NSF Engineering Research Center
for Computer Integrated Surgical
Systems and Technology

LABORATORY FOR
Computational
Sensing + Robotics
THE JOHNS HOPKINS UNIVERSITY

Surgical Instrument for Robotic Open Microsurgery

JOHNS HOPKINS
WHITING SCHOOL
of ENGINEERING

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Project Overview

- Design a microforceps instrument that can be used with the Galen steady-hand robot
- Instrument needs to be held above the robot tool attachment
- Allows for rotation of tool

Technical 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 Update

	Date	Status
Minimum	3/16	
3D printed needle driver prototype		Met
Galen integration		Met
Rotational DOF		Met
Expected	4/9	
Stainless Steel		Postponed
Iterated prototype		Met
Maximum	5/4	
Second instrument with microvascular grasper tip		On schedule
Sterilizable		On schedule
Design for manufacturing ability		On schedule

Existing Forceps designs

There are many varieties of forceps with different mechanisms of actuation, grips and jaws adapted to every surgical application such as grasping, holding, clamping, cutting, dissecting, dilating, suctioning etc.

Classification of forceps

Based on mechanism of actuation we have three main categories:

- 1) Scissoring type

- easy construction

- 2) Tweezer type

- single body

- 3) Sliding rod type

- slim profile

Classification of forceps

Based on grip design we have four categories:

- 1) Loop grip
  - Hard to drop, but difficult to rotate
- 2) Tweezer grip
  - Elastic return, but droppable
- 3) Pliers grip
  - Can apply a lot of force, but clunky
- 4) Misc.

Design Selection

Sliding rod actuation + Tweezer grip

Sliding rod actuation advantages:

Cylindrical nature- inherent rotatability

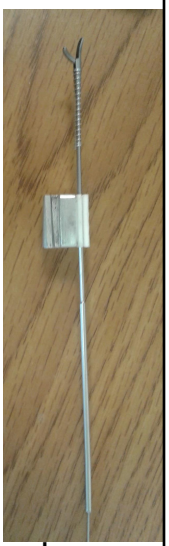
Long and thin nature- easy access of surgical site

Easily cannibalized

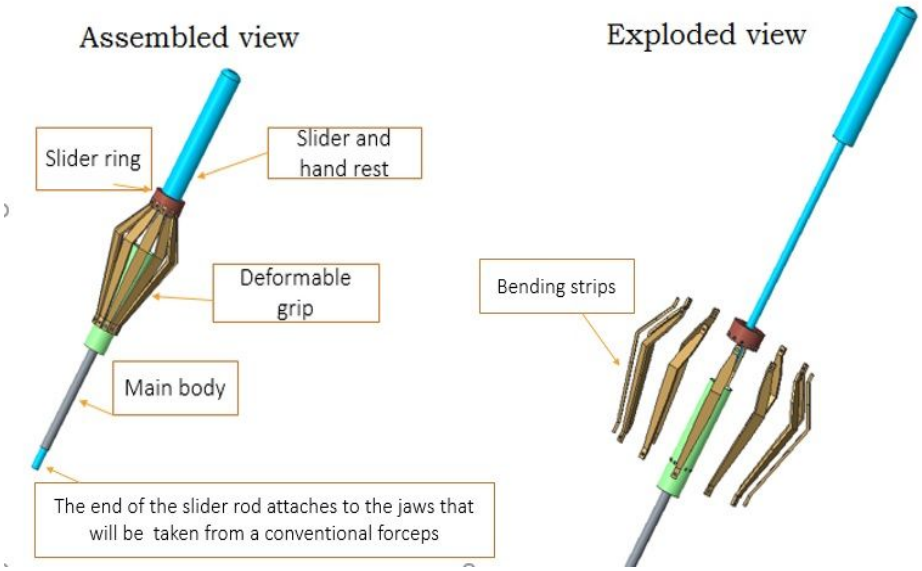
Tweezer grip advantages:

Can be made cylindrical to allows the tool to be rolled

Elastic nature allows for normally-open / normally-closed designs without addition of a spring

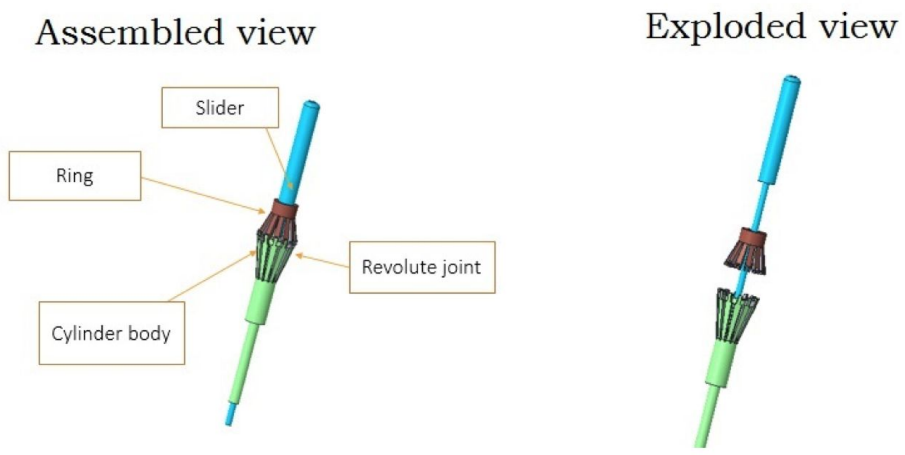


First Round Grip Design

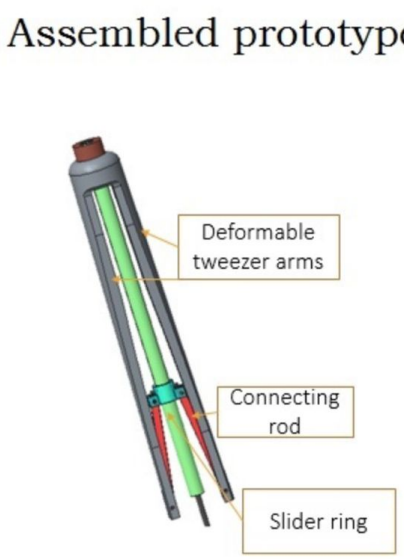


Round Grip Demonstration

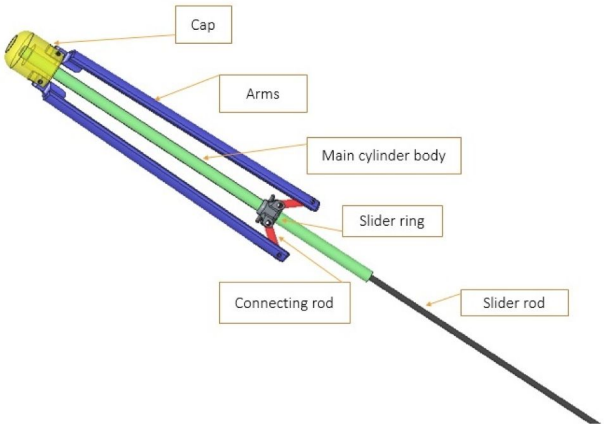
Second Round Grip Design



First Tweezer Grip Design

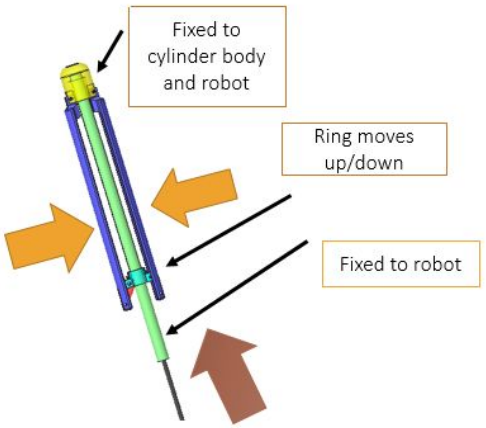


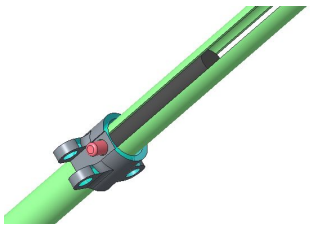
Second Tweezer Grip Design



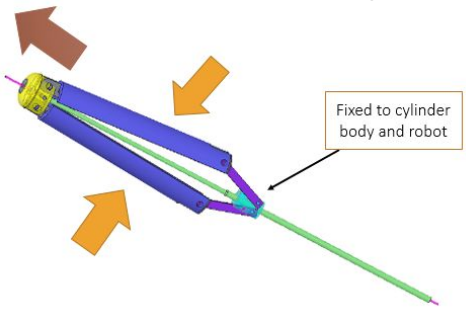
Proposed changes

Latest design





Proposed design



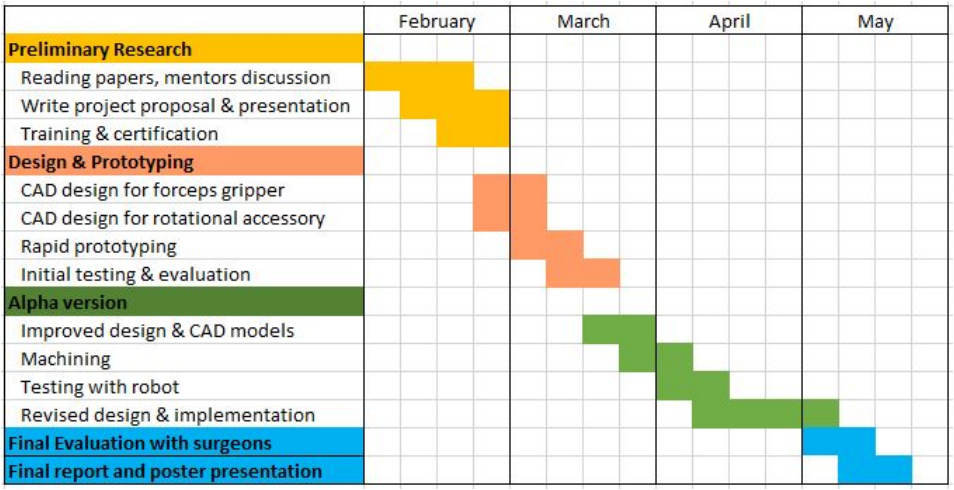
Recommendations from Patkin, M. (1977)

1. Length from grip to top of handle should be ~10cm
2. Handle diameter should be 5 – 10mm
3. The force required for opening or closing the instrument should be 40 – 100 g.
4. A 6:1 mechanical advantage or greater is ideal. 3:1 minimum

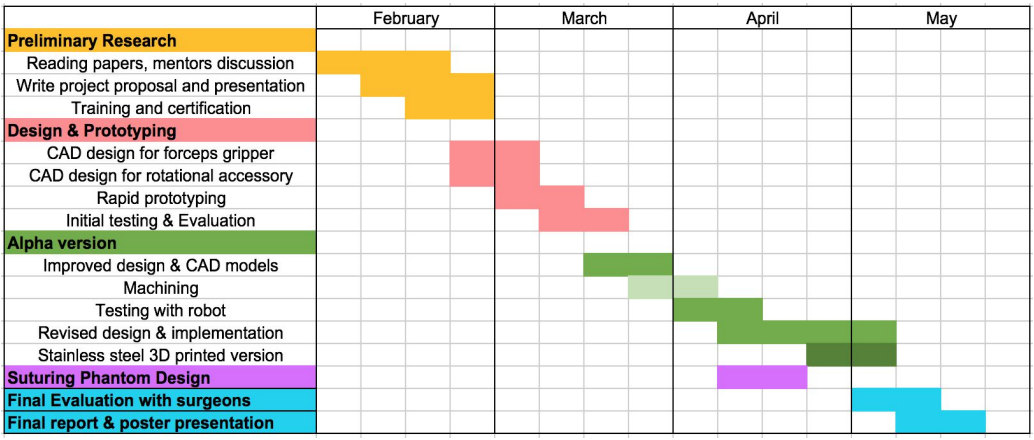
Dependency Status

Dependency	Status	Plan if unable to resolve
Access to Galen	Resolved	N/A
Machine shop access	Resolved	N/A
Funds for machining and training	Resolved	N/A
Availability of residents and experienced surgeons for testing	Pending	Tool will be designed with the feedback we do have

Original Timeline



Updated Timeline



Future work:

- Rapid prototype latest design
- Obtain suitable pins and springs
- Change dimensions and tolerances for stainless steel
- Fabricate metal prototype

Questions?

References

1 . Patkin, M. (1977), Ergonomics Applied to the Practice of Microsurgery. *Australian and New Zealand Journal of Surgery*, 47: 320–329.

2. [Web log post]. (n.d.). Retrieved from http://www.u.arizona.edu/~pen/ame352/Notes%20PDF/3%20Analytical%20kinematics.pdf