Surgical Instruments for Robotic Microsurgery

Computer Integrated Surgery II - Spring 2015

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Team Members and Mentors

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LABORATORY FOR Computational Sensing + Robotics

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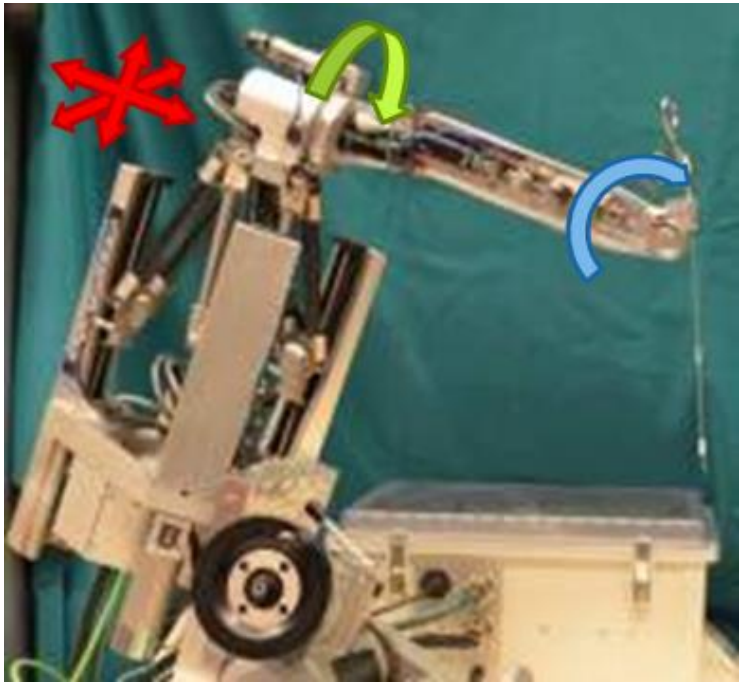
Background and Motivation

Endolaryngeal microsurgery is the treatment of choice for a variety of disorders including

- phonotraumatic nodules
- polyps and cysts
- vocal cord dysplasia and cancer
- benign laryngeal neoplasms such as papilloma

Background and Motivation

Robotic ENT Microsurgery System (REMS)



General purpose “steady-hand” robot

5 DOF:

- 3 translational at delta stage
- 1 roll at arm
- 1 tilt at tool holder

A 6 DOF force/torque sensor

Background and Motivation

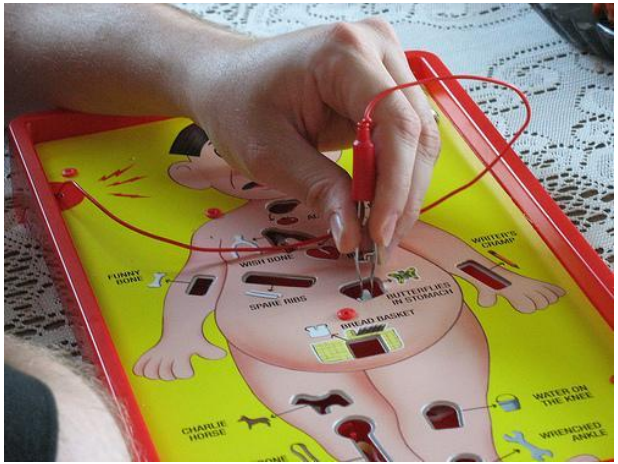
Feasibility Testing:

- Subjects = 3 surgeons (surgeon, fellow, novice)
- Testing phantom = aluminum plate with clusters of holes
- Hole diameters = 1.6mm, 1.1mm, and 0.8mm

“Operation”-like procedure:

- Touch plate → bad buzzer → failure
- Avoid plate → good buzzer → success

Results: 28% success manually, 91% robotically



Background and Motivation

TABLE II. NUMBER OF SUCCESSFUL RESULTS OUT OF 6 ATTEMPTS FOR EACH HOLE SIZE VS. SURGICAL SKILL AND ROBOT/MANUAL.

	Robot				Manual			
Hole Size (mm)	***2.0***	***1.5***	***1.2***	***All***	***2.0***	***1.5***	***1.2***	***All***
Surgeon	4	5	6	15	4	4	1	9
Fellow	6	6	6	18	2	0	1	3
Novice	6	5	5	16	1	0	2	3

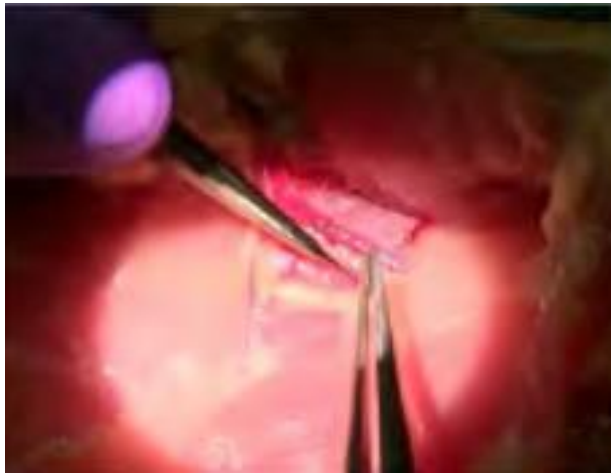
TABLE III. AVERAGE TIME IN SECONDS PER SUCCESSFUL ATTEMPT.

	Robot				Manual			
Hole Size (mm)	***2.0***	***1.5***	***1.2***	***All***	***2.0***	***1.5***	***1.2***	***All***
Surgeon	4.2	11.5	9.3	8.2	6.2	5.6	6.0	5.9
Fellow	8.4	7.3	15.8	10.5	8.6	N/A	9.4	8.8
Novice	9.6	7.8	7.1	8.3	9.2	N/A	10.7	9.9

Olds, Kevin, et al. “Preliminary Evaluation of a New Microsurgical Robotic System for Head and Neck Surgery”. 2004.

Goal

Develop novel surgical instruments for robot assisted vein suturing



Relevance

Two categories of existing robots:

- Broad proficiency (ie. Da Vinci machine)
- Special-purpose (sub branch of head and neck)

New system (REMS) needed for greater proficiency at head and neck level

Admittance-style, not master-slave

Areas for Improvement

Tool changing is tedious

Error from tip deflection (1.167mm overall)

Integrated needle holder is flimsy

Inner components are not efficient

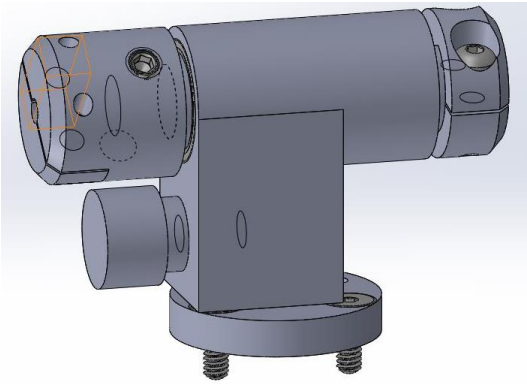
Movement algorithm

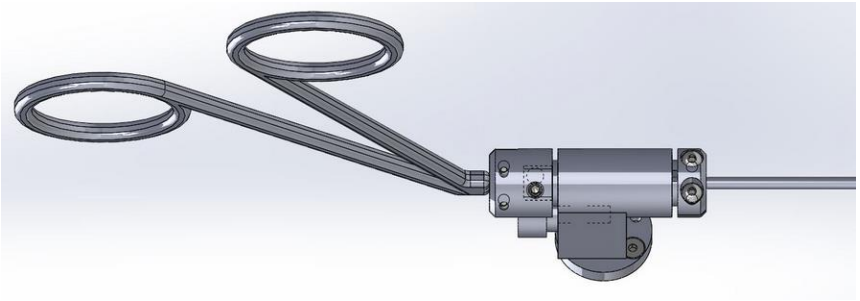
Ineffective needle holder tips, easily worn down

Criteria

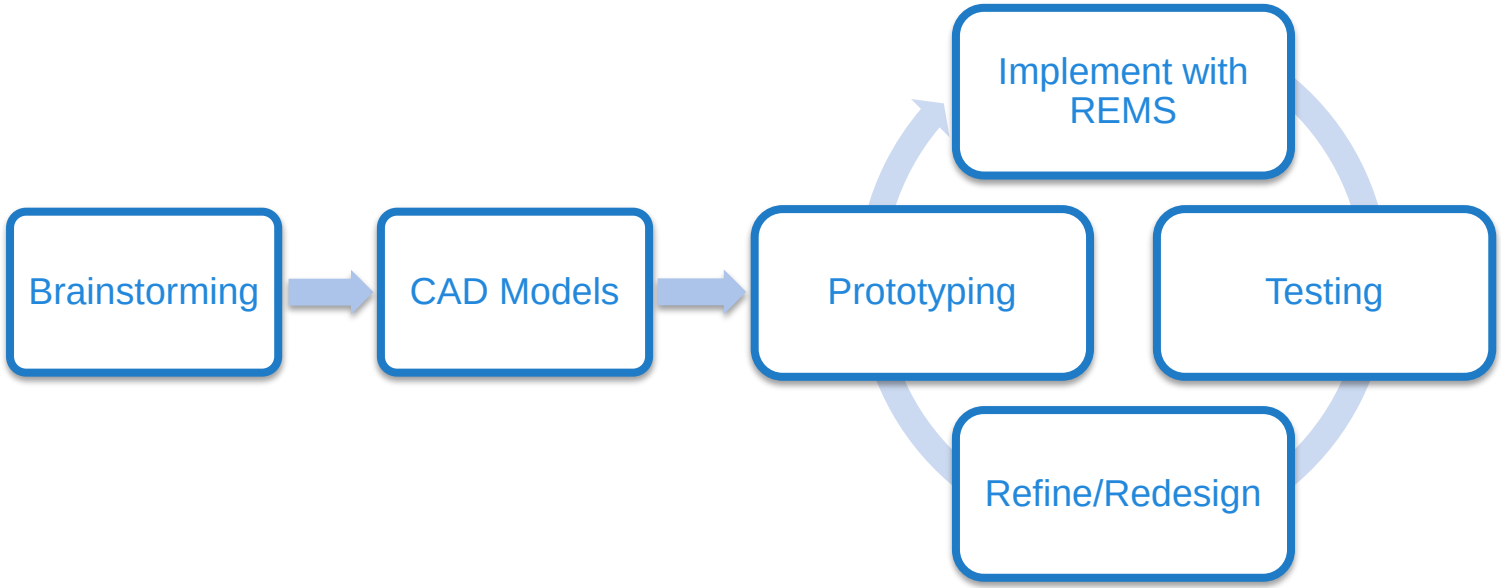
Specifications

- Quick-release tool holder
- Tweezer-like suture needle holder
- Minimal obstruction of surgeon’s hand





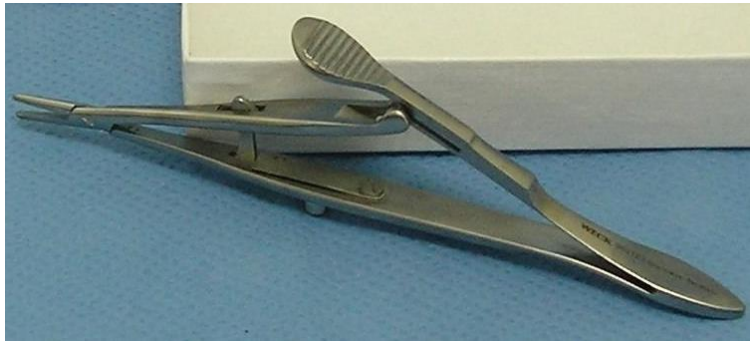
Design Approach



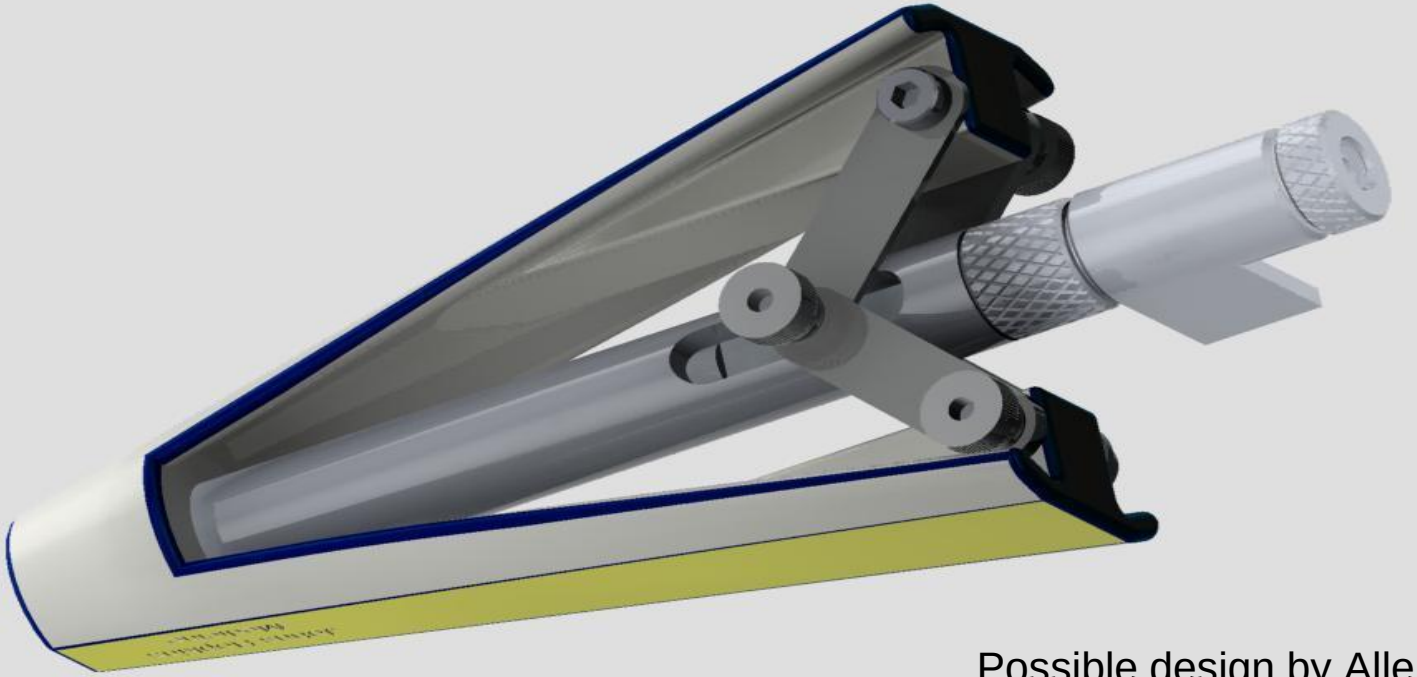
Design of Instruments

Eye Robot Tool

Kalt Eye Needle Holder



Design of Instruments



Possible design by Allen Feng

Deliverables

Minimum

Computer-aided design of:

- suture needle holder
- tool attachment unit

Pilot study with simple tool

Final report analyzing viability of designs

Deliverables

Expected

Building of designed suture needle holder and tool attachment unit

Needle holder tips with improved precision and durability

Implementation of tools with REMS robot

Surgical testing in mock OR by Dr. Richmon

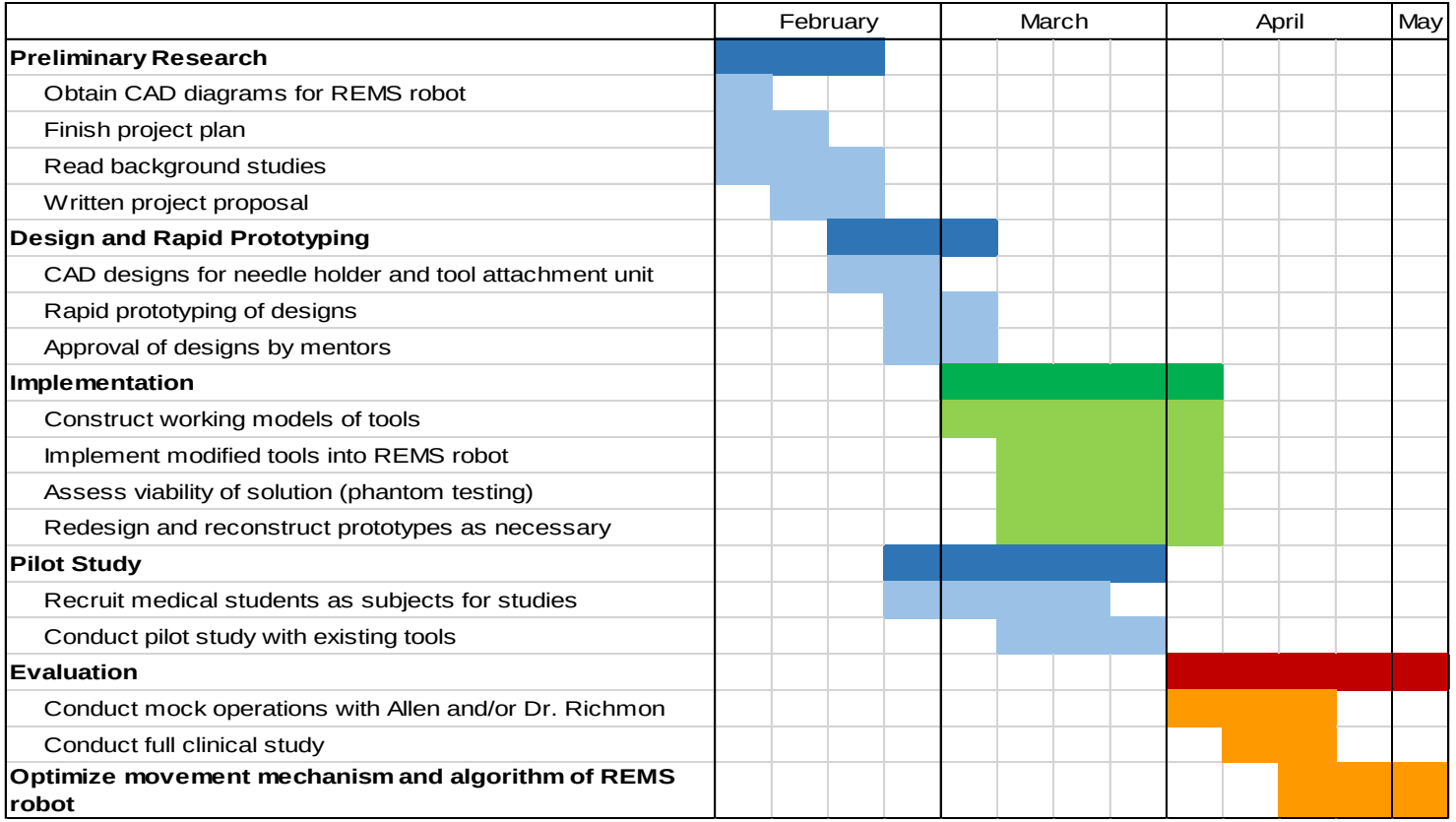
Deliverables

Maximum

Conduct clinical study on viability of new tools with medical students, under the supervision of Allen Feng and Dr. Richmon

Re-designing and optimizing the REMS movement algorithm and/or mechanisms

Projected Timeline



Dependencies

Dependency	Resolution
Machine shop certification	Register by end of February
Access to steady-hand robot	Schedule time to work with robot
Materials to design prototypes	Check availability of materials in machine shop Purchase remaining materials
Funding for materials and prefabricated components	Request funding from Dr. Taylor Estimated to $200
Scheduling of mock operations and study	Schedule with Dr. Richmon and Allen Feng

Management Plan

Zaid	Pranav
Brainstorming and design of needle holder and locking mechanism	
CAD models	Calibration algorithm
Prototyping of needle holder and locking mechanism	
Implementation of tools with REMS and phantom testing	

Weekly meetings with mentor (Kevin)

Bi-weekly updates to Dr. Richmon and Allen