Automated Mosquito Dissection

for Malaria Vaccine Production

Computer Integrated Surgery II

Spring, 2019

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Project Summary

- Integrated computer vision systems with a pick-and-place robot and demonstrated autonomous manipulation of mosquitoes
- Developed and tested electromechanical modules to perform key stages of mosquito dissection and salivary gland collection
- Integrated robotic manipulator with dissection modules to demonstrate entire dissection process
- Designed a rotary stage on which to implement the dissection modules with the goal to increase efficiency

Overall Goal

Design, refine, and integrate several subsystems of an automated mosquito dissection system being developed at the LCSR for malaria vaccine production

The Problem

- The WHO ranked malaria as a top 20 leading cause of death in 2016 with over 219 million individuals infected
- Sanaria Inc. has developed a viable vaccine for malaria that involves using the salivary glands dissected from mosquitoes
- Automation of current manual dissection processes could help Sanaria reach global-scale production level targets

The Solution

- Our team focused on three main objectives:
  - Develop an automated, computer vision-enhanced method for mosquito grasping and placement into a dissection system for subsequent processing
  - Design a dissection system that will first decapitate a mosquito, then extrude and collect glands and exudate.
  - Propose a streamlined dissection system that can operate continuously
- These tasks involve the development or improvement of the following systems:
  - Robotic Pick-and-Place
  - Dissection Modules (cut, squeeze, collect, clean)
  - Linear Dissection Stage
  - Rotary Dissection Stage
  - Integrating Software (actuator control, vision management)

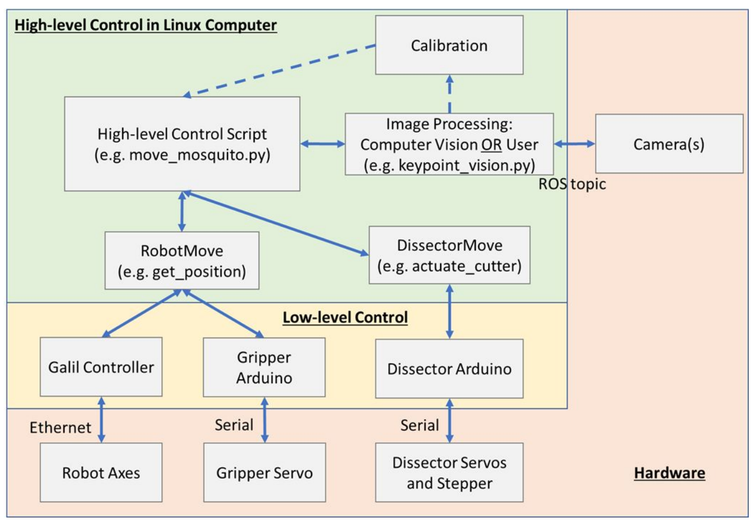

Figure 1: Block diagram of software architecture

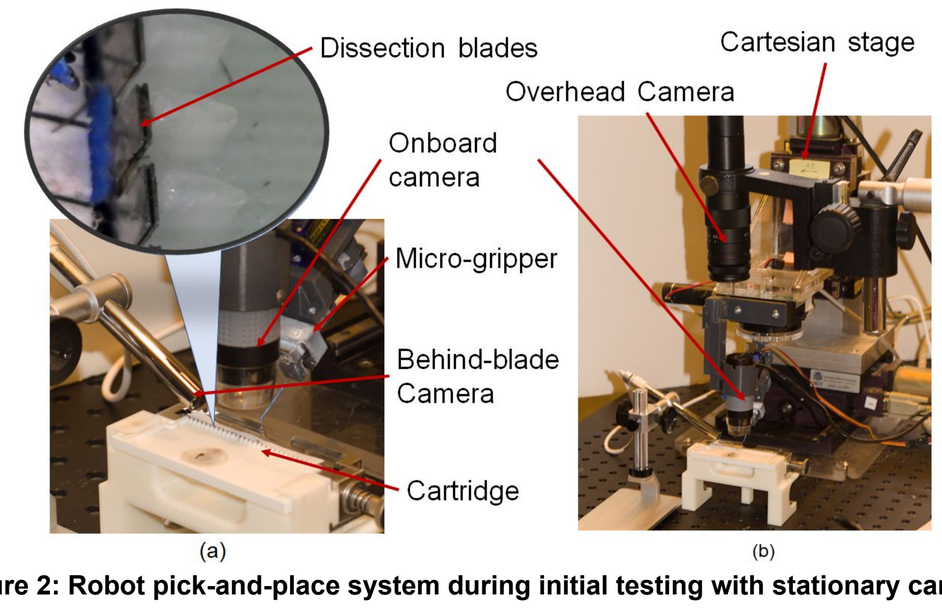

Figure 2: Robot pick-and-place system during initial testing with stationary cartridge.

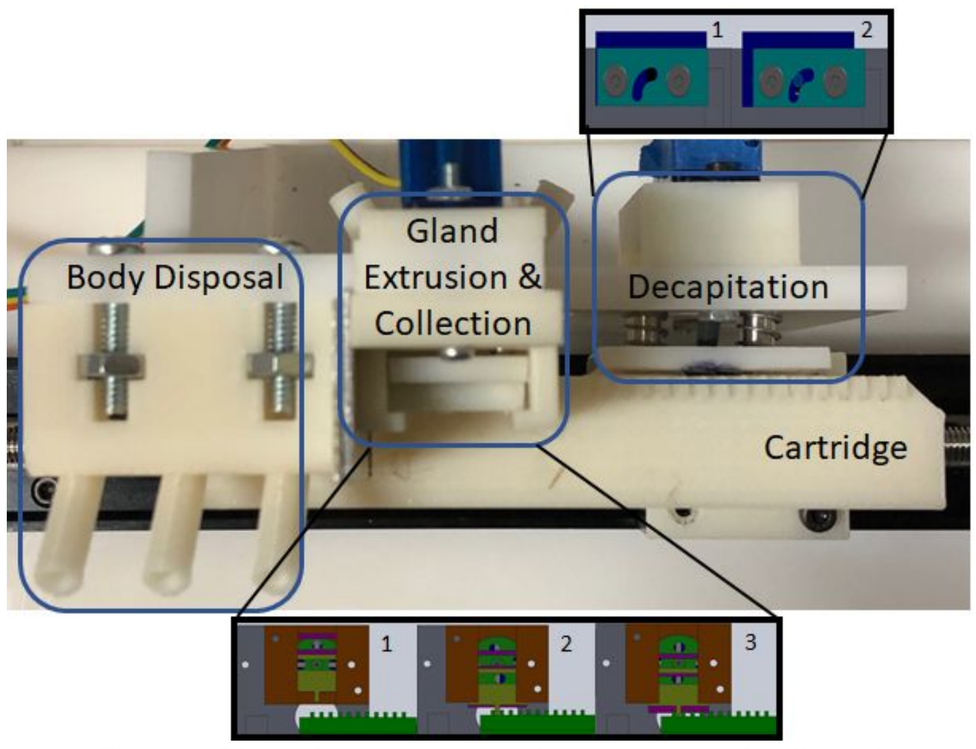

Figure 3: Dissection apparatus and process steps for dissection, gland extrusion, and collection shown.

Outcomes and Results

- Demonstrated 100% success in grasping mosquitoes and 90% proper placement of mosquitoes in 50 trials
- Produced a dissection subsystem designed to decapitate mosquitoes, extrude exudate, and collect exudate
- Proposed a design for continuous processing of mosquitoes and integration of all subsystems

Future Work

- Progress will be passed onto collaborators for future development
- Integration of dissection and pick and place systems will be completed by the end of May

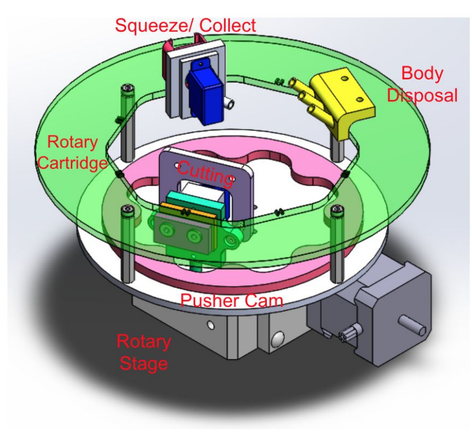

Figure 4: Rotary Stage Design Concept

Lessons Learned

- Manufacturing requirements for robot attached grasper, cutting system, and squeeze/collect system
- Difficulties encountered when working with fresh mosquitoes during experimentation

Roles

- Michael: Development of Dissection Apparatus
- Henry: Robotic System, Software, Systems Integration
- Alex: Rotary Stage Concept Design and assisted in mechanical fixture development

Publications

- Submitted manuscript to CASE 2019
- Results pending, a second manuscript reporting integration of pick and place with dissector system incorporating a mock staging module will be developed

Acknowledgements

- This work was supported by NIH SBIR grant 1R44AI134500-01 in collaboration with Sanaria, Inc. Rockville, MD, USA.
- H. Phalen is supported by the NSF Graduate Research Fellowship under Grant No. 1746891.