**Research Plan at Bio-Inspired Robotics Lab**

Department of Engineering, University of Cambridge

[http://birlab.org](http://birlab.org/)

\* This form should be filled out by research students of the Bio-Inspired Robotics Lab. The form should be drafted and sent to [fi224@cam.ac.uk](file:///Users/fumiyaiida/fumi/CambridgeAdmin/ResearchPlanTemplate/fi224@cam.ac.uk) as soon as possible. Please expect some iterations of revision.

\* Please also review: Instructions for New 4Y Students [link](https://teams.microsoft.com/l/entity/com.microsoft.teamspace.tab.wiki/tab::7d3357dd-06f0-47b9-ad7b-f46d477e846e?context=%7B%22subEntityId%22%3A%22%7B%5C%22pageId%5C%22%3A31%2C%5C%22sectionId%5C%22%3A49%2C%5C%22origin%5C%22%3A2%7D%22%2C%22channelId%22%3A%2219%3Af4af71219bb84fb1883d6e67ead67471%40thread.skype%22%7D&tenantId=49a50445-bdfa-4b79-ade3-547b4f3986e9)

**Date and revision history:**

**1. Basic Information**

Name: Raksina Phongsermsuk

Email: rp663@cam.ac.uk

Project co-supervisor (examiner):

Lab co-supervisor:

Department hazard assessment completed? Y / N (Date: 12/10/2022 )

Lab safety induction completed? Y / N (Date: )

**2. Description of the Project**

**2.1 Project Title**: Design and control of dexterous robotic manipulation of biological samples

Goal: A small, simple and reliable gripper which can re-orientate tube shaped samples used for wax embedding for Histopathology.

Problem: Complex mechanism needed to re-orientate sample which often utilizes large motions from robotic arms to achieve more DOFs, there may not be enough space for these large motions due to small scale of sample and cassette. The use of rigid gripper increases chance of damaging sample.

Hypothesis: Use a soft/hybrid gripper with 2 DOF (one for gripping motion and the other for rotating sample) where rotating mechanism is included within gripper itself so only small motions are performed in order to reorientate sample.

Proof: Experimental results

**2.2 Project Objectives**

Please describe project objectives and indicate how completion of them can be assessed quantitatively.

Objective 1: Design and create gripper to be used to handle tube shaped tissue samples to prepare for wax embedding for Histopathology. It must be able to pick up sample successfully.

Objective 2: The gripper allows for orientation of sample within a small confined space. This can be assessed by percentage successful rotation of sample given specific constraints and/or how much space the orientating motion takes up.

Objective 3: Gripping and/or orientating mechanism has to be simple with minimal inputs and outputs.

Objective 4: Completed paper on gripper.

Objective 5:

**2.3 Project Milestones**

Please describe a list of research milestones, and how each milestone contributes to achieve the objectives defined above in 3.2. Each milestone should have a deadline, and be assessed objectively.

PM0: Research Plan Completed (Date: 17/10/2022)

Description: The Research Plan should be completed assessed by FI.

PM1: Conceptual design of gripper completed (Date: 20/10/2022)

Description: After reading relevant papers on existing grippers and summarizing findings, come up with at least 3 different designs and evaluate pros and cons. Select one design and produce CAD of gripper with relevant manufacturing details and BOM. Design should be approved by PhD supervisors and FI.

PM2: Create prototype that can achieve gripping and orientation (Date:31/10/2022)

Description: Creating first prototype (perhaps using 3D printed or silicon parts) which allows for sample to be reoriented and placed into cassette where motion is constricted to a certain space to avoid collisions. This also includes creating an interface for controlling gripper.

PM3: Create final iteration of gripper (Date:20/01/2023)

PM4: Data collection to be used for performance judgement complete (Date: 20/02/2023)

Description: Collect data on various aspect of grippers such as percentage difference in target temperature/force and measured temperature/force and percentage successful rotation of sample.

PM5: Write up paper (Date: 29/02/2023)

Description: Write paper on design, tests done on gripper and results quantifying its performance. The paper should be written alongside with the project itself.

**2.4 Work Plan**

Please indicate the work you do in each week and month, and how they are related to Milestones and Deliverables above.

Michaelmas Term

Week1: Get research plan approved and read relevant papers

Week2: Researching and brainstorming, this includes reading relevant papers

Week3: Design gripper

Week4: Obtain parts necessary for building first prototype and refine design further if necessary

Week5: Build first prototype

Week6: Integrate motors/actuators to gripper and interface to control these

Week7: Setup test rig and collect data on performance of first prototype

Week8: Build second prototype

------ Christmas Break --------

Lent Term

Week1: Collect data on performance of second prototype

Week2: Build final prototype

Week3: Collect data on performance of final prototype

Week4: Collect data and finish write up

Week5: Finish write up

Week6: -

Week7: -

Week8: -

**Appendix A**

List of publications relevant to this project.

* Hughes Josie, Culha Utku, Giardina, Fabio, Guenther Fabian, Rosendo Andre, Iida Fumiya. 2016. Soft Manipulators and Grippers: A Review. Frontiers in Robotics and AI. 3. 10.3389/frobt.2016.00069. <https://www.frontiersin.org/articles/10.3389/frobt.2016.00069/full>
* Li Zhen, Fu Pan, Wei Bing-Ting, Wang Jie, Li An-Long, Li Ming-Jun, Bian Gui-Bin. 2022. An automatic drug injection device with spatial micro-force perception guided by an microscopic image for robot-assisted ophthalmic surgery. Frontiers in Robotics and AI. 9. <https://www.frontiersin.org/articles/10.3389/frobt.2022.913930>
* Brown, E., Rodenberg, N., Amend, J., Mozeika, A., Steltz, E., Zakin, M.R., Lipson, H. and Jaeger, H.M. 2010. Universal robotic gripper based on the jamming of granular material. *Proceedings of the National Academy of Sciences*, *107*(44), pp.18809-18814. <https://doi.org/10.1073/pnas.1003250107>
* Crooks Whitney, Vukasin Gabrielle, O’Sullivan Maeve, Messner William, Rogers Chris. 2016. Fin Ray® Effect Inspired Soft Robotic Gripper: From the RoboSoft Grand Challenge toward Optimization. Frontiers in Robotics and AI. 3. <https://www.frontiersin.org/articles/10.3389/frobt.2016.00070>
* Liu, Sandra Q., and Edward H. Adelson. "GelSight Fin Ray: Incorporating Tactile Sensing into a Soft Compliant Robotic Gripper." *2022 IEEE 5th International Conference on Soft Robotics (RoboSoft)*. <https://ieeexplore.ieee.org/iel7/9762008/9762065/09762175.pdf>
* Kevin C. Galloway, Kaitlyn P. Becker, Brennan Phillips, Jordan Kirby, Stephen Licht, Dan Tchernov, Robert J. Wood, and David F. Gruber.Soft Robotic Grippers for Biological Sampling on Deep Reefs.Soft Robotics.Mar 2016.23-33.[http://doi.org/10.1089/soro.2015.0019](https://doi.org/10.1089/soro.2015.0019)
* Sinatra, N. R., Teeple, C. B., Vogt, D. M., Parker, K. K., Gruber, D. F., & Wood, R. J. (2019). Ultragentle manipulation of delicate structures using a soft robotic gripper. *Science Robotics*, *4*(33), eaax5425. <https://www.science.org/doi/abs/10.1126/scirobotics.aax>