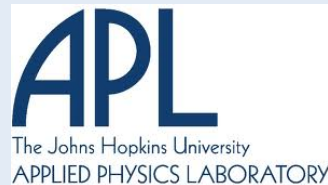


HAPTIC INTERFACE FOR SURGICAL MANIPULATOR SYSTEM

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BIOMECHANICAL AND IMAGE-GUIDED SURGICAL SYSTEMS (BIGSS) LABORATORY

JOHNS HOPKINS UNIVERSITY

COMPUTER INTEGRATED SURGERY II: GROUP 5
SPRING 2012

PROBLEM:

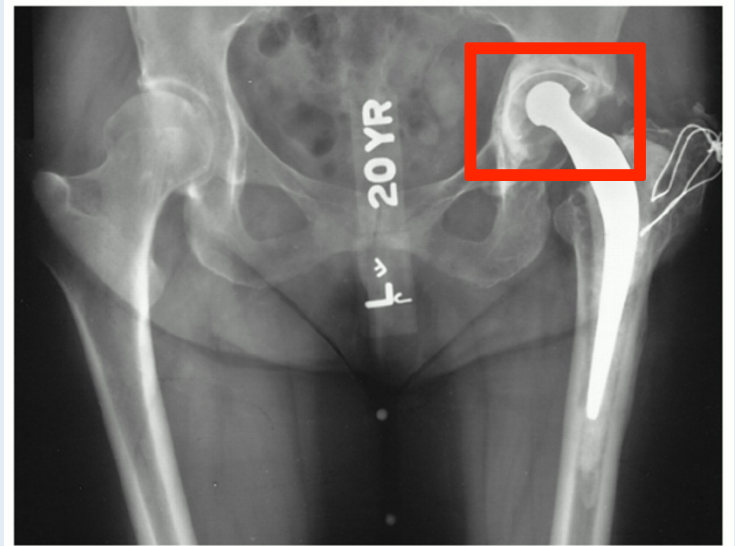
NO INTUITIVE WAY TO CONTROL ROBOT

SOLUTION:

DEVELOP INTUITIVE WAY TO CONTROL ROBOT

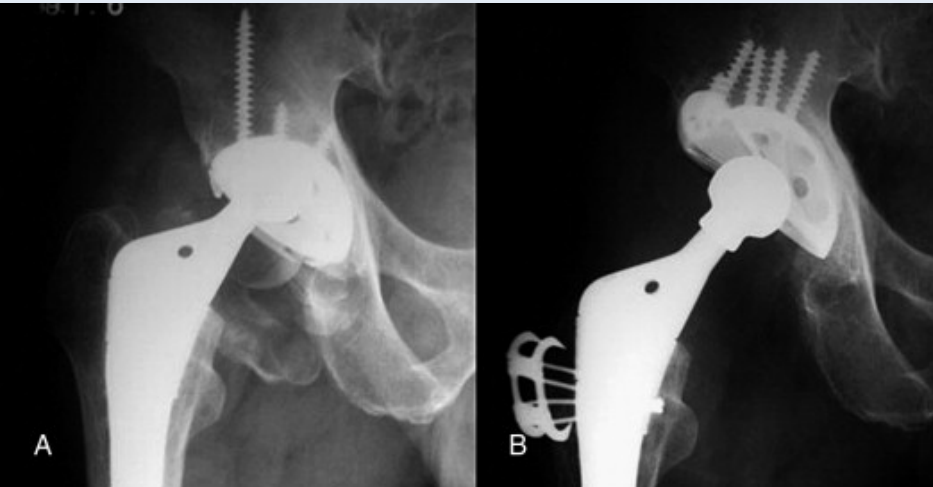
BACKGROUND: OSTEOLYSIS

- Osteolysis: Degeneration of bone tissue
- Associated with wear particles following total hip replacement
- May lead to bone fracture or implant loosening
- Lesion has spongy consistency surrounded by ring of rigid “wall”



<http://www.jbjs.org/data/Journals/JBJS/759/JBJA0791218340G03.jpeg>

BACKGROUND: REVISION SURGERY



<http://ars.sciencedirect.com/content/image/1-s2.0-S0883540307003294-gr2.jpg>

- Lesion accessed through screw holes
- Manually eliminate particle debris and osteolytic lesions
- Surgically challenging: <50% of lesion typically grafted

BACKGROUND

Motivation

Technical Approach

Deliverables

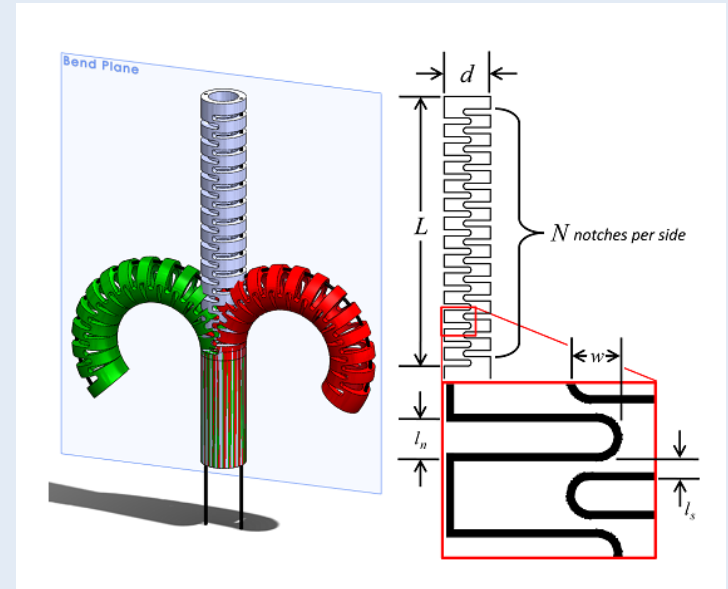
Milestones

Dependencies

Management Plan

BACKGROUND: ROBOTICALLY ASSISTED SURGERY

- Hyper-redundant cable-driven surgical manipulator system
- Snake-like cannula
- Preliminary test shows 94% coverage of lesion



http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5980285

BACKGROUND

Motivation

Technical
Approach

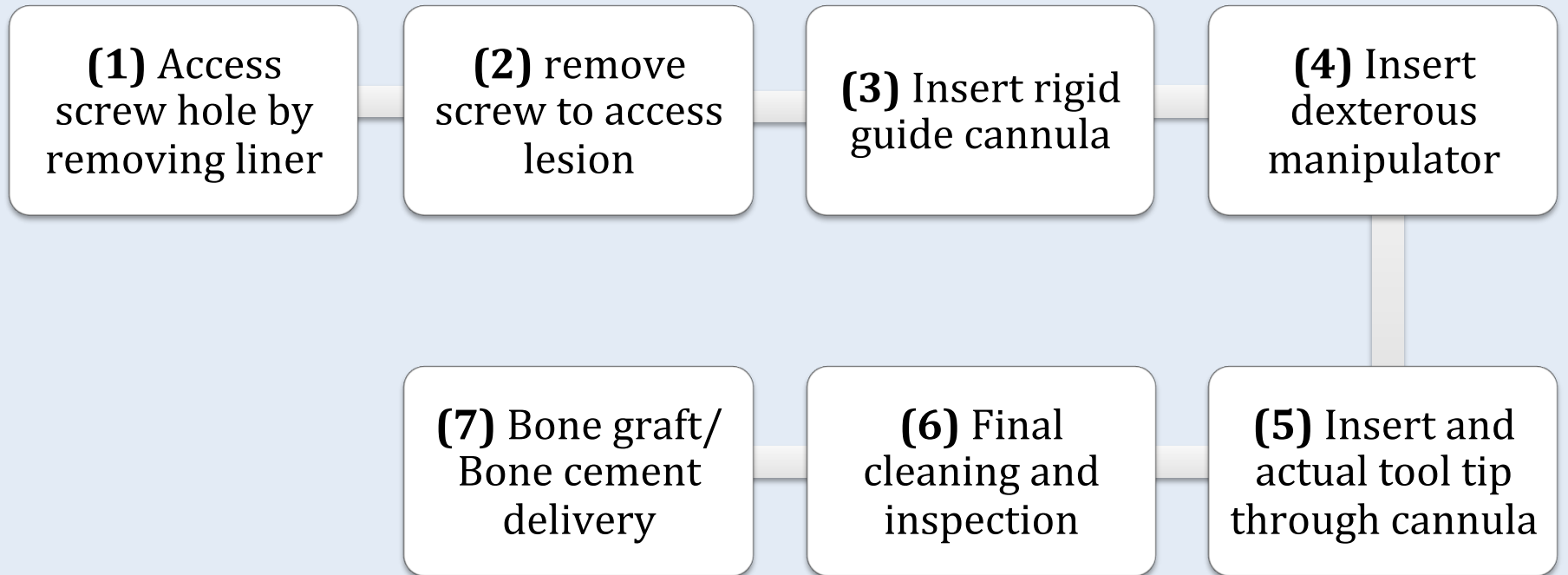
Deliverables

Milestones

Dependencies

Management Plan

BACKGROUND: ROBOTICALLY ASSISTED SURGERY



BACKGROUND

Motivation

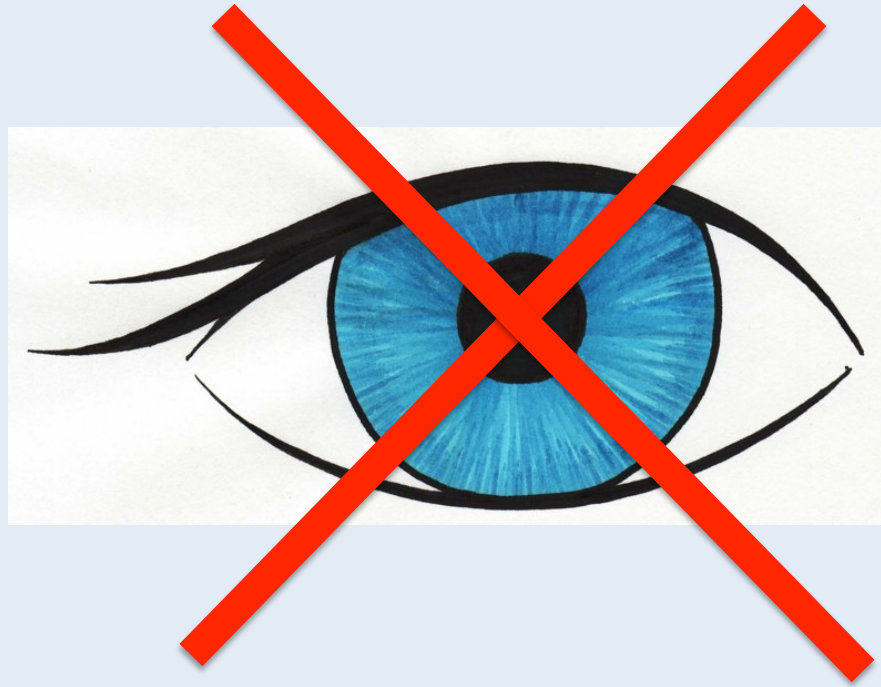
Technical Approach

Deliverables

Milestones

Dependencies

Management Plan



- Coverage
- Contact

Background

MOTIVATION

Technical
Approach

Deliverables

Milestones

Dependencies

Management Plan

MOTIVATION

PROBLEM:

AN INTUITIVE INTERFACE FOR THE MANIPULATOR DOES NOT EXIST.

SOLUTION:

DEVELOP SUCH AN INTUITIVE INTERFACE USING THE PHANTOM® PREMIUM. WE ALSO PLAN TO INTEGRATE HAPTIC FEEDBACK TO GIVE THE SURGEON A BETTER IDEA OF THE LESION LANDSCAPE.

Background

MOTIVATION

Technical
Approach

Deliverables

Milestones

Dependencies

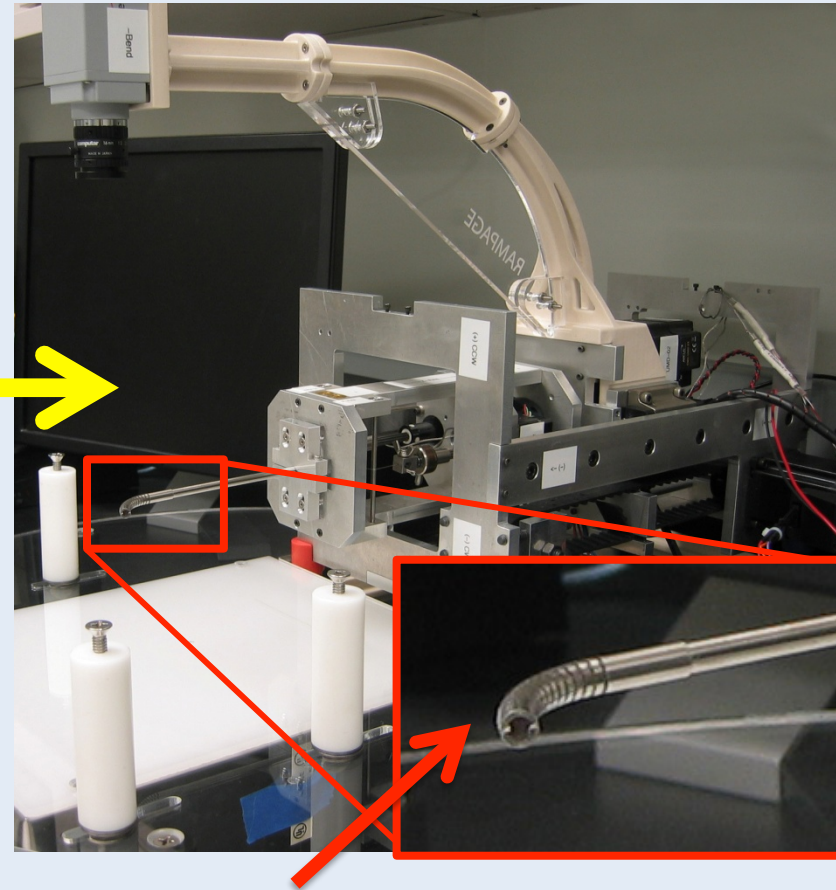
Management Plan

PHANTOM Premium Haptic Controller

http://ciis.lcsr.jhu.edu/dokuwiki/lib/exe/fetch.php?media=courses:446:2012:2012_possible_projects.pptx-web.pdf



http://ciis.lcsr.jhu.edu/dokuwiki/lib/exe/fetch.php?media=courses:446:2012:2012_possible_projects.pptx-web.pdf



Manipulator

Background

Motivation

**TECHNICAL
APPROACH**

Deliverables

Milestones

Dependencies

Management Plan

TECHNICAL APPROACH

First

- Understand system hardware and software
- Set up hardware and the keystroke MATLAB controller for manipulator.
- Recreate keystroke controller in C++

Background

Motivation

**TECHNICAL
APPROACH**

Deliverables

Milestones

Dependencies

Management Plan

TECHNICAL APPROACH

Second

- Develop simplified* inverse kinematics model of manipulator
- Develop PHANTOM-manipulator mapping schemes
- Dynamic simulation

*assuming equal joint angles

Background

Motivation

**TECHNICAL
APPROACH**

Deliverables

Milestones

Dependencies

Management Plan

TECHNICAL APPROACH

Third

- Implement mapping schemes
- Compare mapping schemes
- Implement force feedback

Background

Motivation

**TECHNICAL
APPROACH**

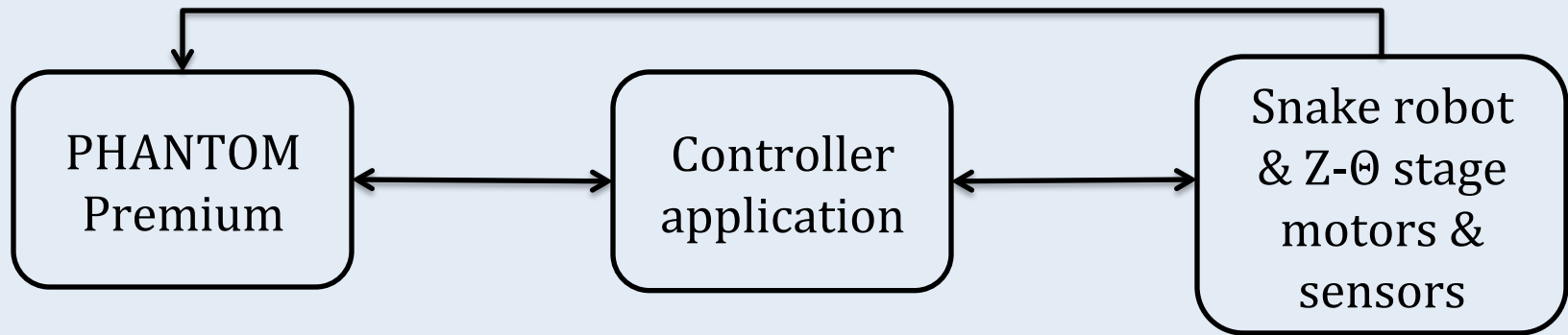
Deliverables

Milestones

Dependencies

Management Plan

Force feedback



Background

Motivation

**TECHNICAL
APPROACH**

Deliverables

Milestones

Dependencies

Management Plan

DELIVERABLES

- Minimum:
 - Develop simplified inverse kinematics model
 - Develop interface coupling the PHANTOM to the manipulator and incorporating force feedback
- Expected:
 - Develop 3D visualization of the manipulator for testing and training purposes.
 - More fully integrate force estimation and haptic feedback into interface.
 - Have surgeon provide qualitative feedback.
- Maximum:
 - Run quantifiable trials having inexperienced subjects learn to operate manipulator via PHANTOM. Compare multiple different interfaces and gestures to find best one.
 - Draft a preliminary conference paper documenting the use of this haptic interface to control the manipulator.
 - Draft a preliminary conference paper describing outcome of user trials.

Background

Motivation

Technical
Approach

DELIVERABLES

Milestones

Dependencies

Management Plan

MILESTONES

- Get PHANTOM® running using provided Sensable software
 - Planned Date: 20 Feb 2012 (~2-3 hr)
- Control software for PHANTOM®
 - Planned Date: 28 Feb 2012 (~2-3 hr)
- Identify/create and implement test mappings from PHANTOM® to graphical interface
 - Planned Date: 29 Feb 2012 (4-6 hrs)
- Be able to control manipulator using keystrokes in MATLAB
 - Planned Date: 2 March 2012 (~2-3 hrs)
- Develop simplified inverse kinematics model for manipulator
 - Planned Date: 9 March 2012 (~2 wks)
- Develop initial PHANTOM-manipulator mapping schemes incorporating haptic feedback on paper
 - Planned Date: 6 March 2012 (3 days)
- Develop dynamic 3D visualization of the manipulator (eventually to become part of PHANTOM GUI controller)
 - Planned Date: 28 March 2012 (~2 wks)

Background

Motivation

Technical
Approach

Deliverables

MILESTONES

Dependencies

Management Plan

MILESTONES

- Control manipulator using PHANTOM by implementing mapping schemes and be able to gather and import data from manipulator
 - Planned Date: 28 March 2012 (~2 wks)
- Incorporate force feedback into mapping schemes
 - Planned Date: 3 April 2012 (5 days)
- Complete preliminary testing and refine mapping scheme
 - Planned Date: 17 April 2012 (2 weeks)
- Have surgeon provide qualitative feedback
 - Planned Date: 20 April 2012 depending on surgeon availability (1 day)
- Testing and trials with inexperienced users
 - Planned Date: 27 April 2012 (1 week)
- Poster presentation
 - Planned Date: 10 May 2012 (1 day)

Background

Motivation

Technical
Approach

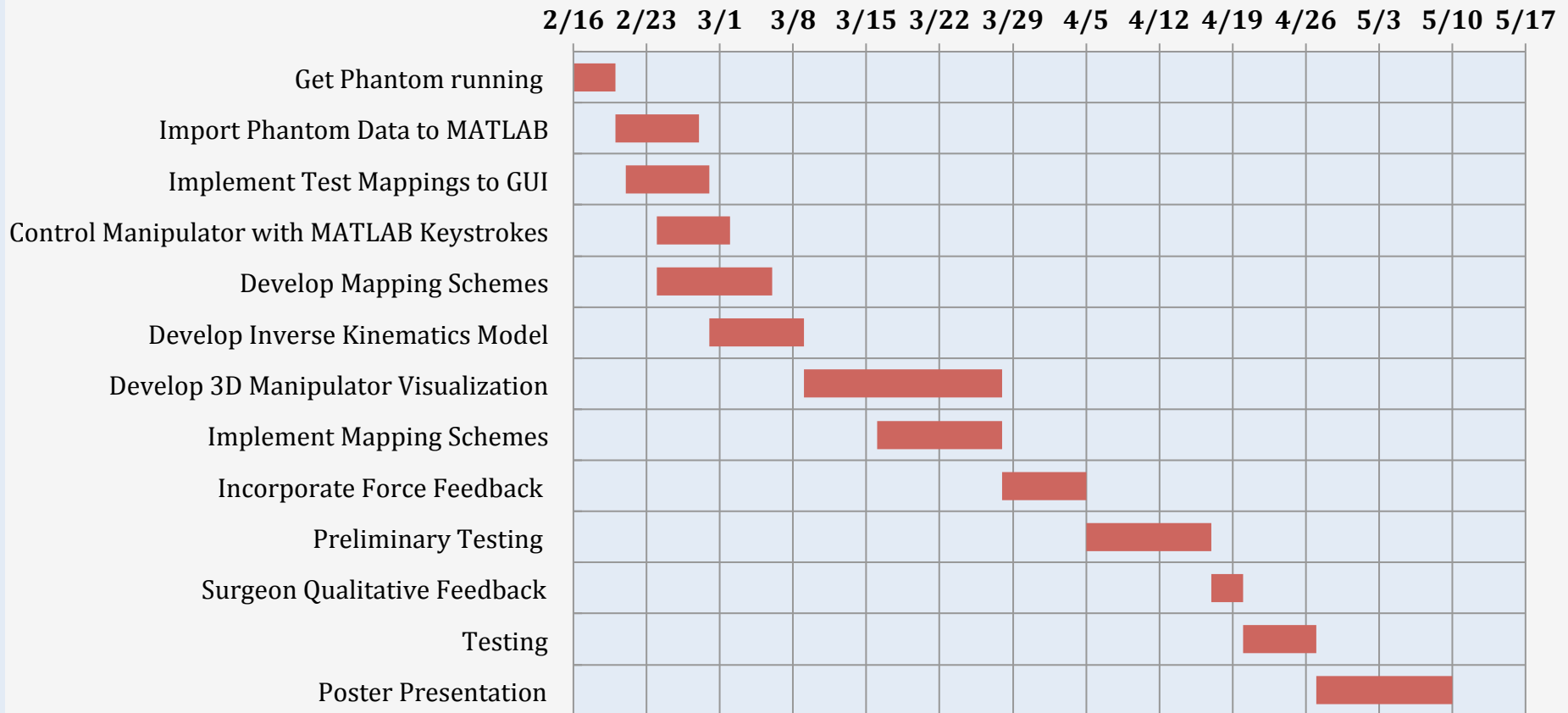
Deliverables

MILESTONES

Dependencies

Management Plan

MILESTONES: GANTT CHART



Background

Motivation

Technical Approach

Deliverables

MILESTONES

Dependencies

Management Plan

DEPENDENCIES

- Access to BIGSS Lab: Resolved**
- Constant Access to PHANTOM Premium: Resolved**
- Constant Access to Surgical Manipulator: Resolved**
- Meeting times with mentors: Resolved**
- Access to CISST Library: In Progress**
 - Resolve by: 2/29/2012
 - Contingency Plan: Contact Anton
 - Affects: Entire project
- Availability of Surgeon: Unresolved**
 - Resolve by: 4/19/2012
 - Plan to resolve: Contact Dr. Mears
 - Contingency Plan: Reschedule for available date
 - Effect on project: Expected deliverables—cannot receive surgeon feedback

Background

Motivation

Technical
Approach

Deliverables

Milestones

DEPENDENCIES

Management Plan

DEPENDENCIES

Test subject availability: Unresolved

- Resolve by: 4/15/2012
- Contingency Plan: Offer rewards (e.g. candy) or test on ourselves
- Affects: Expected deliverables—ability to refine model before presenting to surgeon and running quantifiable trials on inexperienced users

IRB approval for trials (if necessary): Unresolved

- Resolve by: 4/15/2012
- Plan to resolve: Contact Dr. Mears
- Contingency Plan: Talk to Mike about other ways to test device, limited testing on ourselves
- Affects: Expected deliverables—ability to refine model before presenting to surgeon and running quantifiable trials on inexperienced users

MANAGEMENT PLAN

- Weekly in-person meetings with Michael and Ryan to check in and ask questions along with constant email contact
- Group meetings every Monday in lab pod from 8-9p to report status updates and assign tasks for the upcoming week
- Weekly email chain to facilitate constant contact and status updates
- Work will be done cooperatively for the most part, especially at first. In general, Jessie will mainly work with the simulation and kinematics model while Piyush and Manish work on interfacing the PHANTOM and manipulator and testing various interfaces.
- Revise Gantt chart and milestones as necessary

Background

Motivation

Technical
Approach

Deliverables

Milestones

Dependencies

**MANAGEMENT
PLAN**

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- [3] M.D.M. Kutzer, S.M. Segreti, C.Y. Brown, R.H. Taylor, S.C. Mears, and M. Armand, **Design of a new cable driven manipulator with a large open lumen: Preliminary applications in the minimally-invasive removal of osteolysis**, in Proceedings of the 2011 IEEE International Conference on Robotics and Automation (ICRA2011), May 2011, pp. 2913-2920.
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Questions?

Thank you