Septum reconstruction from tool motion data

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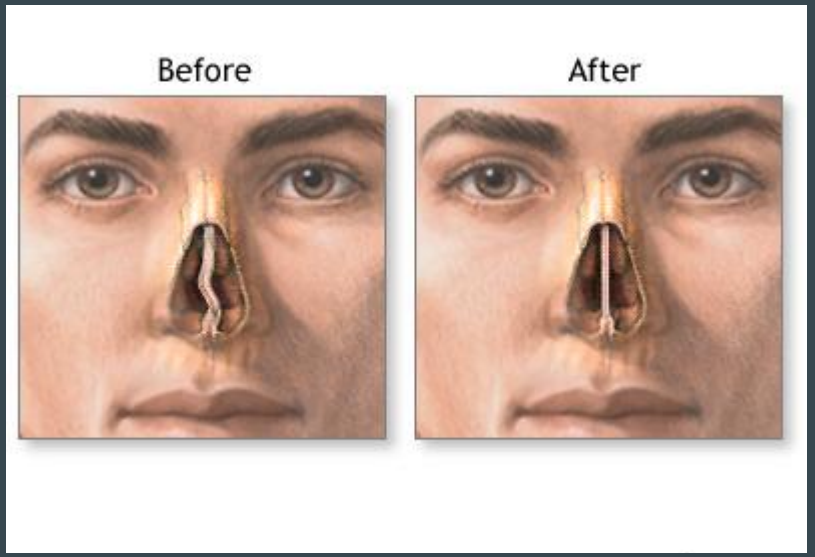
Medical Background

- Septoplasty is a procedure done to correct a deviated (not straight) septum
- This procedure is the 3rd most common ear, nose, and throat surgery performed[1]
- It is considered one of the most basic procedures that all ENT surgeons must master



[1]Bugten V, Nilsen AH, THorstensen WM, Moxness MHS, Amundsen MF, Nordgard S. Quality of life and sympoms before and after nasal septoplasty compared with healthy individuals. BMC Ear, Nose, and Throat Disorders. 2016

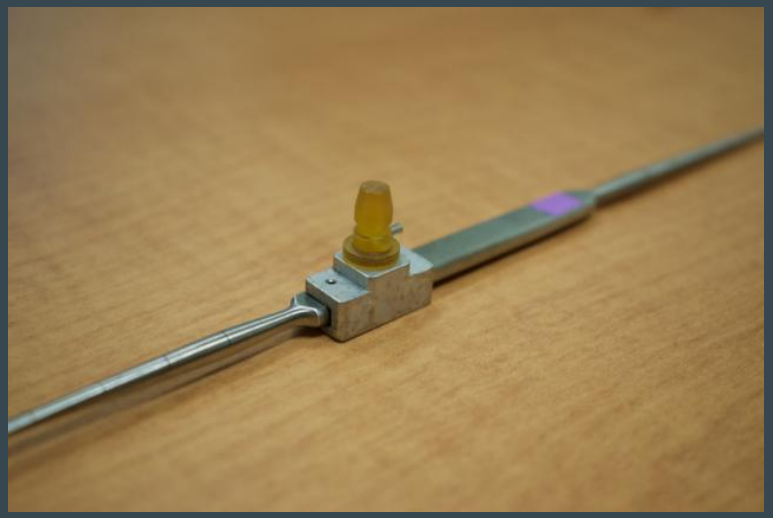
Importance

- Septoplasty usually exists as a black box, the structure of the septum is unseen before and after the surgery (unless imaging is performed, which is rare and expensive). This model will allow others besides the operating surgeon to have a view into the structure being operated on.

- This model can be used to classify the difficulty in operating on a specific septum

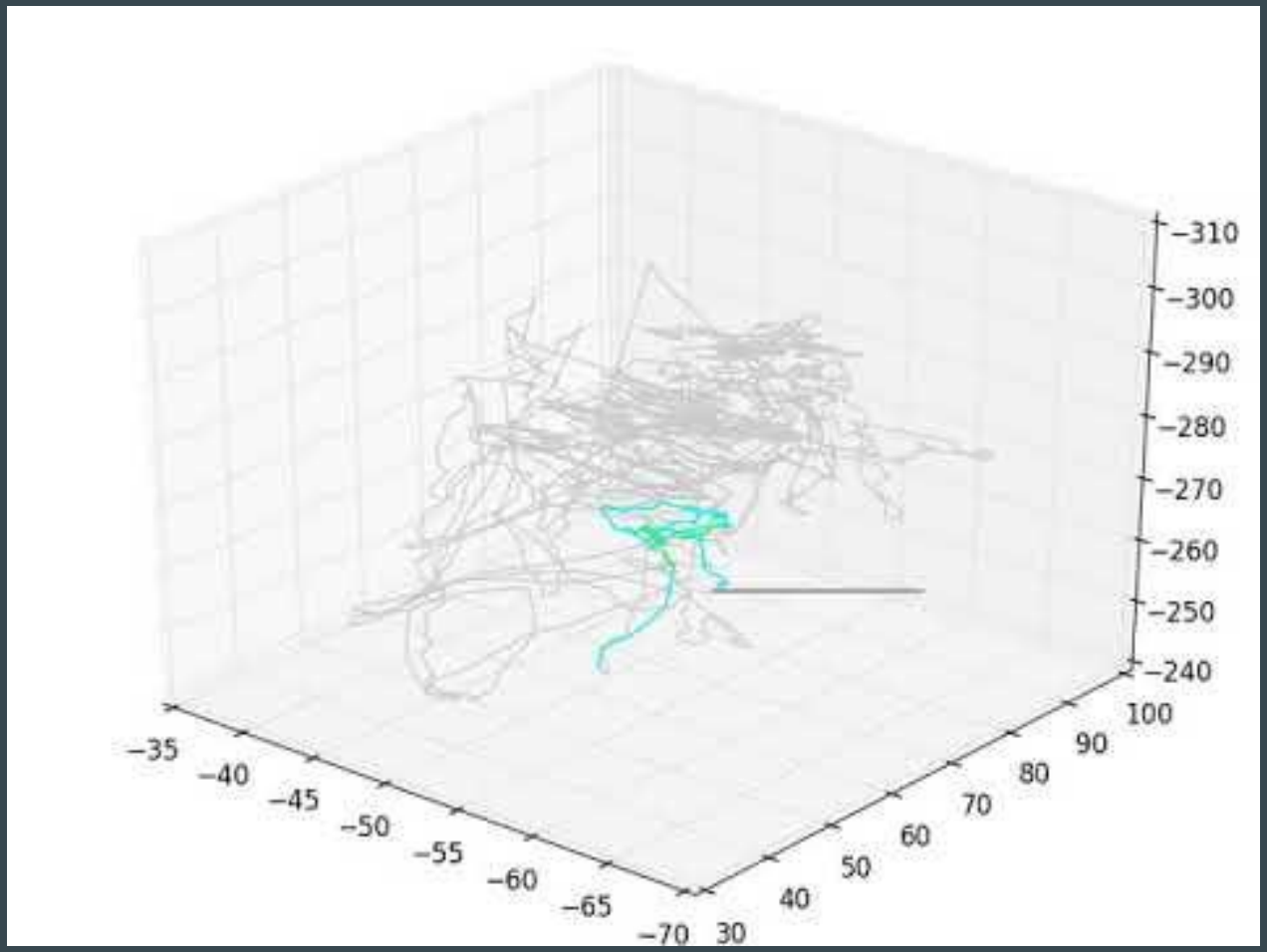
- This model can be combined with other measures to classify skill level of a particular surgeon to be used for future training or other purposes

Technical Background



- Two data sets exist, R21 and R01
  - R01 is newer, but not formatted correctly
  - R21 is older, but readily usable
- R21 has only one tracked tool, R01 has seven tracked tools
- There are a few cases in R01 that have matching CT scans
- There also exists a model of the sinus that we wish to use as a starting point for reconstructed septums

Demo data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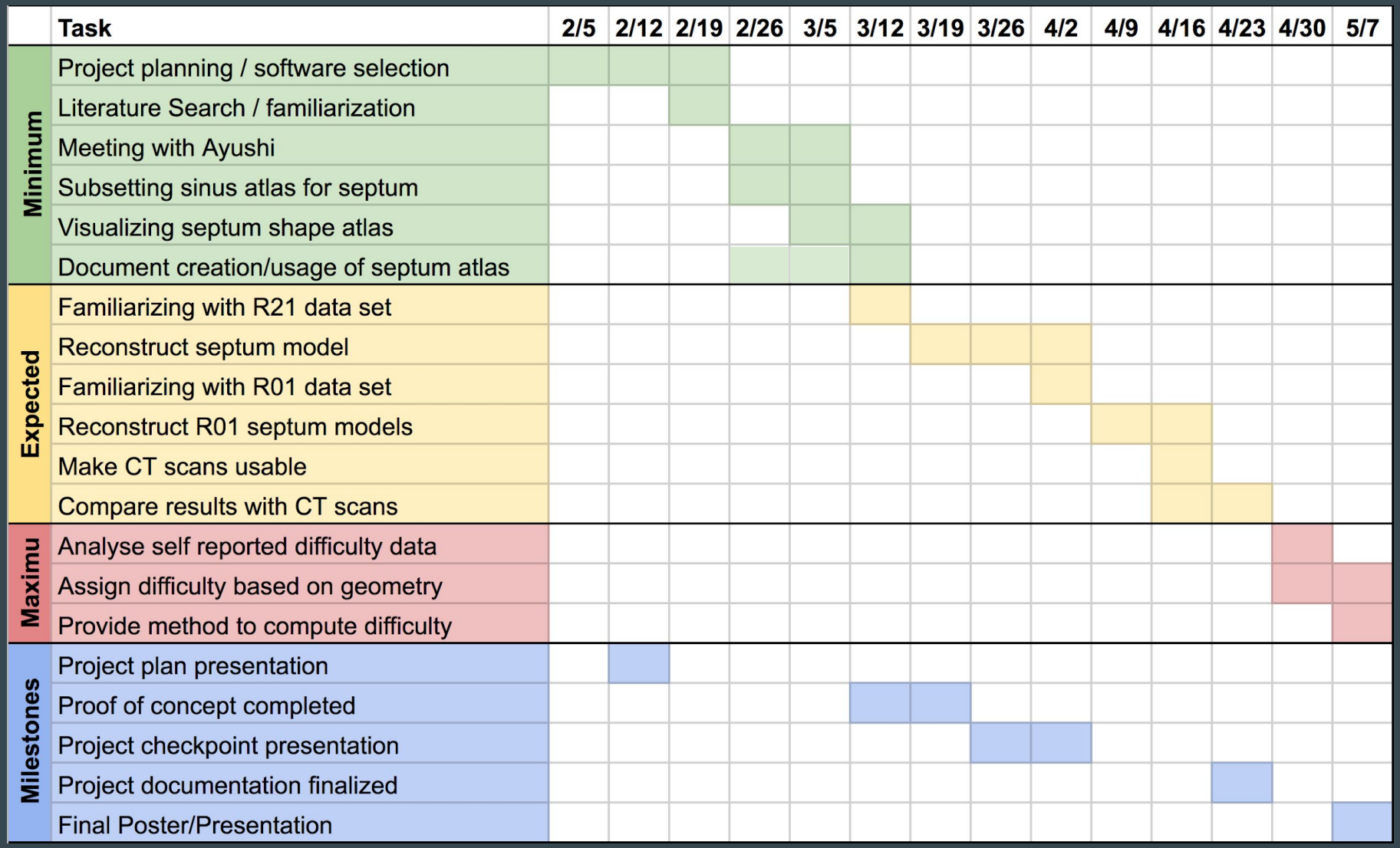
Timeline


Task
2/5
2/12
2/19
2/26
3/5
3/12
3/19
3/26
4/2
4/9
4/16
4/23
4/30
5/7
Minimum
Project planning / software selection
Literature Search / familiarization
Meeting with Ayushi
Subsetting sinus atlas for septum
Visualizing septum shape atlas
Document creation/usage of septum atlas
Expected
Familiarizing with R21 data set
Reconstruct septum model
Familiarizing with R01 data set
Reconstruct R01 septum models
Make CT scans usable
Compare results with CT scans
Maximu
Analyse self reported difficulty data
Assign difficulty based on geometry
Provide method to compute difficulty
Milestones
Project plan presentation
Proof of concept completed
Project checkpoint presentation
Project documentation finalized
Final Poster/Presentation

Deliverables

Minimum:

- Subsetted model of the sinus that Ayushi Sinha has been working on to have a workable shape atlas for the septum.
- Documentation covering what our septum atlas is, how to use it and how it was generated.

Expected:

- Algorithm to output a visualization of a septum given tool motion data collected during septoplasty.
  - This will need to be tested with the R21 data minimally, and hopefully, the R01 data
  - Includes documentation for usage

Maximum:

- Try to assign a ‘difficulty level’ to the septum based on the geometry that we generated and ratings of difficulty provided by the surgeons.

Dependencies

- Access to surgical tool motion data from septoplasty server (R21 & R01)
  - IRB required
- Access to software necessary
  - Python, Matlab, may need specialized visualization tools (ros/Rviz etc.)
  - GitLab access to existing code
- Access to work on sinus atlas done by Ayushi Sinha
- Access to surgeons who perform septoplasty (Dr. Ishii)

Management Plan

- Weekly meetings with LOS group
- Structured meeting times with one another to work and discuss progress or hardships

Division of Work

We will work together while doing more detailed planning and literature searches. Manyu will focus more on developing the algorithm for creating a septum from tool motion data and Rohit will spend more time working with the subsetted ‘ideal’ model of a septum.

Additional Reading

- Poddar, Piyush & Ahmidi, Narges & Swaroop Vedula, S & Ishii, Lisa & Hager, Gregory & Ishii, Masaru. (2014). Automated Objective Surgical Skill Assessment in the Operating Room Using Unstructured Tool Motion. International journal of computer assisted radiology and surgery.

- Berger, Tagliasacchi & Seversky. (2014). State of the Art in Surface Reconstruction from Point Clouds. The Eurographics Association.

- Bernard, Salamanca, Thunberg. (2017). Shape-aware surface reconstruction from sparse 3d point-clouds. Medical Image Analysis.

- Wu, Murtha, Jaramaz. (2015). Construction of statistical shape atlases for bone structures based on two-level framework. International Conference on Computer Vision Theory