CS 446 – Computer Integrated Surgery - II

Micron Range of Motion Visualization

Project Proposal

Group 14

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Contents

Project summary

In this project I will be developing a visual alert assistance system for the surgeons dealing with very small anatomy. In this project I will be getting information from micron motion and accordingly present a visual feedback to surgeons.

I will be mainly using **CISST** & **SAW** libraries to communicate and get micron tip position.

Background

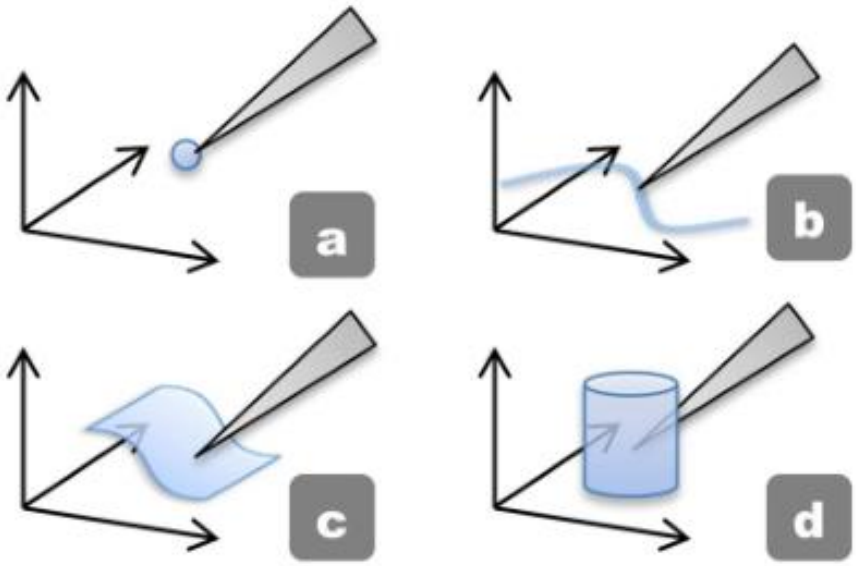
Peeling delicate retinal membranes, which are often less than five microns thick, is one of the most challenging retinal surgeries. Preventing rips and tears caused by tremor and excessive force can decrease injury and reduce the need for follow up surgeries. So to address issues in the delicate micromanipulation of retinal membranes, a fully handheld micromanipulator, Micron was created by **Carnegie Mellon University**, Pittsburgh.

Utilizing stereo vision and tracking algorithms, the robot activates motion-scaled behavior as the tip nears the surface, providing finer control during the critical step of engaging the membrane edge. It removes involuntary motion, such as tremor, by the actuation of the tip to counteract the effect of the undesired handle motion. The key components are a 3-degree-of-freedom (DOF) piezoelectric manipulator that has a 400-µm range of motion, 1-N force capability, and bandwidth over 100 Hz, and an optical position-measurement subsystem that acquires the tool pose with 4-µm resolution at 2000 samples/s

Significance and Importance

Microsurgical tools play a very significant role in very small and critical anatomies. Tremor compensation is a key component of many surgical robots and tries to eliminate the frequency bands dominated by tremor in order to remove unwanted motion while preserving the operators' intended movements.

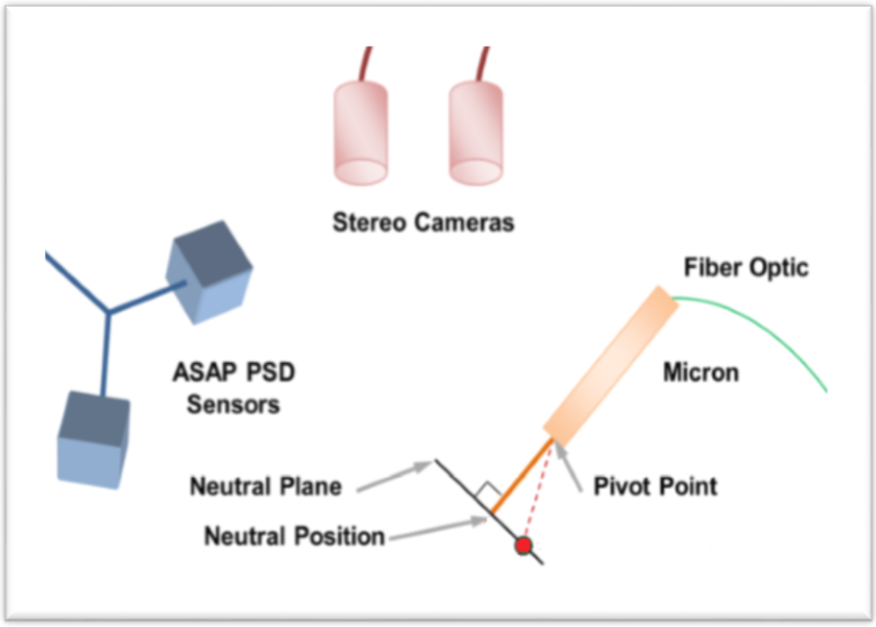
Micron is one such microsurgical tool. It has been developed with actuators not on robot arm, but between the handle grip and the tool tip. Micron can move the tool tip independently of the hand motion, allowing it to perform behaviors such as tremor reduction, motion scaling and virtual fixtures.



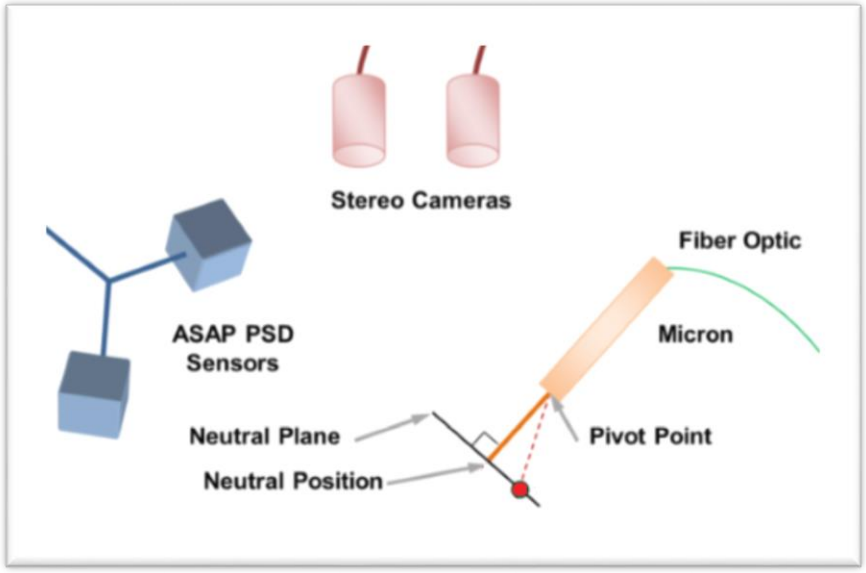
Virtual fixtures constraining the tip to a subspace with increasing degree of freedom:
(a) Point, (b) Curve, (c) Surface, and (d) Volume.

However, the micron has a range of motion, in which the tool-tip moves. If the micron goes out of the range, then it starts moving in haphazard manner. And the surgeons would want to know before this happens.

For this reason it's important to have a visual assistance for the surgeons, so that they can take precautions before micron goes out of control.

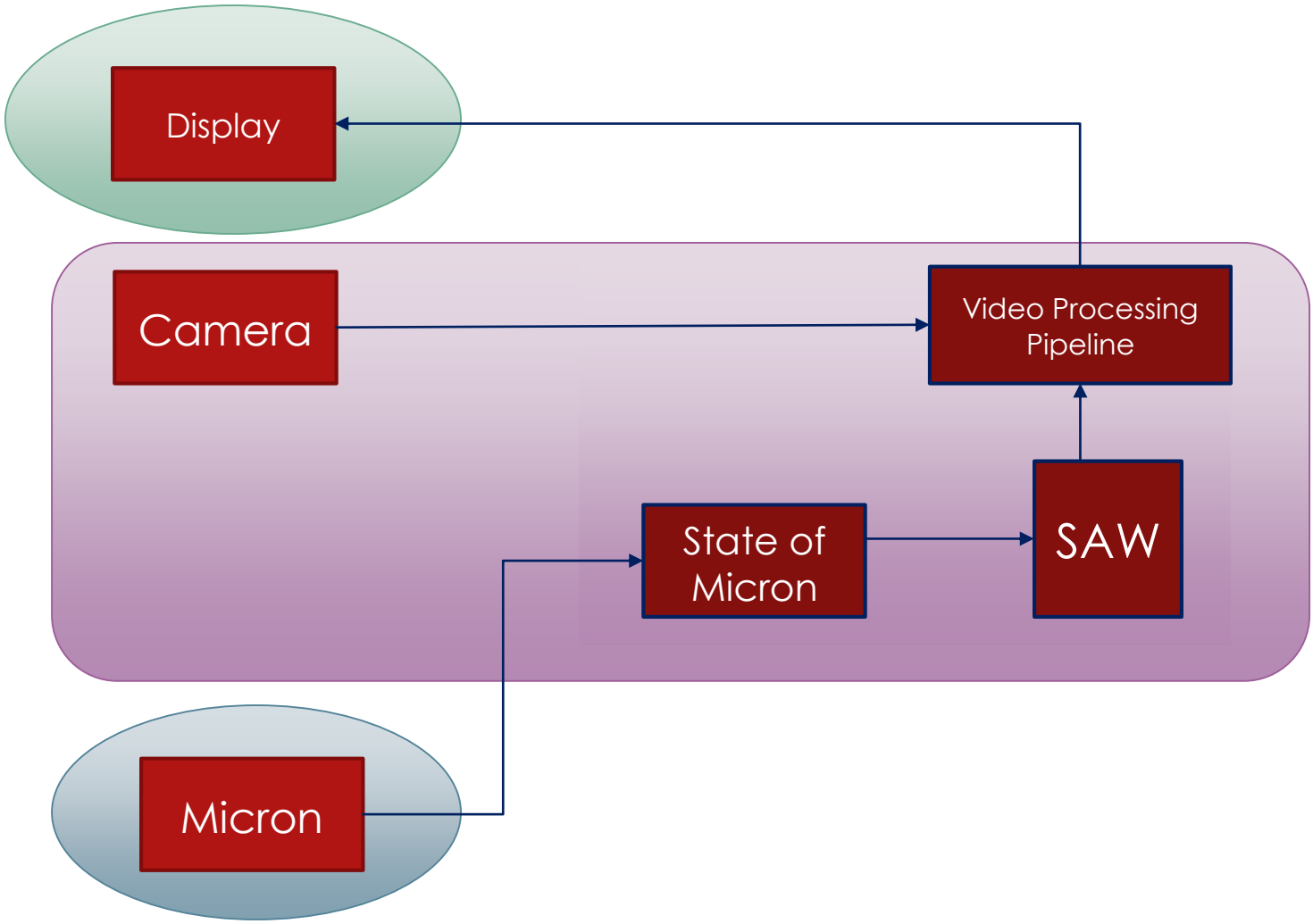


Problem



Solution

Technical Approach



As you can see, there are three different systems.

- System – 1 :- Micron is totally different device
- System – 2 :- Camera capture device, SAW, video processing unit .. etc.
- System – 3 :- Display System

System – 1 :- Micron device is connected to this system. Information of the micron state is sent to system-2.

System – 2 :- In here there is camera capture device, which sends each picture frame to the video processing unit, where it is filtered and various overlays are added to the picture.

Also, information from micron device, along with the pixel coordinates of the micron tip, collected from tool tracker, is processed and the information is added to the respective overlays.

System – 3:- The modified picture from the video processing unit is displayed on the display screen.

Procedure - I'll will be getting information from micron. I'll use this information to track the motion of the micron tip and its relative position from the micron handle. This information will be displayed, graphically, on the top right corner of my test application. This will help surgeons know the position of the micron tip in its range of motion.

Once I know the position of the micron tip in its range of motion, I'll have to develop a graphical alert system, for the surgeons to judge more precisely when to take the micron out or move the micron accordingly , without causing any retinal damage.

Surgeons will be able to on/off this feature according to their comfort.

Deliverables

Minimum deliverable

- Develop a test application with some overlays.
- Test the application with random simulated data.
- Communicate with the micron and retrieve the information
- Display the information according on the overlays

Expected deliverable

- Develop the visual assistance system
- Get feedback from the surgeons

Maximum Deliverable

- Conduct rigorous testing and improve the tool tracker
- Improve the robustness of the software.

Dependencies

PHASE - 1

Dependency	Source	Status/Comments	What If ??
PC or Laptop	Self	Acquired	Project Delayed
Access to Micron	Dr.Russel Taylor	Not Acquired/Will need once to test the application	Simulate the data
Cisst and Stereo Vision Libraries	Open Source-Online	Installed	Custom Libraries
QT Creator - IDE	Open Source-Online	Installed	Use other free IDEs available
Material to understand Micron better	Dr.Russel Taylor	Acquired	Learn Myself
Documentation of previous work	Marcin Balicki/Balazs Vagvolgyi	Acquired	Learn myself

PHASE – II

Dependency	Plan/Source	Status/Comments	What If ??
Access to Micron	Dr.Taylor	In Process/Wont need till the completion of Phase-I	Simulate
Access to Stereo Video Microscope	Dr.Taylor	In Process/Wont need till the completion of Phase-I	Simulate

Timeline

	Week Starting with	Feb. 4	Feb. 11	Feb. 18	Feb. 25	Mar. 4	Mar. 11	Mar. 18	Mar. 25	Apr. 1	Apr. 8	Apr. 15	Apr. 22	Apr. 29	May 6
PHASE -I	Understanding CISST and SteroVision libraries							Spring Break							
	Setting up development Environment														
	Understanding the Existing Framework														
	Create a test Application														
	Include some overlays														
	Communicate with the micron and get the information														
PHASE - II	Develop Application using simulated data														
	Feedback														
	Alert system														
	Feedback														
	Debugging														
	Improve the tracker														

Management Plan

I am planning to spend average of 16 hours per week on this project. I have weekly meetings with mentors. I will have weekly progress reports to be discussed in the meetings.

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