HCESC

Health Care Engineering Systems Center

Summer Internship 2020 Presentations

CT VR

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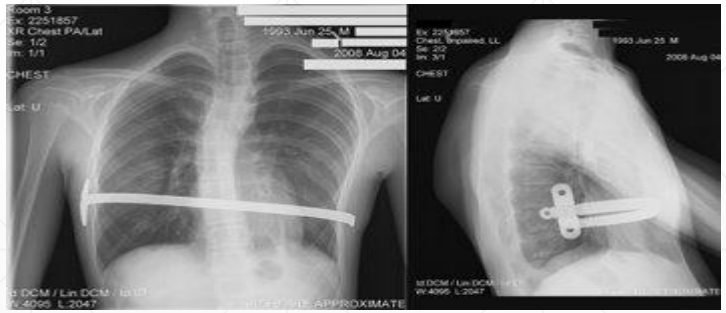
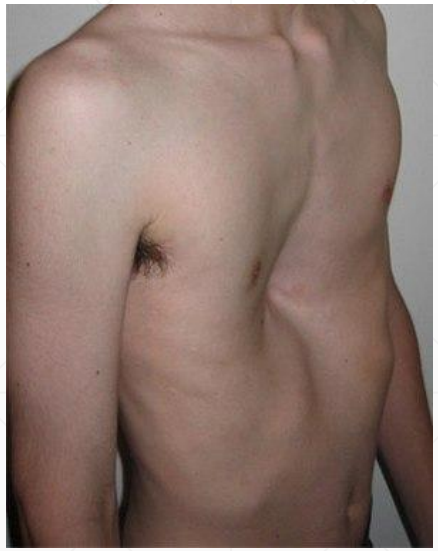
Goal of the Project

- Build a simulation/surgical trainer for Nuss procedure which is used to correct pectus excavatum AKA sunken chest
- Build custom 3D model of a human from CT scans and use it within the simulation





Timeline During Summer

- Research on the surgical procedure
- Find available works and tools used for simulation

- Obtaining 3D model of patient anatomy
- Finite element analysis (FEA) on sternum

- A proof-of-concept developed in Unity3D

Accomplishments

Features:

1. Custom patient model
   Created from DICOM files, supplied by OSF engineers.
2. 3D reconstruction from CT scans
   After getting the .stl models from OSF, we optimized the models and did further segmentations to facilitate real time rendering and interaction, without being very computationally costly.
3. Ability to customize Nuss bar
   Wrote scripts to let user modify the pectus bar (the main patient unique surgical equipment) in real time based on patient chest model.
4. Realtime results of Nuss bar rotation
   Wrote scripts to allow users to move the pectus bar freely (translationally and rotationally). However, these can only be done one function at a time. The reasoning behind this was two fold - it would allow novice users to interact with the model more easily; and it would allow us to get a more structured data for our future research (to use Imitation Learning to automate the surgical procedure)

Accomplishments

1. Real Time interaction of bar the human body
   The bar interacts with the skeletal system, the tissues, the skin and the sternum. The idea is when there is a collision of the bar with any tissue or skeletal system with excess force, the user will be notified. (will be implemented through FEA), but for now if the bar deforms the tissues and the sternum too much the model will glitch showing the user they are making a mistake!
2. Option to see through skin
   In the real procedure the doctor uses a laparoscope to see what is going on inside the skin, but in out training model the user has the option to see through the skin. We are not specialists, however, we feel this addition will help the user during the procedure training. (need consensus from experts)
3. 2 different camera angles for viewing
   During the procedure the user has the option to see from two critical angles. We choose this over letting the camera follow the user as a still frame would allow the users to deal with the more miniscule movements required in a surgery.

… continuation of accomplishments

- We are happy to implement and demonstrate the planned features for our project. Over this internship period we had to learn various softwares and some definitely had a steep learning curve. Overall we learnt a lot from our project and will continue to develop it further.

Challenges

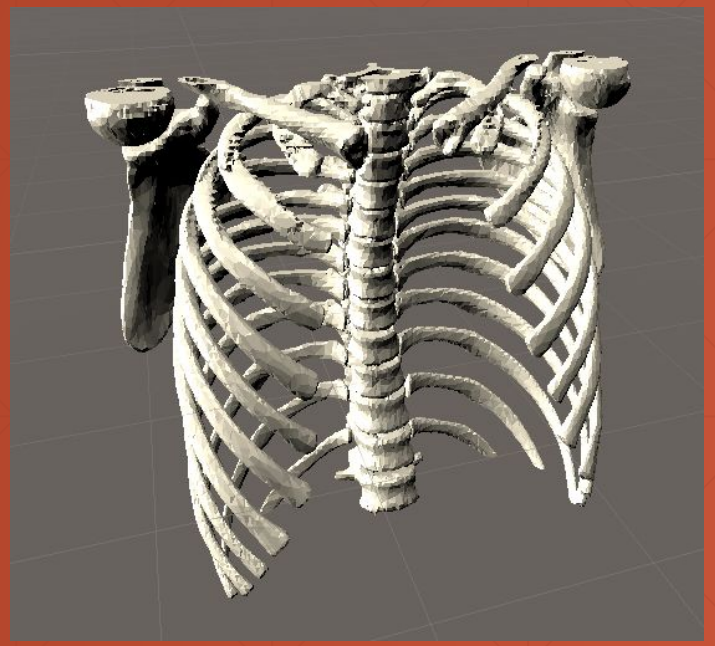
1. We had to learn and familiarize ourselves with the condition and the state of the art surgical procedures.

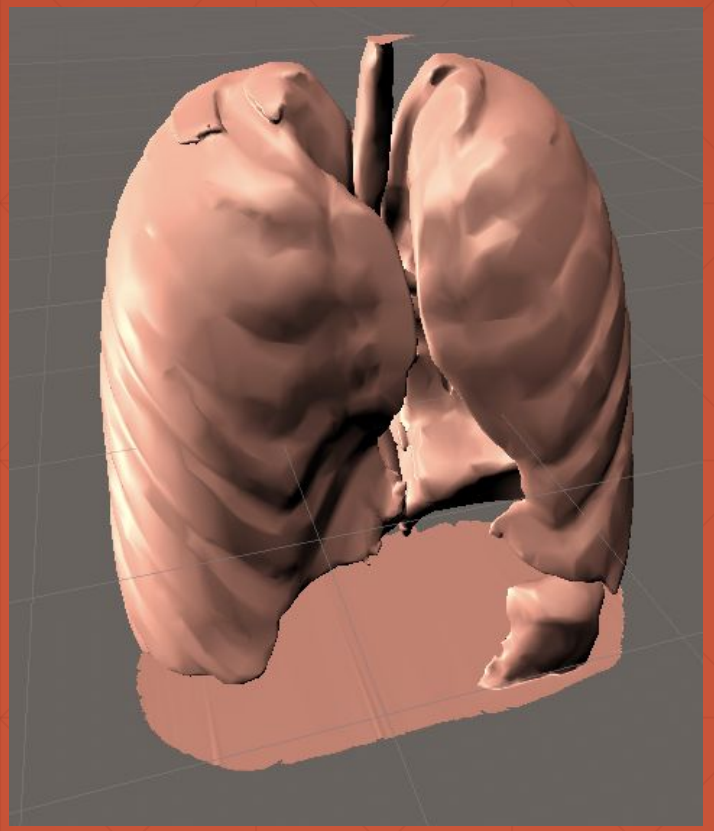
2. We had to learn different softwares and especially how to model human anatomies accurately and interactions. (Blender, Unity, Abaqus)

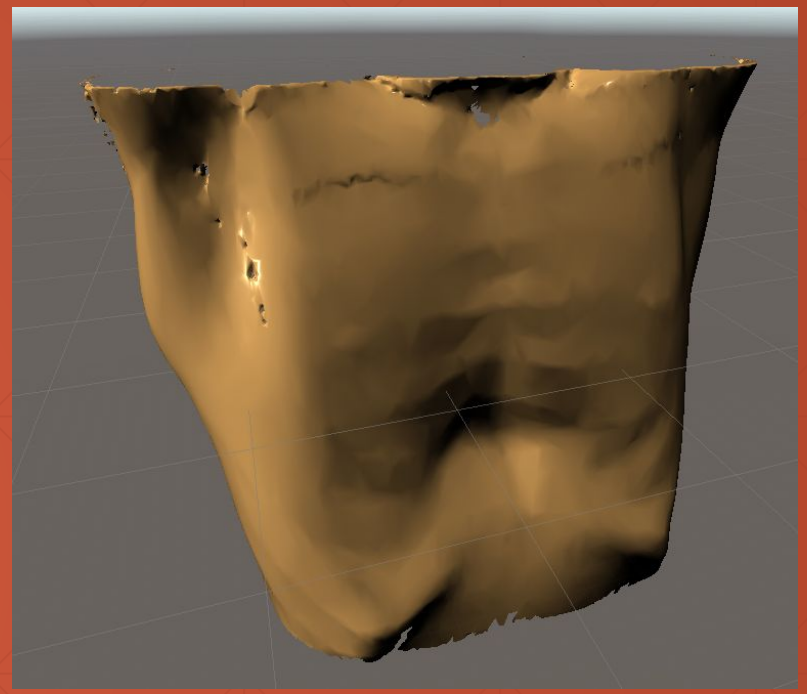
3. Understanding the exact requirements of the users and figuring out complexity, realism and computationally optimized interactions and mesh rendering.

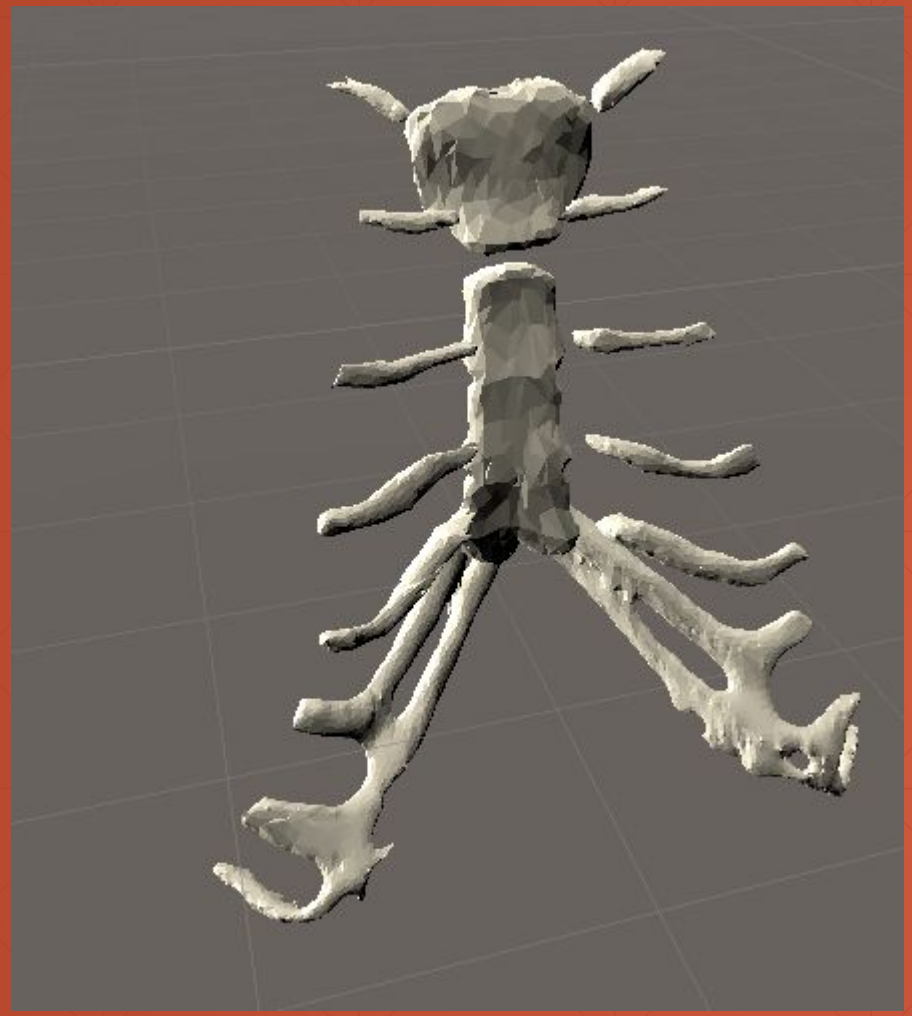
4. FEA Analysis (still a work in progress)

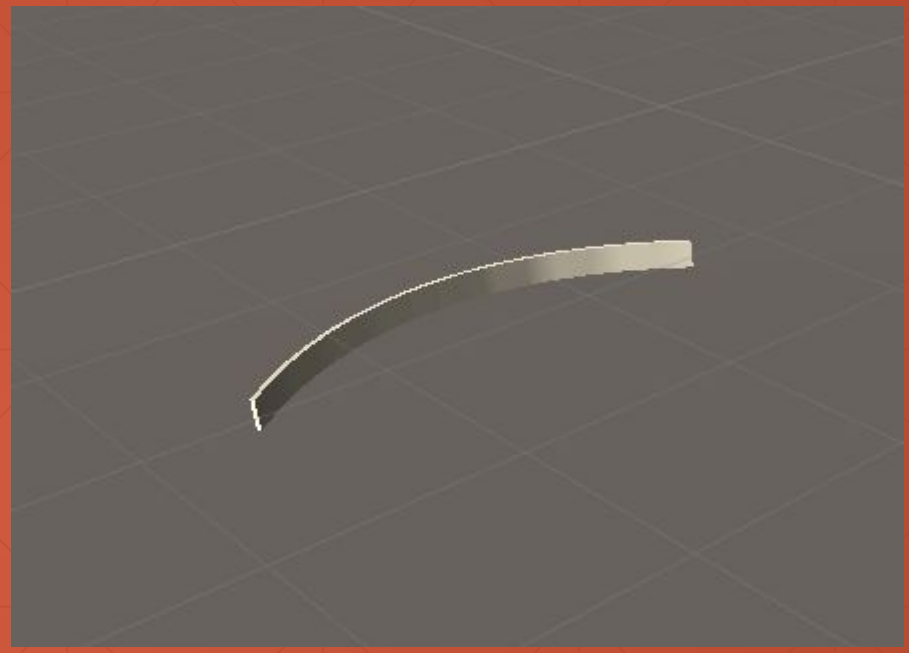
5. Use ‘hacks’ to recreate visually accurate looking interactions so that they can be rendered in real time and also add our own innovations for an unique VR experience.











Demo

Future Works / Recommendation

Future works

1. The plan is to continue researching under Dr. Kim and implement FEA Analysis and Imitation Learning.

What can be done better?

The interactions between the different objects can be improved.

A more streamlined and automated process to create the 3D model segmented between the different components so it can be deployed publicly.


QUESTION