp’t (IROS 2016 Simulation Manipulation Challenge) http://motion.pratt.duke.edu/klampt/ https://github.com/krishauser/IROS2016ManipulationChallenge
- Box2D

Planning ideas

- Sampling based planning
  http://yutingye.info/SIG12_files/SIG12ye_preprint.pdf
  https://www.youtube.com/watch?v=x8c27XYTLTo&feature=player_embedded

- Contact invariant optimization (Mordatch)
  https://homes.cs.washington.edu/~todorov/papers/MordatchSCA12.pdf
  https://www.youtube.com/watch?v=Gzt2UoxYfAQ

- GraspIt! https://graspit-simulator.github.io/

Other ideas

- Human subjects studies (e.g., manipulation labeling)

- “Area” studies (more like a very detailed research report with suggestions for future research)

Final Thoughts

- What question do you want to answer or idea to you want to test?