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Realtime Feedback Tool for Nasal Surgery

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Mentors - Narges Ahmidi, Dr. Masaru Ishii, Dr. Lisa Ishii

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Background

Septoplasty surgery is a surgery that uses a surgeon's instinct in estimating nasal region to cut.

Training residents in septoplasty is hard because the residents cannot see the septoplasty process demonstration that's being done by the fellow

There is no existing technology that is being used for visualizing the septum surface and visualizing nasal cutting tool line-of-cut for septoplasty surgery.

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Goal

Fully functional and clinically acceptable software that assists surgeons in performing septoplasty, and increases the accuracy of the procedure.

Informative visualization that improve the learning environment for the attending septoplasty surgery resident.

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Technical Summary

Determine surgical scissor line-of-cut from training with phantom

Generate septum surface using EM pointer

Generate line-of-cut for surgical scissors using EM tracker

Visualize the predicted line-of-cut to the surgeon in real-time

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Deliverables

Requirement: All Code in C++ / Python

Minimum:

1. Training procedure for any model of scissors
    a. Meet surgical team biweekly and iterate on design until completed
2. Line of Cut prediction
3. Visualizing line of cut prediction and septum surface / phantom
4. Septum surface reconstruction by tracing the actual septum
5. Documentation for all software and mechanical designs

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Deliverables

Expected:

1. Real-time visualization of line of cut prediction on septum surface (> 15 Hz refresh rate)
2. Http-based web service to send data from existing software to our project
3. Software that validates the accuracy of a cut with respect to the prediction on the phantom

Maximum:

1. Get maximum accuracy for line-of-cut prediction using existing sensor (to be updated when we get complete specification of every sensor and tracker we use).
2. Septum surface reconstruction by randomized septum surface touching.

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Dependencies

1. EM Trackers and EM Control Unit -- provided by mentor
2. EM Tracker holder -- provided by mentor, expected arrival in March
    a. We will rapid-prototype a temporary EM tracker holder for testing purposes.
3. Surgical Scissors -- provided by mentor
4. Access to laboratory environment -- provided by mentor
5. Learning CISST library for a variety of applications (pivot calibration, 2D-3D registration, etc.)

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Dependencies

6. Code for Communicating with EM Tracker and reading pose in realtime -- provided by mentor
7. Pointer tool for surface reconstruction -- provided by mentor
8. Phantom for septal plane -- use chicken breast

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Management Plan - Meetings

Felix and Michael meet every Tuesday from 5-10pm, Friday from 3-8pm

Felix and Michael working on Saturday from 9am-7pm

Biweekly meetings with surgical team

Biweekly meetings with mentor to give progress updates

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Management Plan - Skills

Felix -- Computer Vision, Robotics, CAD design, machine shop skills, software development in C++ and Python

Michael -- Development of Visualization / analysis software, high performance computing, backend web infrastructure, software engineering

Management Plan - Bookkeeping

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Code backed up in private Github repository

Use Jira to track task completion

Inventor’s notebook kept in accordance with best practices (for patent purposes)

Management Plan - Gantt Chart

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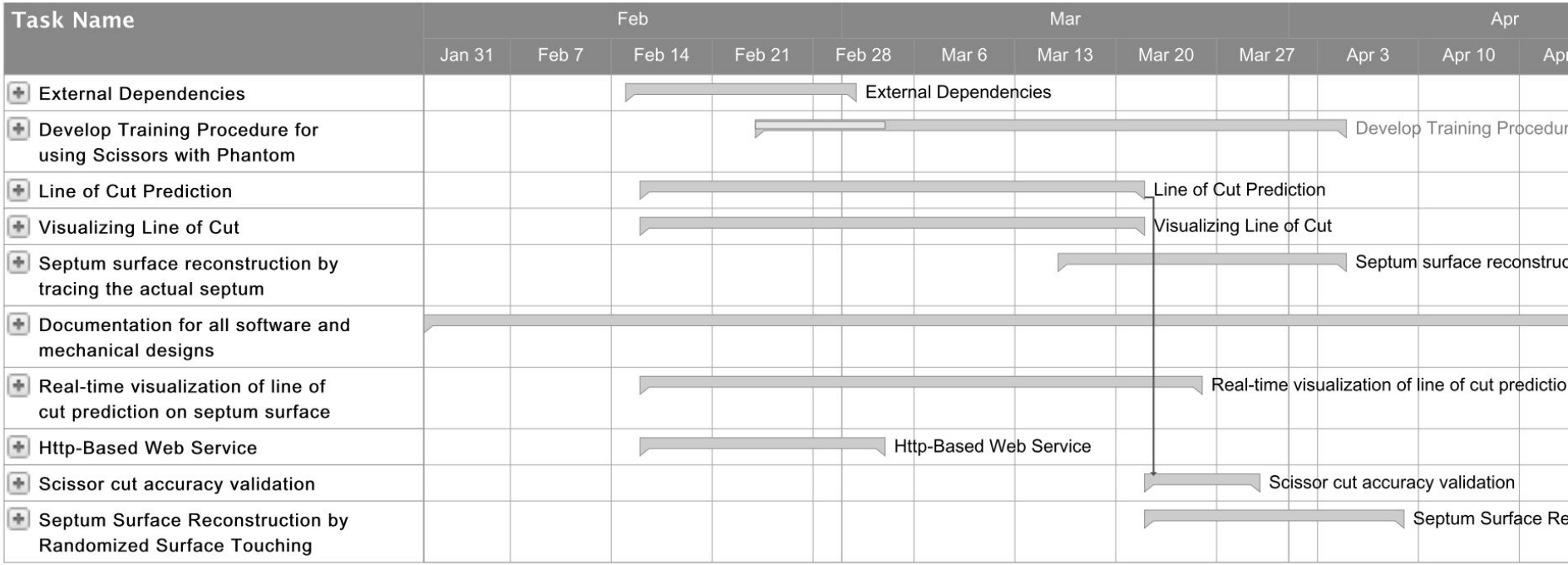

Line of Cut Prediction

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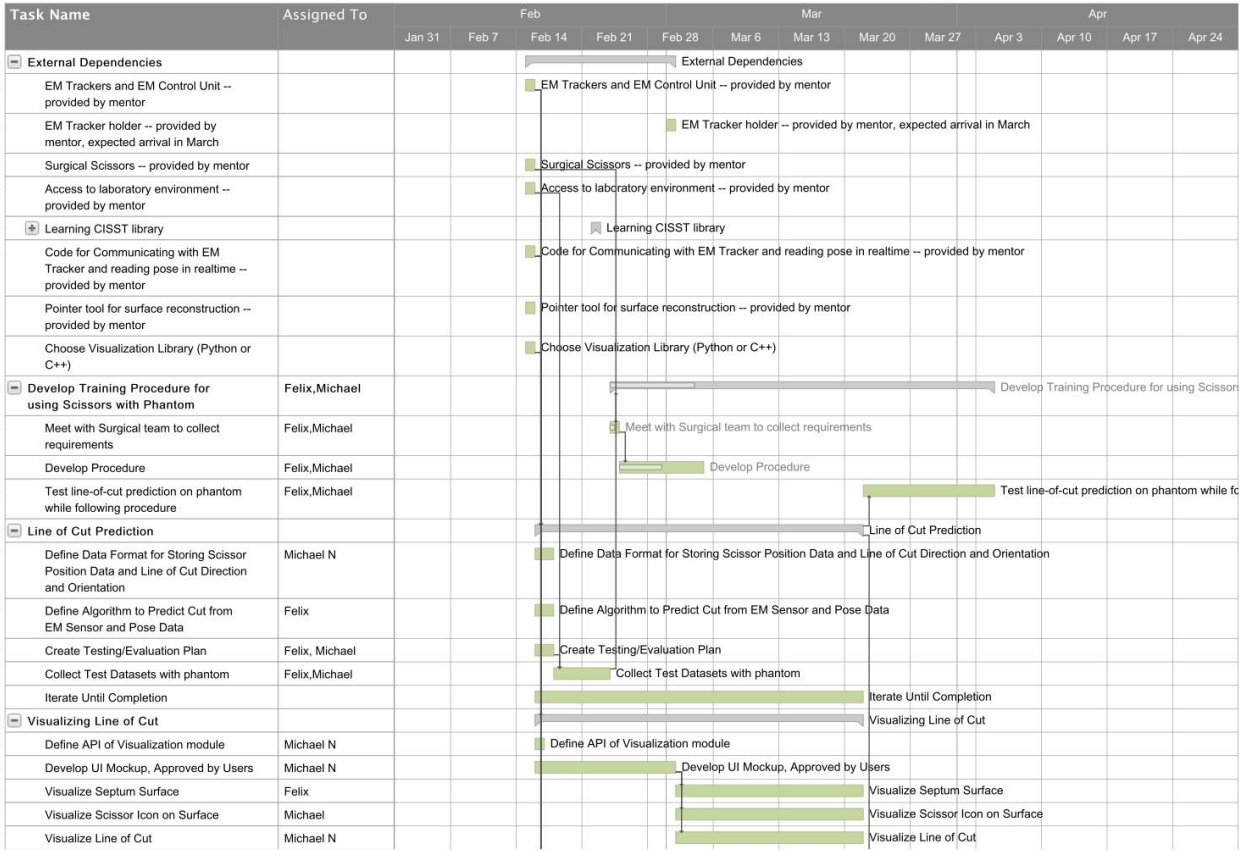

	Task Name	Assigned To
1	External Dependencies	
2	EM Trackers and EM Control Unit -- provided by mentor	
3	EM Tracker holder -- provided by mentor, expected arrival in March	
4	Surgical Scissors -- provided by mentor	
5	Access to laboratory environment -- provided by mentor	
6	Learning CISST library	
9	Code for Communicating with EM Tracker and reading pose in realtime -- provided by mentor	
10	Pointer tool for surface reconstruction -- provided by mentor	
11	Choose Visualization Library (Python or C++)	
12	Develop Training Procedure for using Scissors with Phantom	Felix,Michael
13	Meet with Surgical team to collect requirements	Felix,Michael
14	Develop Procedure	Felix,Michael
15	Test line-of-cut prediction on phantom while following procedure	Felix,Michael
16	Line of Cut Prediction	
17	Define Data Format for Storing Scissor Position Data and Line of Cut Direction and Orientation	Michael N
18	Define Algorithm to Predict Cut from EM Sensor and Pose Data	Felix
19	Create Testing/Evaluation Plan	Felix, Michael
20	Collect Test Datasets with phantom	Felix,Michael
21	Iterate Until Completion	
22	Visualizing Line of Cut	
23	Define API of Visualization module	Michael N
24	Develop UI Mockup, Approved by Users	Michael N
25	Visualize Septum Surface	Felix
26	Visualize Scissor Icon on Surface	Michael
27	Visualize Line of Cut	Michael N

Jan 31 | Feb 7 | Feb 14 | Feb 21 | Feb 28 | Mar 6 | Mar 13 | Mar 20 | Mar 27 | Apr 3 | Apr 10 | Apr 17 | Apr 24

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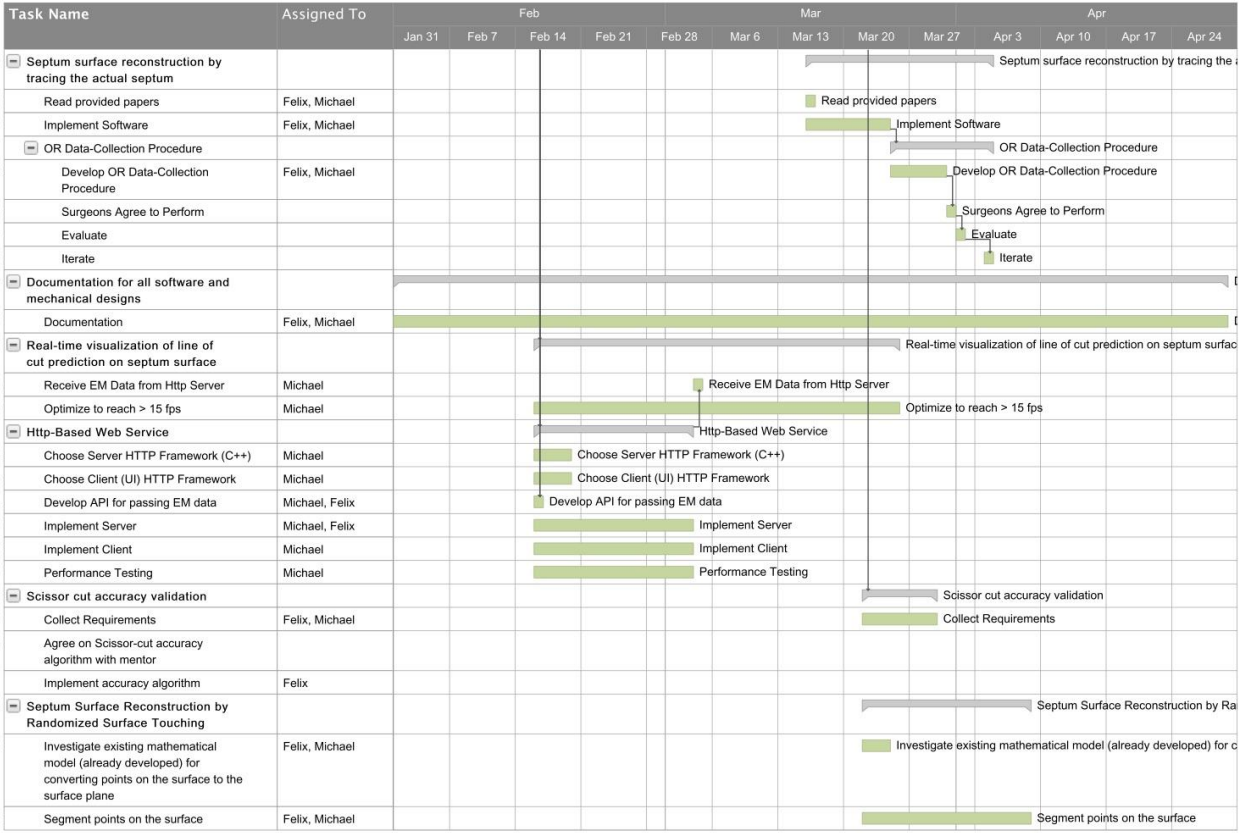

	Task Name	Assigned To
28	**Septum surface reconstruction by tracing the actual septum**	
29	Read provided papers	Felix, Michael
30	Implement Software	Felix, Michael
31	**OR Data-Collection Procedure**	
32	Develop OR Data-Collection Procedure	Felix, Michael
33	Surgeons Agree to Perform	
34	Evaluate	
35	Iterate	
36	**Documentation for all software and mechanical designs**	
37	Documentation	Felix, Michael
38	**Real-time visualization of line of cut prediction on septum surface**	
39	Receive EM Data from Http Server	Michael
40	Optimize to reach > 15 fps	Michael
41	**Http-Based Web Service**	
42	Choose Server HTTP Framework (C++)	Michael
43	Choose Client (UI) HTTP Framework	Michael
44	Develop API for passing EM data	Michael, Felix
45	Implement Server	Michael, Felix
46	Implement Client	Michael
47	Performance Testing	Michael
48	**Scissor cut accuracy validation**	
49	Collect Requirements	Felix, Michael
50	Agree on Scissor-cut accuracy algorithm with mentor	
51	Implement accuracy algorithm	Felix
52	**Septum Surface Reconstruction by Randomized Surface Touching**	
53	Investigate existing mathematical model (already developed) for converting points on the surface to the surface plane	Felix, Michael
54	Segment points on the surface	Felix, Michael

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Management Plan - Gantt Chart

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Purchase Requests

Jira subscription ($10/month) for tracking tasks, subtasks, and development progress

Private Github repository ($7/month) to backup code

Chickens for phantom (market price)

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