Surgical Instrument for Robotic Open Microsurgery

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Galen Robotics

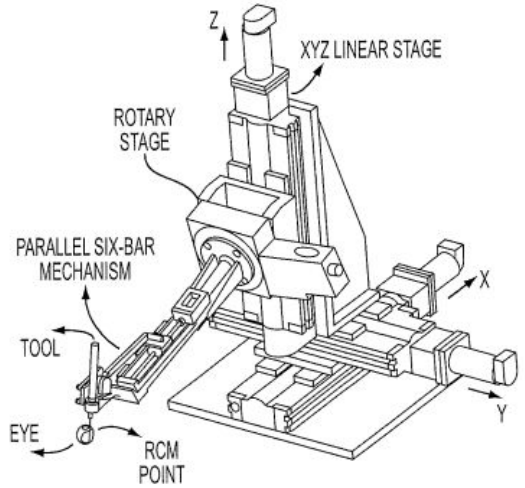
Background

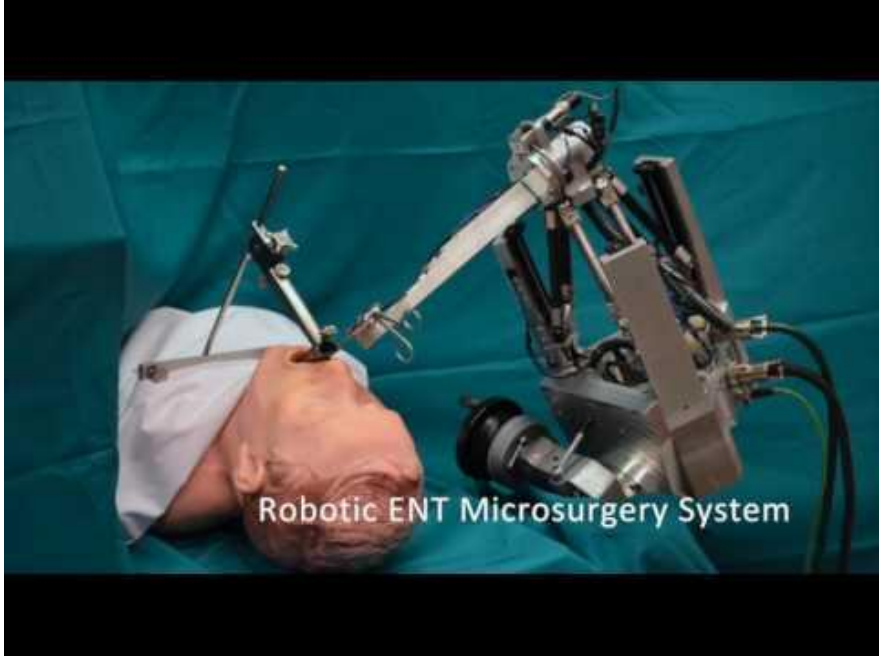
- Microvascular anastomosis- connecting blood vessels to restore circulation
- Lengthy procedure which requires precision- impeded by natural hand tremor
- Experienced microsurgeons operate at an accuracy of 50 μm; robotic assistance refines this accuracy by a factor of 10

Background

Galen robot (a.k.a REMS, Steady-hand robot)

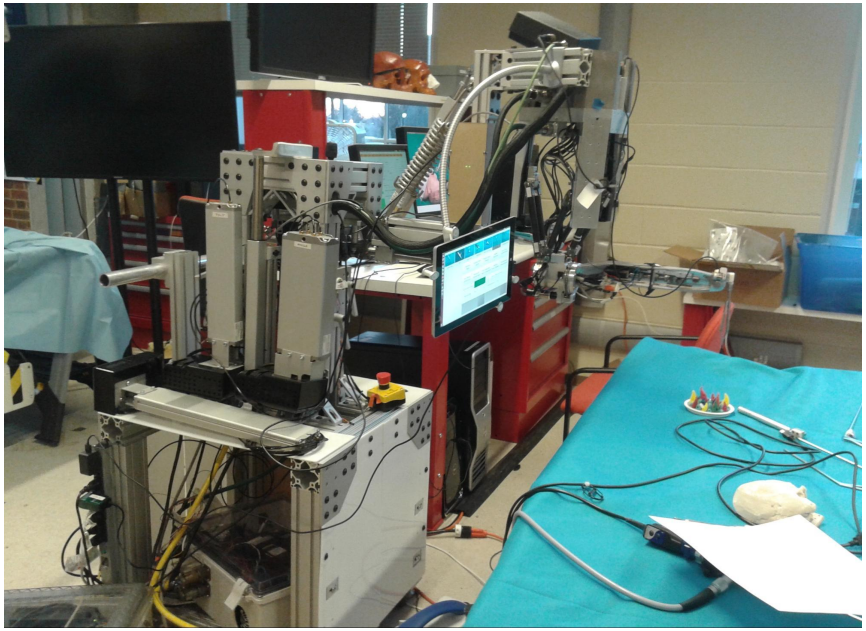
- 7 DOF manipulator (5 DOF active, 2 DOF passive)
- Holds surgical instrument while surgeon guides the robot's end-effector directly (cooperative control vs master-slave), gain foot pedal controls the admittance
- Control algorithms cancel out tremor, can add virtual fixtures





Microsurgery using the Galen

Latest version of the Galen



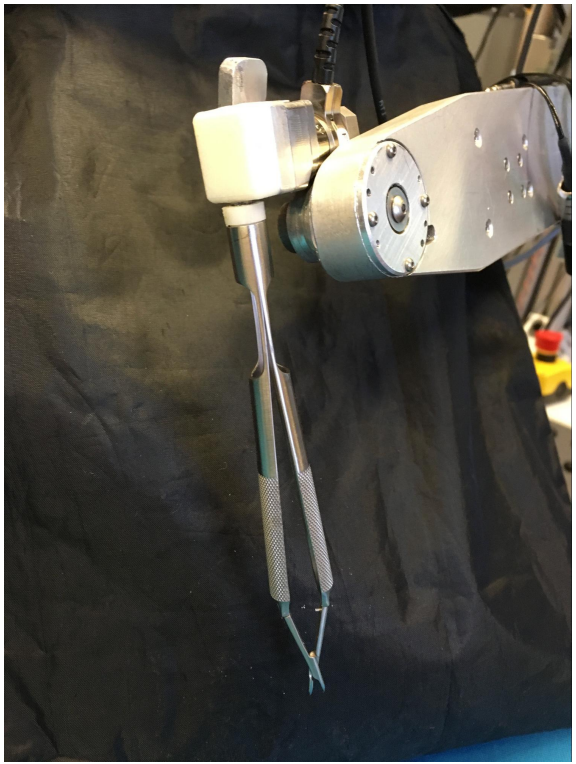
Advantages:

- Does not disrupt usual workflow of surgeon
- Does not require extensive training unlike Da Vinci system
- Can quickly change tools
- Can use of multiple robots without obstructing the view of the operating area

Current Needle driver for microvascular surgery

Held by Galen at the top, with the surgeon's hand guiding it next to the tip

- Cooperative control scheme requires different ergonomics- harder to orient instrument when there is a large lever arm
- Workspace not well-utilized - surgeons prone to exceed workspace limits
- Surgical tool forces are now absorbed by the robot & surgeon no longer receives haptic feedback and might damage the tissue by applying excessive forces



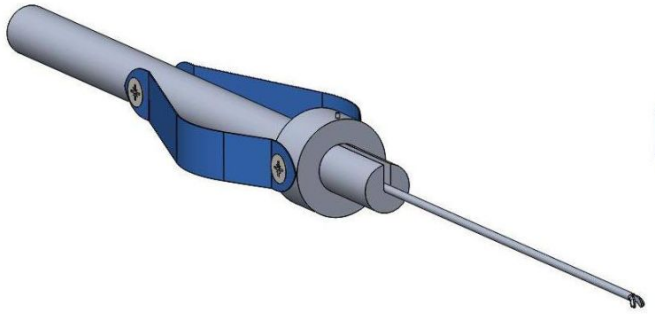
2015 design - microvascular needle driver

Pros:

- Slim profile
- Good design for manufacturing ability

Cons:

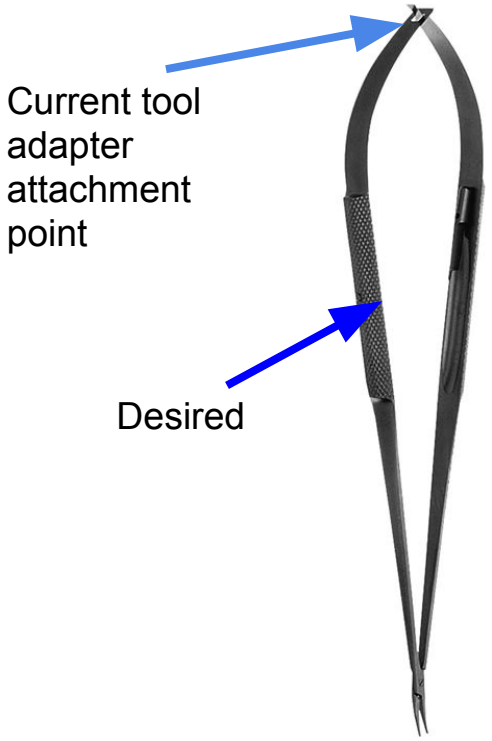
- Designed for a different tool adapter
- Difficulty in rotating about its axis easily
- Not robust
- Sterilization issues



Project Goal

Overall goal is to develop special surgical instruments that are ergonomic and provide dexterity and haptic feedback when integrated with the robot's tool holder

Current goal is to design a needle driver with the tool attachment point below where the surgeon would hold it



Design Approach

- Take apart existing forceps and cannibalize useful parts.
- Design different gripper/actuators for the forceps.
- Design tool-holder accessory for rotational DOF
- Prototype feasible designs
- Test with Galen and evaluate
- Iterate over design and fabrication methods

Deliverables

Minimum:

- A needle driver prototype made with the correct dimensions, Galen integration, ability to rotate, and grasping tool tip

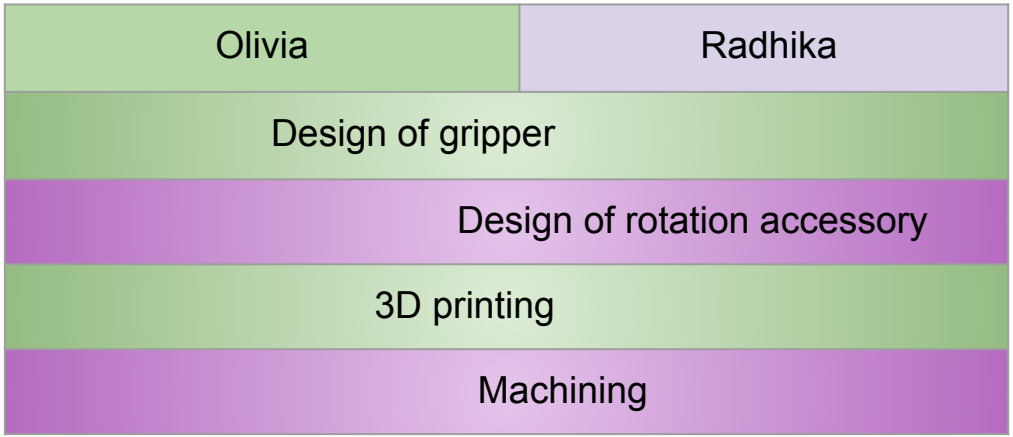
Expected:

- Needle driver that is made out of stainless steel

Maximum:

- Two tools - needle driver and vascular holder - that are designed for manufacturing ability and sterilizability

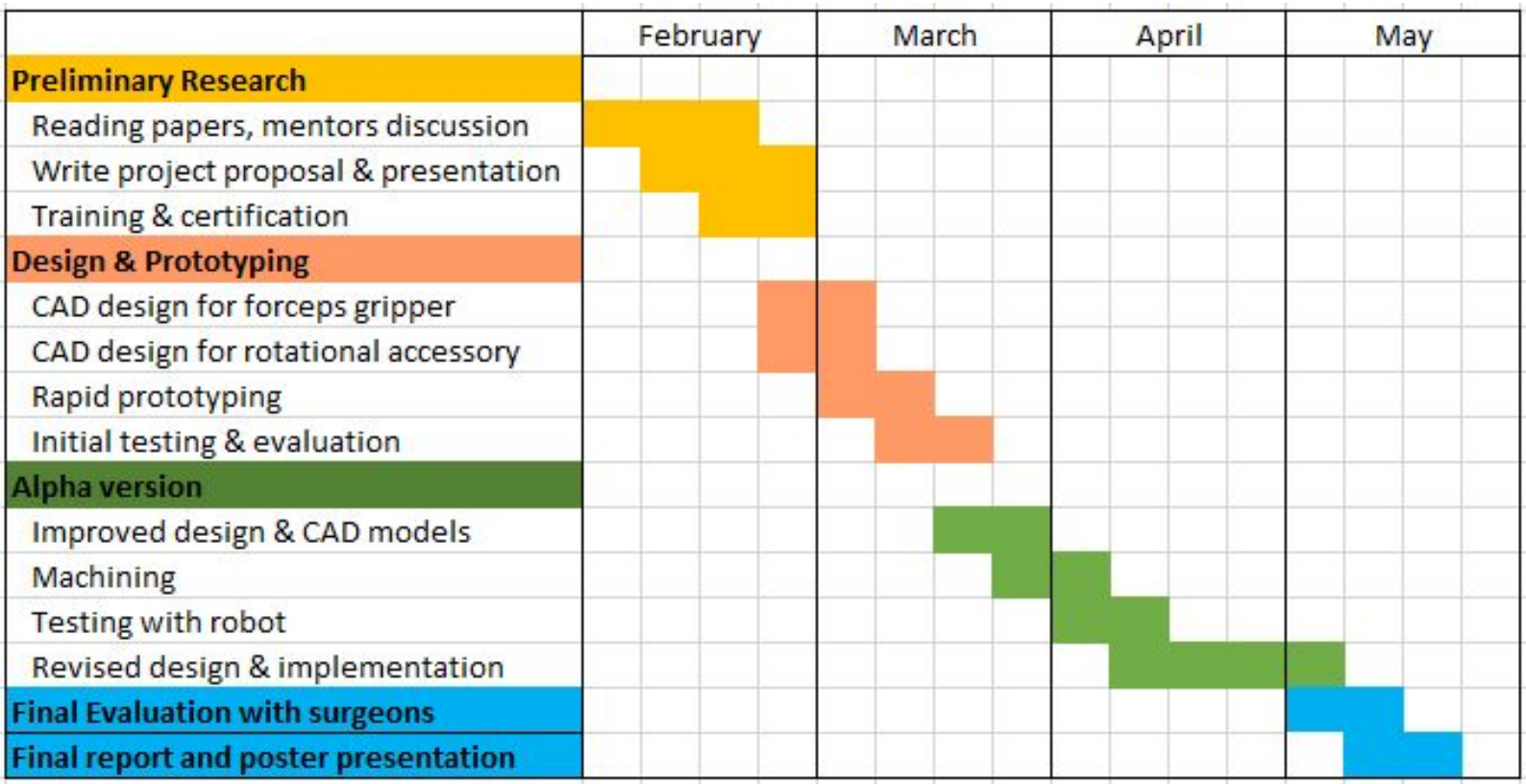
Management plan



Bi-weekly meeting with Yunus

Meeting with Dr. Taylor and Dr.Razavi as and when possible

Timeline


February
March
April
May
Preliminary Research
Reading papers, mentors discussion
Write project proposal & presentation
Training & certification
Design & Prototyping
CAD design for forceps gripper
CAD design for rotational accessory
Rapid prototyping
Initial testing & evaluation
Alpha version
Improved design & CAD models
Machining
Testing with robot
Revised design & implementation
Final Evaluation with surgeons
Final report and poster presentation

Milestones

Accomplishment	Estimated Date	Status
Presentation	February 16	Ongoing
Proposal	February 20	Ongoing
Certification	February 28	Incomplete
CAD model for tool and accessory	March 7	Incomplete
3D printed model	March 16	Incomplete
New design	March 28	Incomplete
Fabricated alpha version	April 9	Incomplete
Testing & Surgeon feedback	April 17	Incomplete
Modified design & evaluation	May 4	Incomplete
Final presentation	May 18	Incomplete

Dependencies

Dependency	Plan to Resolve	Estimated Resolution Date
Access to Galen	Olivia already has access to the Mock OR	Resolved
Machine shop access	Sign up for WSE “Maker Space” training and self-service machine shop training, attend training and get certification	Feb 28th
Funds for machining and training	Speak to project mentors about project budget and fund access	Feb 28th
Availability of residents and experienced surgeons for testing	Coordinate with Galen Robotic’s medical collaborators	March 30th

References

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