Automatic Brain Segmentation for 3D Printing - Phase 5

Group B1
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Our Team

Mechanical Engineers

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Nathan Carpenter
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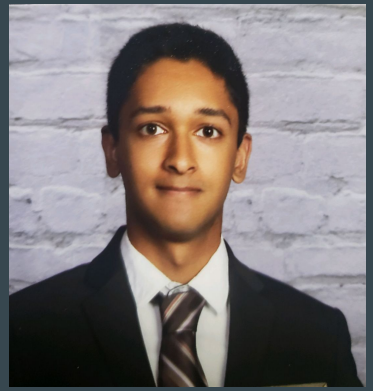

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Dix Hills, NY

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Problem Statement

- Create a personalized brain model from an MRI scan
- Make the process from MRI scan to brain model nearly fully automatic
  - Only a single input needed from the customer
- Print 3D model to help doctor/surgeons have an accurate visual aid when explaining the patient's brain ailments or upcoming surgeries
- Create 3D models to serve as gifts/souvenirs for patients receiving brain-related treatment

Work Done So Far (Phases I-IV)

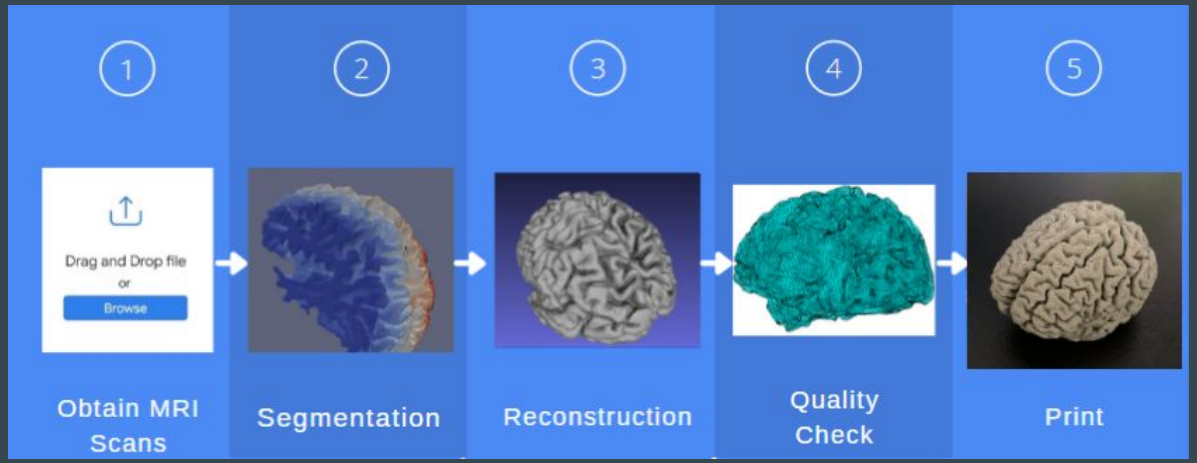
- Proposal and Conceptual Designs
- Technical Analysis
- Engineering Design and Alpha Prototype Plan
- Fabrication Plan and Alpha Prototyping Design
- The team established feasibility of the alpha prototype pipeline
    - This was done by using the softwares manually to get a print complete

Phase 4 Feedback

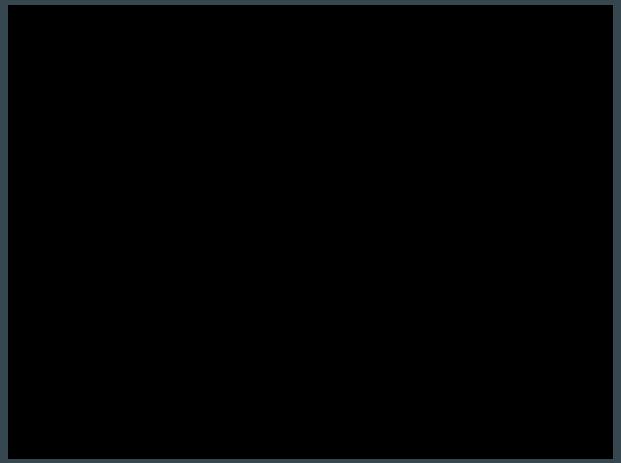
Phase 4 Panel Feedback	Solutions/Responses
How much do you plan on spending? How much have you spent?	We have spent ~$35 on printing models. We plan on spending another 50-60 to continue print testing and to print out the remainder of the models for the Innovation Expo.
How is the model going to show inner abnormalities of the brain?	With our project displaying inner abnormalities is possible by printing a model with two materials however for this project the group prioritized the process over the model
Is there a way to print the model in multiple sections?	Freesurfer has an option to segment the brain into different parts however again we were not focused on this aspect, but it can be done in the future.

Final Beta Prototype Design

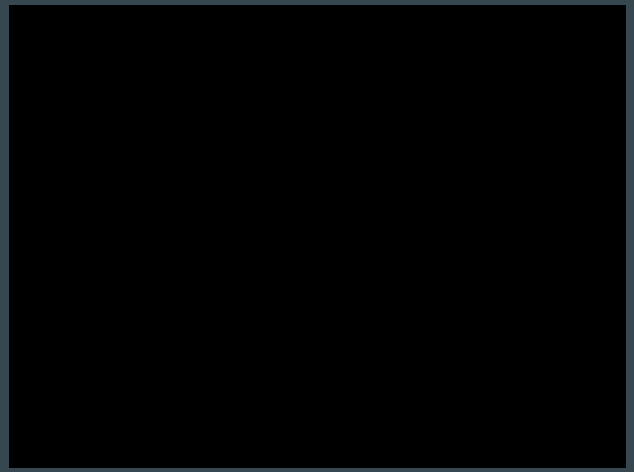
1. Our UI design
   a. Within UI is code to execute process
2. Freesurfer Software
3. Meshlab Software
4. Meshmixer/Matlab
5. Printer



Progress: UI

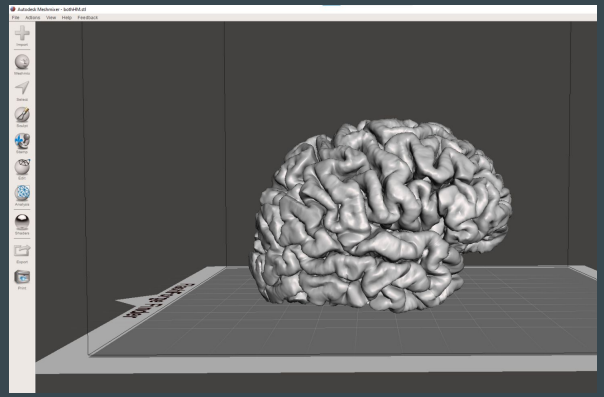


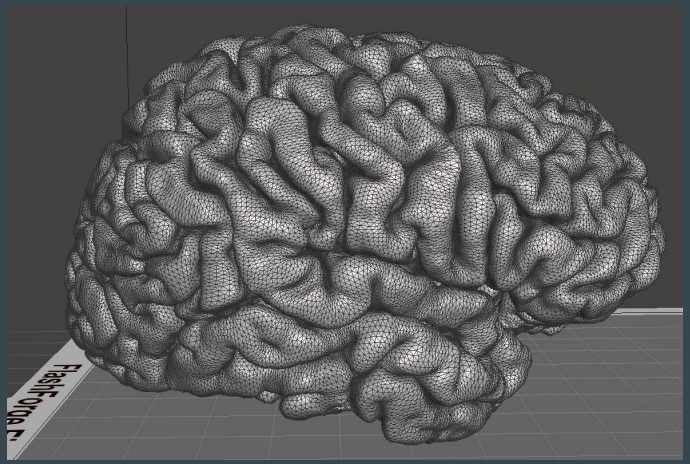
Progress: Meshlab Automatic Smoothing Demonstration



Progress: Meshmixer Smoothing and Quality Check

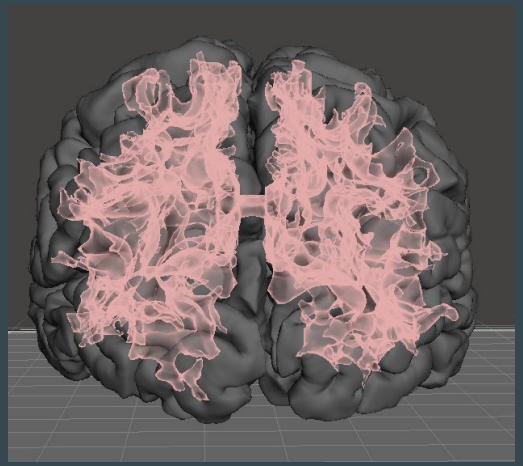
- We are using the Meshmixer API to run scripts that will perform further smoothening to meet quality standards
- The mesh density will be reduced in Meshmixer if necessary
- Support material will also be generated in Meshmixer during this phase

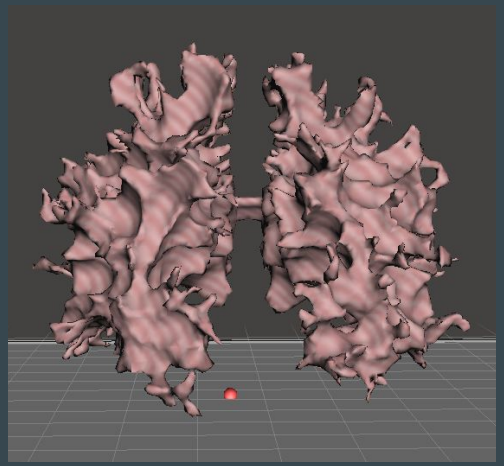


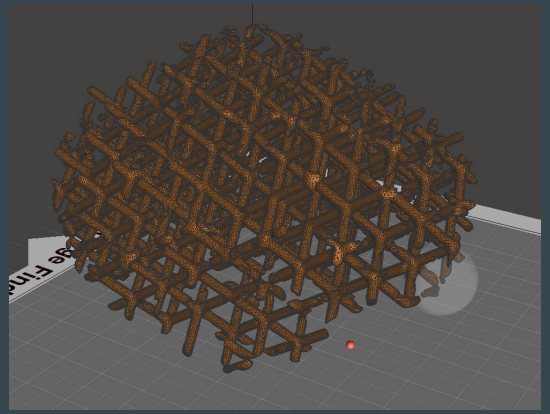


Infill Pattern Created in Meshmixer

- In Meshmixer the Make Solid tool is used
- Then the Make Pattern tool is used to create the Lattice Structure
- Composition Mode and Clip To Surface are important parameters to ensure the infill supports the exterior surface
- This will make our models lighter weight and cheaper to print in the future

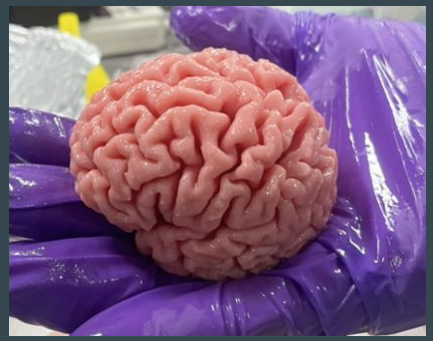






3D Printing Progression

- The group plans to have 3D Prints of a brain model taken from each stage of the pipeline to show progress for the Innovation Expo
- The pink model was segmented in freesurfer and converted to .stl format
- The white model was enhanced with MeshLab and Meshmixer after freesurfer segmentation

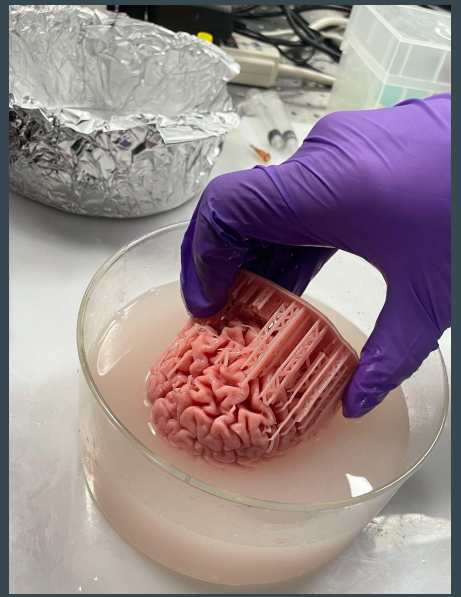


Freesurfer model (In Pink)

Final (In White)

Printing Process

- We used a Phrozen Sonic Mini 4K 3D Printer to print both of the resin models
- The material was a mix of red and white water washable Resin
- The total print time was 5 hours
- Once the print was complete it was immediately washed to remove any uncured resin

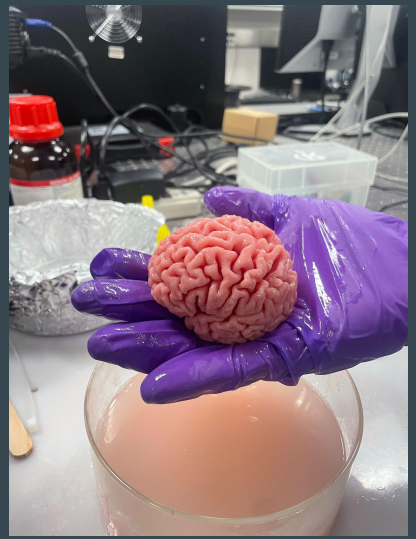


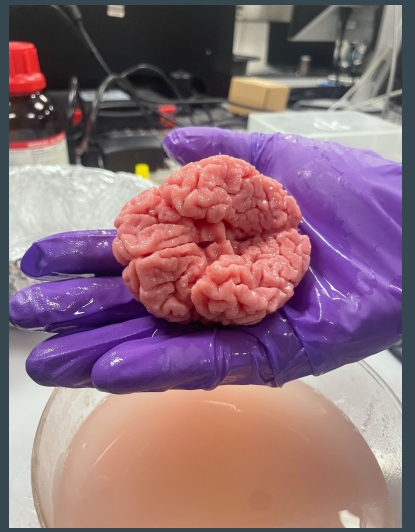
Printing Process cont...

- The support material was removed from the model by hand and pliers
- The model was cured after all the supports were taken off
- During this process, the resin model was solidified by energy radiated by UV light
- We will continue to look for the best printing orientation of the model to reduce the amount of supports needed while maintaining a high
- print quality

Printing Process cont...

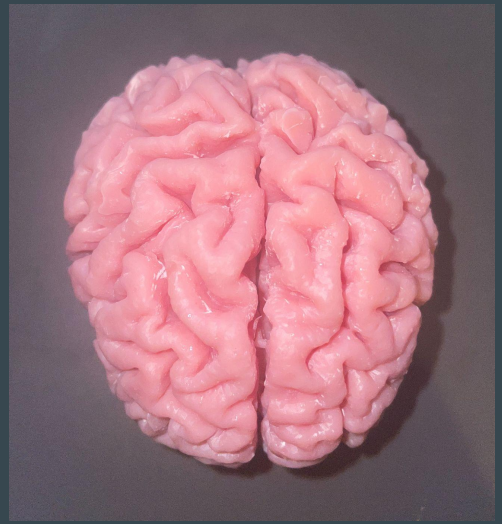
- The model was washed again after the curing process
- Overall the model quality was good
- There were some slight defects in two areas on the sides of the model
- This will be fixed by improving the printing orientation





FreeSurfer Model vs Enhanced Model

- The pink model has a much rougher surface than the white model
- The surface of the white model that was enhanced is very smooth and coherent
- The white model needed much less support material than the pink model
- This shows that our quality improvement process is effective



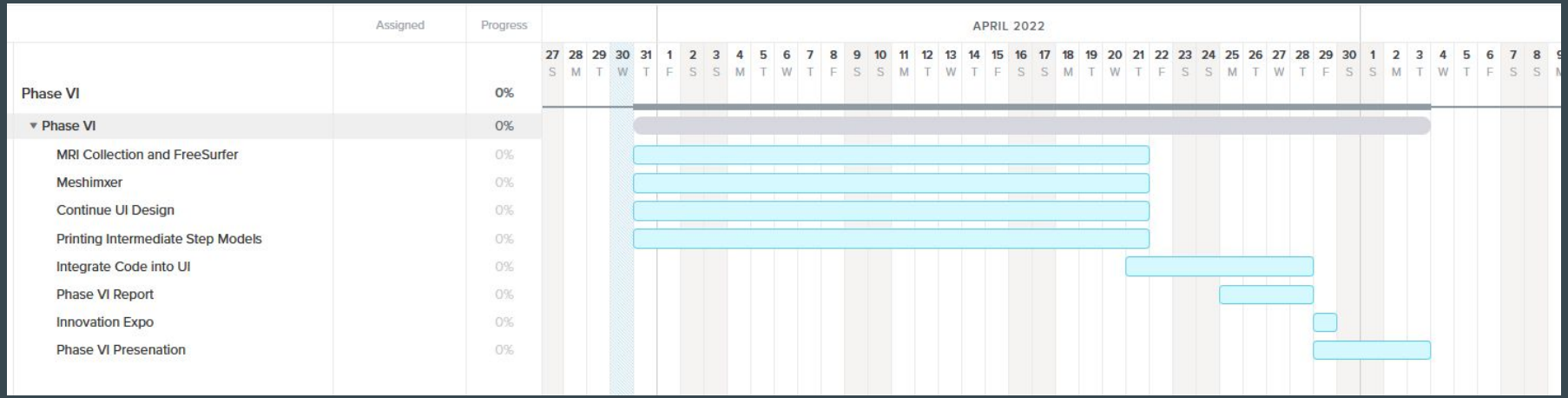
Future Model Improvement

- Create an interior pattern to reduce the weight of the model
- Print more models at the different stages of our pipeline
- Explore ways to get the cost of materials down by buying resin in larger quantities
- Print full sized models
- Print white matter models

Continued Work on Beta Prototype (Code)

- Finish development of the code to automatically execute scripts within Freesurfer
- Integrate helper functions to move the file from location to location
- Code for status updates on the UI

Gantt Chart


Assigned
Progress
APRIL 2022
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Phase VI 0%
Phase VI 0%
MRI Collection and FreeSurfer 0%
Meshimxer 0%
Continue UI Design 0%
Printing Intermediate Step Models 0%
Integrate Code into UI 0%
Phase VI Report 0%
Innovation Expo 0%
Phase VI Presenation 0%

Thank You!