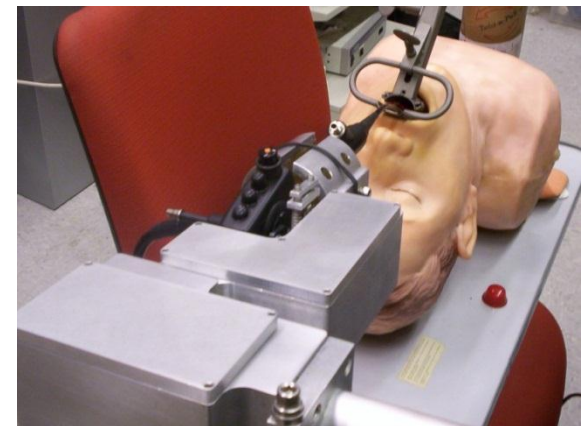


Robotic Endoscopic Tumor Ablation System

Elizabeth Cha

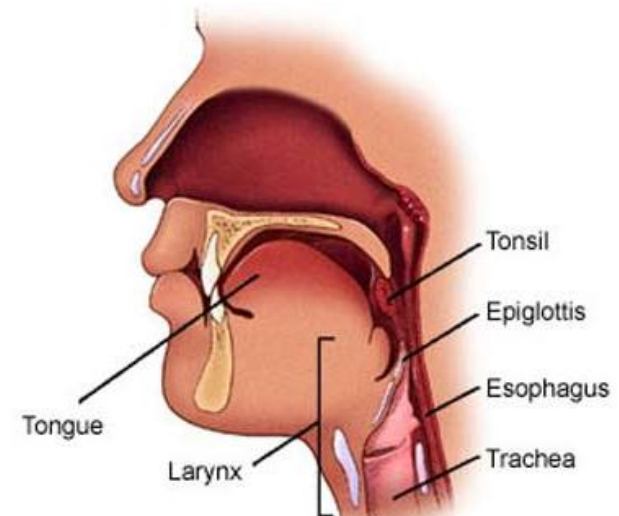
Mentors: Kevin Olds, Dr. Russell Taylor

Sponsor: Dr. Jeremy Richmon



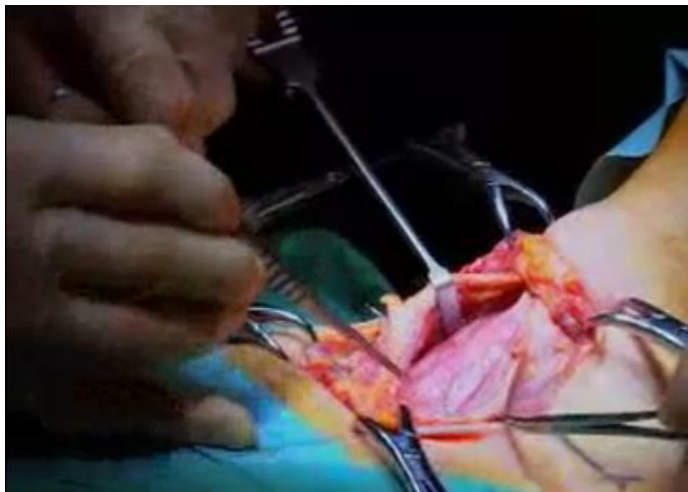
Motivation

- There are approximately 25,000 new cases of throat cancer every year in the US, resulting in approximately 6,000 deaths per year
- Radiation and chemotherapy have many undesirable side effects, especially in a sensitive and critical area like the throat
- Surgical approaches are often used to treat throat cancer



Surgical Techniques

- Types of surgical techniques in throat surgery:
 - Through incisions in the patient's neck
 - Inside the airway using an endoscope and specialized surgical tools including a cutting laser



Pros and Cons of Intra-Airway

- Advantages of Intra-Airway
 - Less risk of infection
 - Less scarring
 - Smaller risk of complications (damaged vocal cord nerves, etc.)
 - Faster recovery time
- Disadvantages of Intra-Airway
 - Limited visibility
 - Limited working room



Current Intra-Airway Surgery at JHMI

- Minimum of 4 hands needed:
 - Laser and endoscope are separate instruments
 - Endoscope needs two hands to operate
 - 3rd grabbing instrument is needed
- Laser is rigid and cannot bend around corners
- Scope does not remain stationary when hands removed and is difficult to control accurately
- **Result: working environment is crowded and awkward and visibility is poor**

Problem

- Current methods for throat tumor removal require multiple surgeons, risky/expensive surgeries with general anesthesia, and unnecessarily long hospital stays
- Other devices are not specialized, too expensive or don't have the functionality for a full system.



Goal

Design, build, and test a clinical quality prototype robotic throat tumor ablation system to aid in performing minimally invasive intra-airway surgery done potentially as an outpatient procedure under local or weak general anesthesia.

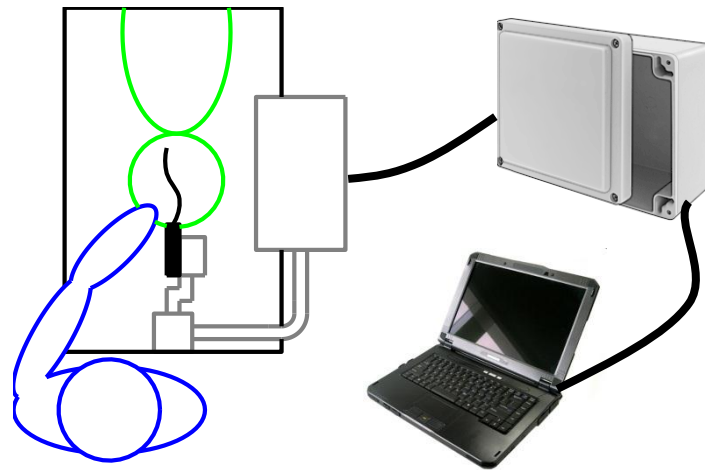
- Reduce number of hands needed
- Control all motion of endoscope
- Allow for use of one hand to control system leaving surgeon free to hold tool in other
- Have scope remain stationary with no hands

Solution

- Use a robotized endoscope with:
 - Single hand operation for laser/scope, leaving the other hand to use tissue manipulators
 - Built-in working channel for cutting laser
 - Precision movement
 - Laser and scope remain stationary when hands removed
 - Use pre-existing clinical endoscope and laser to minimize cost

Our Approach

- Design and build a 3 axis robotic assistance device
- Uses a laptop for surgeon to control system



Constraints and Design Issues

- Resistant to long term exposure to hospital grade cleaning agents
- Cannot contain any allergens or toxic materials
- Submersion proof
- Well grounded
- Should not have a lot of mass over the patient
- As few visible moving parts as possible
- Corrosion resistant seals
- All exposed metal parts must be stainless steel, aluminum, or plastic
- Robot must be able to resist bumps and minor abrasions

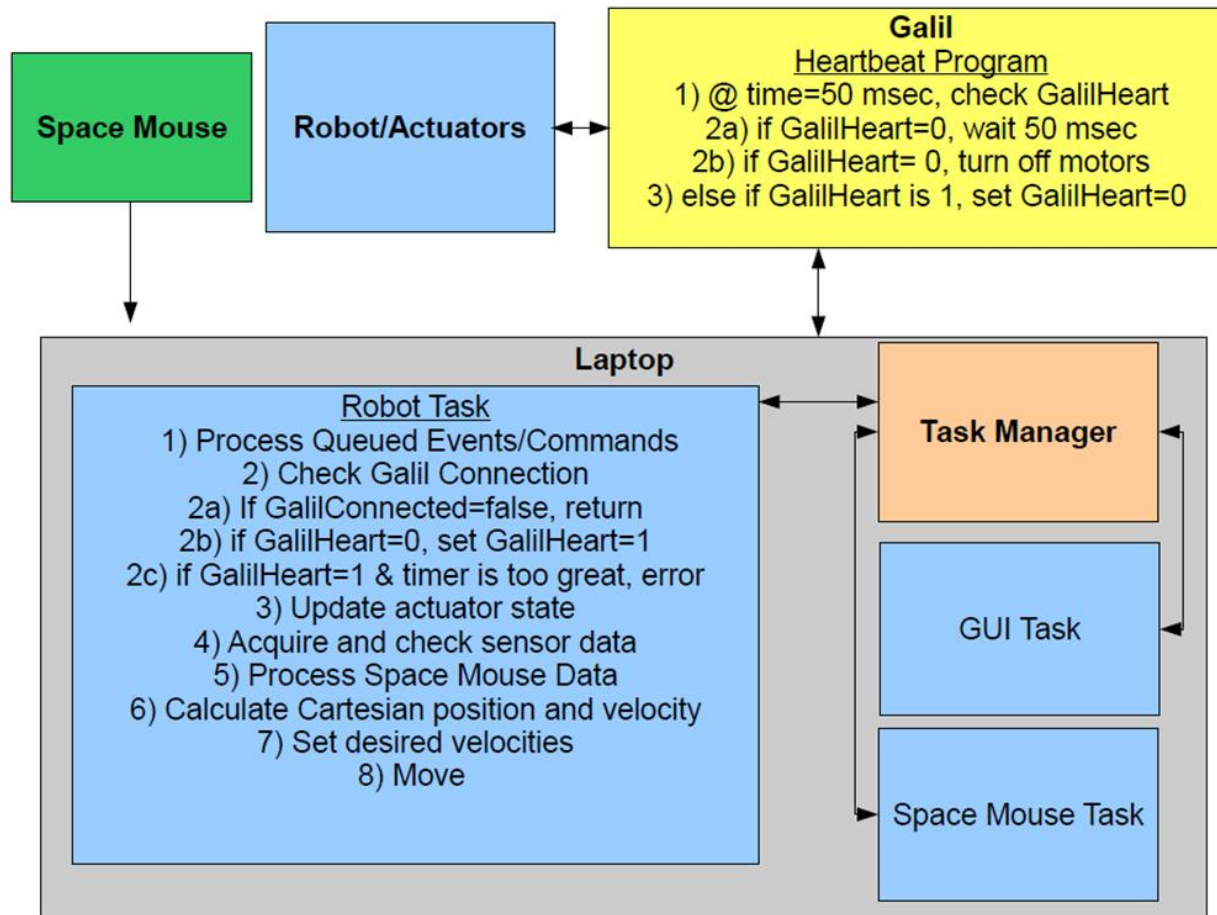
Prototype I



Hardware

- 3 servo brushed, coreless motors
- Integrated magnetic encoders
- Linear potentiometers for redundant sensing
- Galil Motion Controller (DMC-4030)
 - C++ Wrapper
 - Analog and Digital Inputs
 - Auto-tuning Control Loop

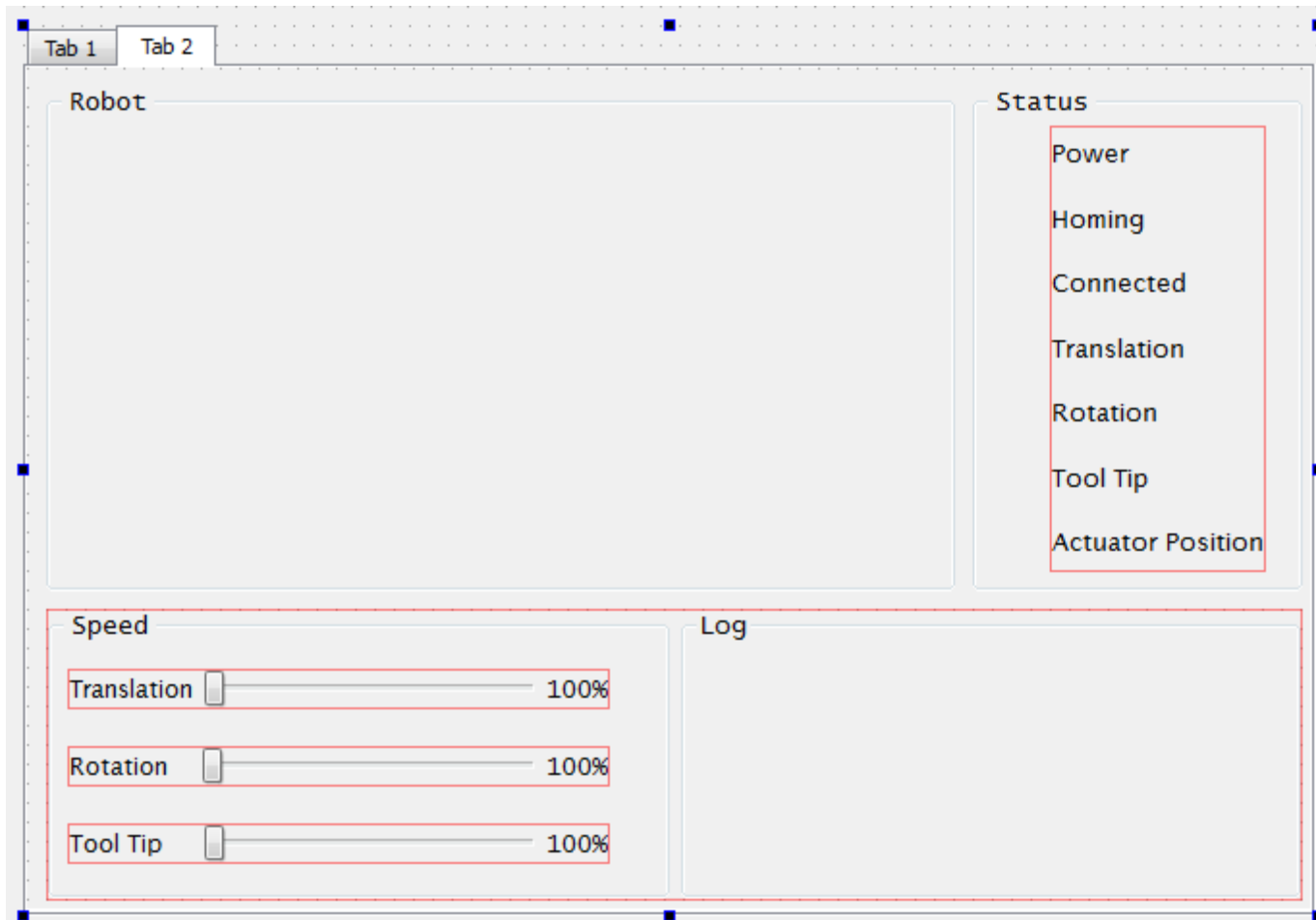
Software



Software

- Utilizes CISST libraries
- Controls each axis of motion separately
- Contains software safety features and limits
- GUI
 - alternative way to move robot
 - adjust speed and other variables
 - visualization/debug feature

GUI



Tab 1 Tab 2

Robot

Status

- Power
- Homing
- Connected
- Translation
- Rotation
- Tool Tip
- Actuator Position

Speed

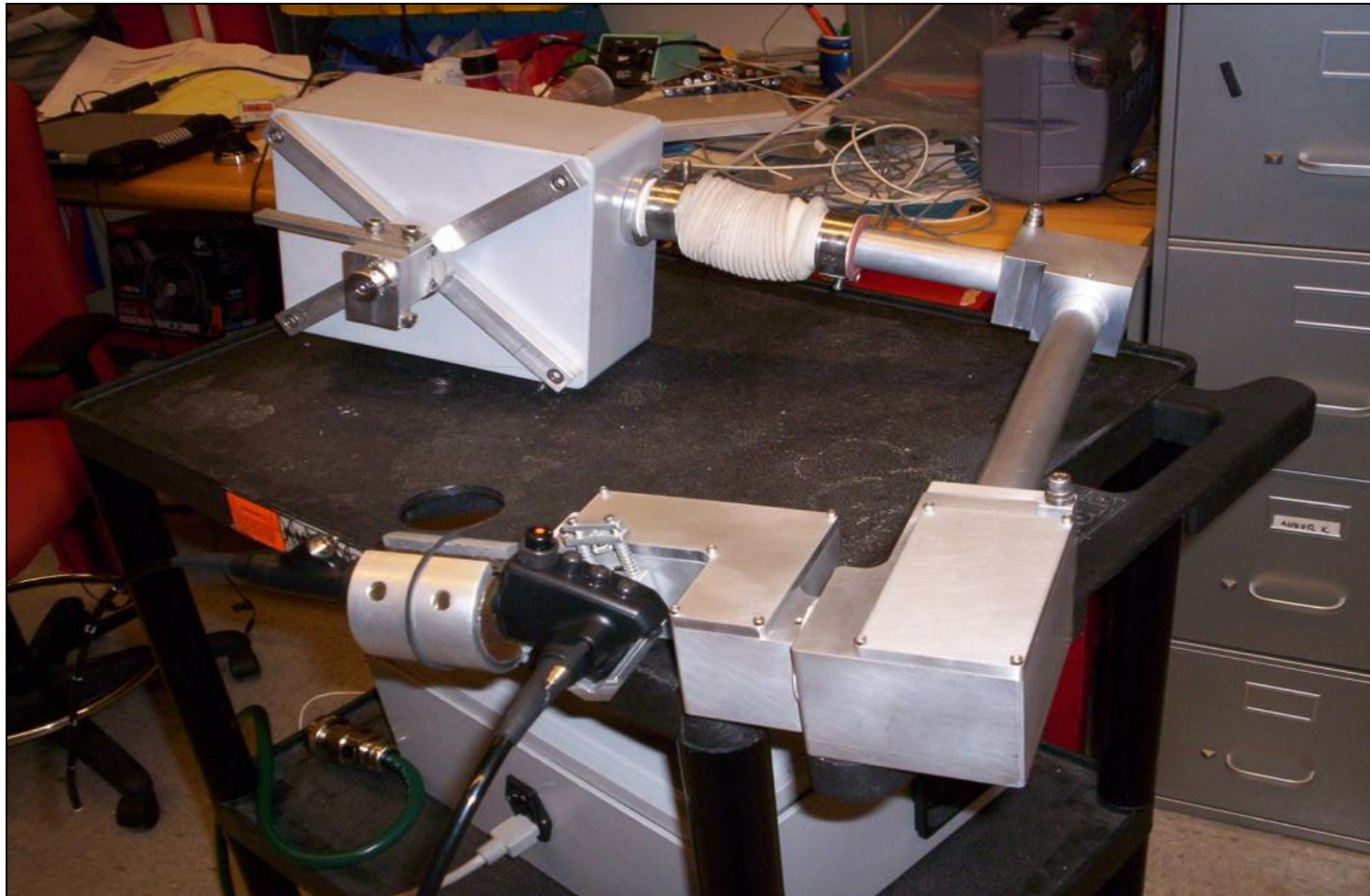
Translation 100%

Rotation 100%

Tool Tip 100%

Log

Prototype 2



Deliverables

- Minimum
 - Functioning system capable of performing mock operations with phantoms
- Expected
 - System capable of performing extensive cadaver experiments demonstrating functionality of system
 - User interface able to control and adjust system
- Maximum
 - Design and construction of a new input device
 - System able to pass clinical engineering standards

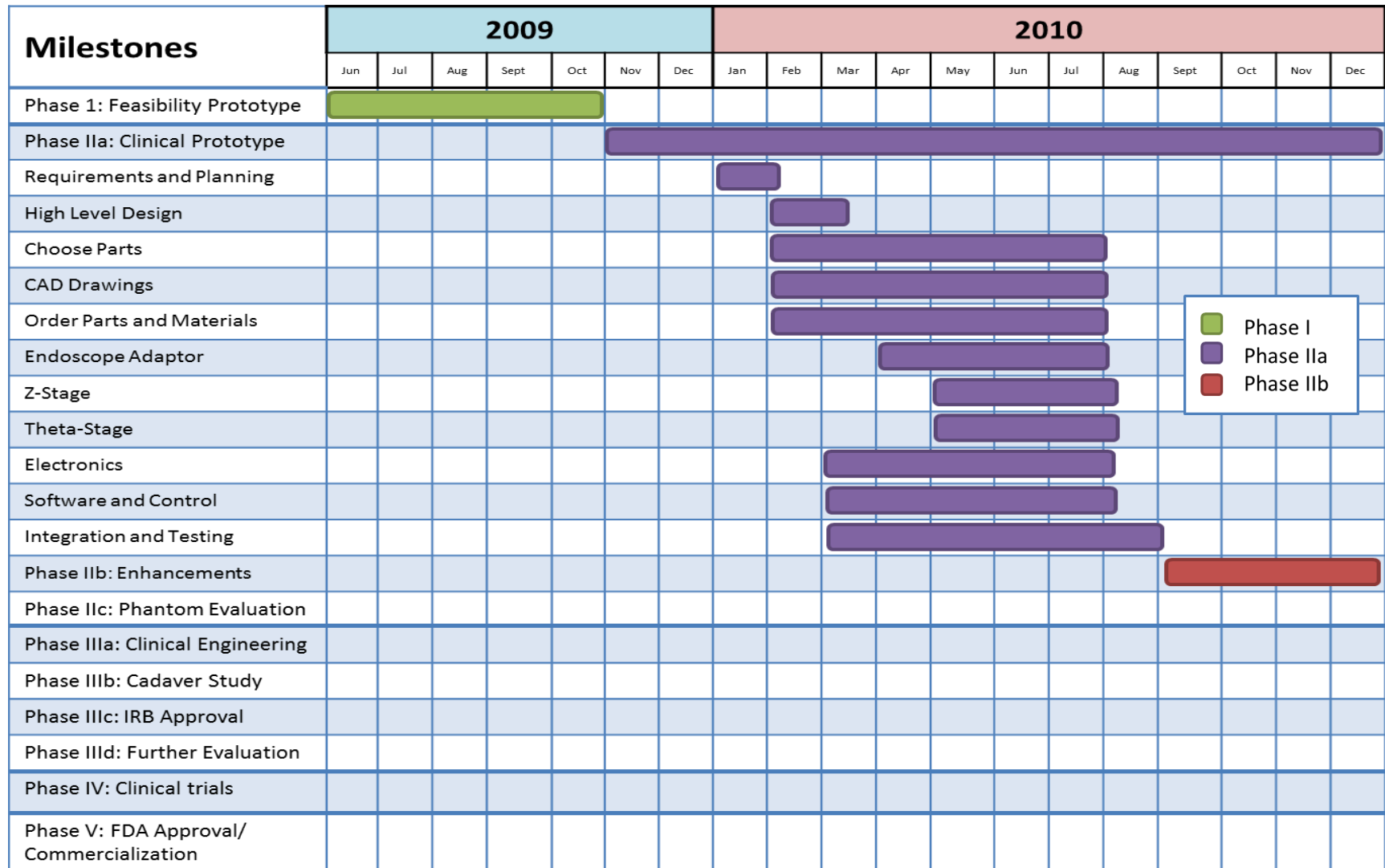
Testing Plan

- Clinical Engineering Standards (waterproof, grounded, chemical resistant, etc..)
- Phantom Evaluation
- Initial Cadaver Study
- Final Cadaver Study

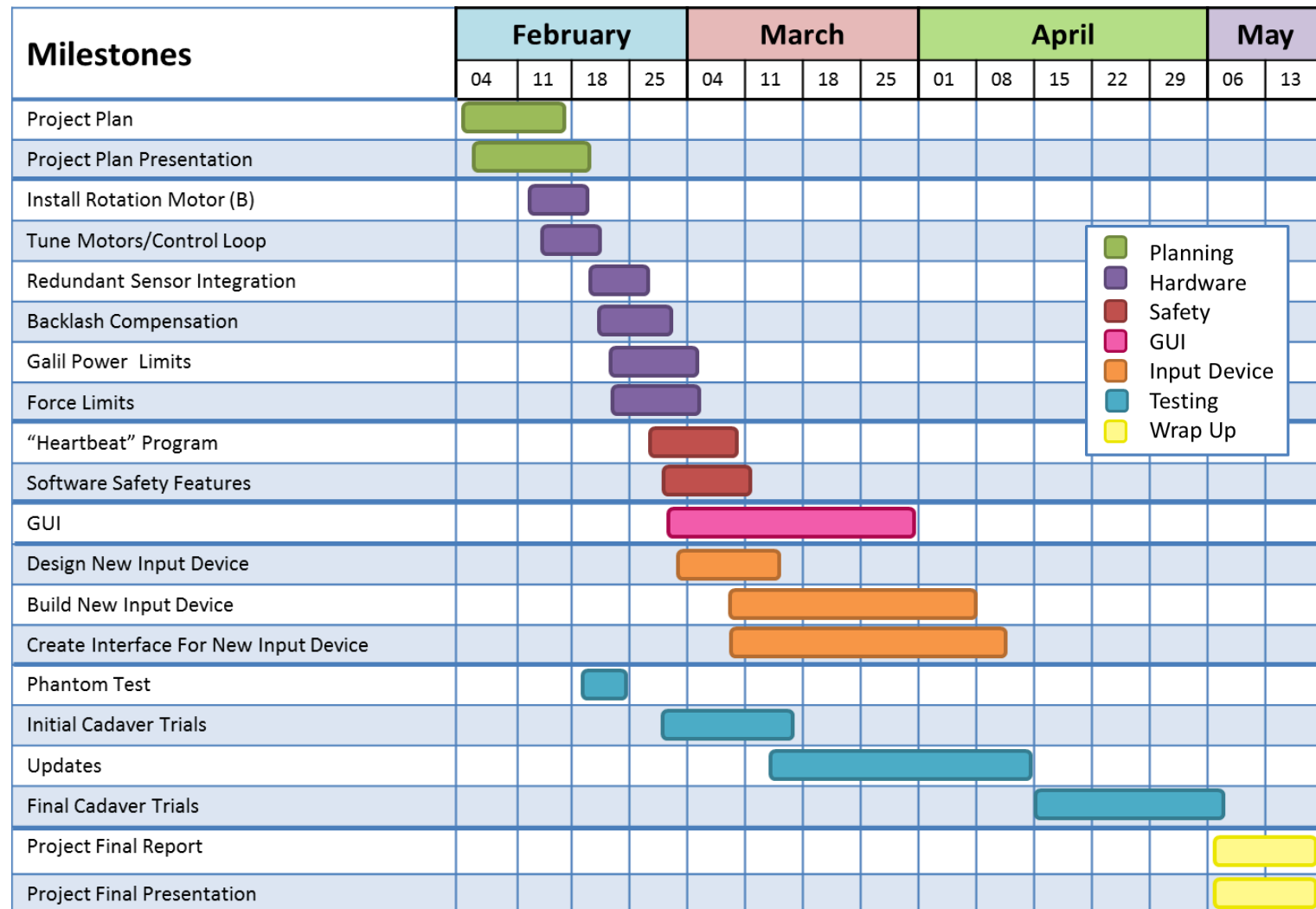
Dependencies

Dependency	Plan to Resolve	Resolve By	Affects
Cadavers Required	Have Surgeons Order	Resolved	Expected
Surgeon Feedback	Schedule Meeting	Resolved	Minimum
New Space Mouse	Order new mouse	Resolved	Minimum
New Translation Motor	Order new motor	Resolved	Maximum
Mechanical Work	Have Kevin finish	February 16	Expected
Funding	Submit budget proposal	Resolved	Maximum
New Input Device	Find an alternative or build alternative	April 1	Maximum
Electronics Equipment	Ask Dr. Taylor	March 9	Expected
QT toolkit/RobotGUI task	Talk to students in Lab	March 1	Maximum

Previous Work



Timeline and Milestones



Management Plan

- 25 hours per week on project
- Reassess deliverables at each milestone
- Meeting Schedule
 - Daily meeting with Kevin Olds
 - Weekly meeting with Dr. Taylor
 - Monthly meeting with Dr. Richmon

Budget

Items	Budget Allocation
Scope	\$22,000
Scope interrogator	\$2,000
Hardware	\$12,000
• Theta-stage	\$2,000
• Z-stage	\$2,000
• Motor Controller	\$2,000
• Motors/Encoders	\$1,500
• Misc. Shop Materials	\$500
• Computer/accessories	\$1,000
• Machinist Fees	\$1,000
• Phantom Costs	\$500
Enhancements	\$2,900
Phantom Study	\$925
Clinical Engineering	\$2,875
Cadaver Study	\$11,875
Total	\$54,575

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Questions?