**Research Plan at Bio-Inspired Robotics Lab – Dhruv Trehan**

Updated: 2024.10.13

1. **Major Deadlines/Milestones** 
   1. Your BIRL supervisor:
   2. Department Deadlines

Hazard Assessment Forms: 16th October

Michaelmas mid-term assessment: 8th November?

Michaelmas term presentation: 21st – 28th November

Michaelmas end-term assessment: 6th December

Technical Milestone Report: 23rd January

Lent mid-term assessment: 21st February

Lent end-term assessment: 21st March

Final Report: 2nd June

Final Presentation: 3rd-11th June?

* 1. BIRL Deadline

Research plan deadline: October 21

100 paper reading: November 8

Michaelmas term presentation: November 20 Lab meeting

First draft of TMR: 2 Weeks before official date

Lent term presentation: 2 Weeks before official date

First draft of final report: 2 Weeks before official date

Easter term presentation: 2 Weeks before official date

* 1. Absence/Travel plans: N/A

1. **Career Plan**
   1. Career planning/milestones

PhD

* 1. Career development actions

Started Applying

1. **Research Projects/Milestones**
   1. Title

Soft Tactile Sensing for Robotic Manipulation

* 1. Layman Outline

Testing different configurations of electrode placement to see which gives ideal trade-off in ease of manufacture to accuracy, testing with material detection

* 1. Five Bullets

**Goal:** To introduce the benefits of EIT sensing technologies [Torque (X Nm)] into soft dexterous parallel grippers (e.g. Robotiq) during twisting tasks

A black robot with a blue light

Description automatically generated

**Problem:** Putting large numbers of small electrodes into a gripper’s soft pads inhibits its flexibility & dexterity during pick & place tasks, as well as making the pads more complex/expensive to manufacture.

I.e. There is a trade-off between high-resolution performance and the sensor’s flexibility/manufacturability.

**Hypothesis:** By defining a reward function that couples resolution and flexibility, we can find an electrode layout for specific tasks which achieves comparable performances with ‘more convenient’ electrode locations/numbers.

**Proof:** EIDORS simulations will test effect of electrode locations on rectangular perimeter, proposing solutions which can be physically tested on rectangular PCB:

A diagram of a rectangular object with orange dots

Description automatically generated

Results then used to create new physical electrode layouts for 5 pick & place tasks: gives a X% more compliant surface achieving 80% results with just 30% of electrodes.

**Conclusion:** Regularly-spaced electrode layouts are not the best compromise between manufacturability & performance for EIT grippers: this pipeline gives a task-by-task approach of finding a more optimal layout.

Figure 1: Description of Goal/problem

Figure (2ish): Setup labelled

Figure:

**Figure 10: To discuss**

* 1. Milestones:

Week 3 Mich: Touch/no touch experiments in simulation

Week 4 Mich: Robot using screwdriver and receiving signal (touch/no touch)

Simulate Twisting

Week 5 Mich: Ground truth measurement of twist + raw data

Week 6 Mich: Getting torque, comparing to real torque

Week 7 Mich: Optimization – removing electrodes comparing to full electrode configuration

Week 8 Mich: Video

Deliverables:

Graph: X-axis, ground truth real torque vs measured torque, different lines for different configurations

Video: Demonstrating torque measurements with ground truth, set minimum torque limit to twist a screw

Lent Term

Deepen analysis of why it works

Variations of Electrode configuration

Updated Plan as of 26/11/2024

* Do torque sweep experiment
  + Different normal forces
  + Different positions
  + Analysis
  + Why? If something interesting comes out

1. **Work plan**

**Materials to Classify: Metal, Plastic, Wood, Leather, (Hand?)**

**Michaelmas term**

**Week1:** **Start EIDOR and start simulating in parallel, run sample code on the**  **default circular shape**

**Learn how to use Robotic Gripper and set it up**

**CAD Gripper mount**

**(PhD applications throughout)**

**Week2:**  **Build Sensors**

**Gripper Shape in Simulation (4mm spacing with 2mm diameters)**

**Do analytical estimate of grippers response to torque**

**Week3:**  Prepare a Presentation

**Interfacing to MATLAB and get first signal from sensors**

**Compare simulation with real world results**

**(Using Results Iterate on Experiments and Begin Presentation Writeup)**

**Week4: Using Review from Mid term assessment meeting iterate on experiments and continue presentation write up**

**Week5: Continue experiments, presentation and begin technical write-up (with the aim of getting a conference paper)**

**Week6: Finish Presentation, continue writing technical report and experiments**

**Week7: Write-up continues as do reports**

**Week8: Focus on experiments as term will be ending**

**Winter break: Finish technical write-up**

**Lent term**

**Month1: Post write-up have a relook at experiments to run and do them**

**Electrode Placement Optimisation**

**Analysis + Paper writing**

**Using simulations to influence design of hardware**

**Month2: Finish Experiments + Writing for Conference Paper**

**Spring break: Writing Up Technical Report + Presentation**

**Easter term**

**Month1: Tidy up any loose ends**

**Month2: Finish Report and Presentation Write-Up**

**5. 100 paper reading references**

[1]

[2]

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**Appendix**