# Individual Lab Report - 7

## Autonomous Reaming for Total Hip Replacement

HIPSTER | ARTHuR


Gunjan Sethi

Team C:

Kaushik Balasundar | Parker Hill | Anthony Kyu
Sundaram Seivur | Gunjan Sethi


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# 1 Individual Progress

## 1.1 Feasibility Check for UI Development Tool

For the development of the UI framework, I did some research about which tools will be suitable. I researched about RQt and Open3D. Since our system pipeline already uses Open3D, it was the first choice. The main features we need in the UI are the capability to display several basic text elements and manipulate pointclouds. RQt struggles with sophisticated pointcloud views and manipulatiomn whereas Open3D's support for GUI development is not very well supported. Thus, we have decided to move ahead with using RQt as the overall framework. The registration pipeline will still use Open3D.

## 1.2 STL-PCD Pipeline

Our stakeholders shared some high quality scans earlier this month. I developed a pipeline to convert them from STL to PCD format. Our current pipeline only supports PCD. Figure below shows a high resolution pelvis scan in Open3D.

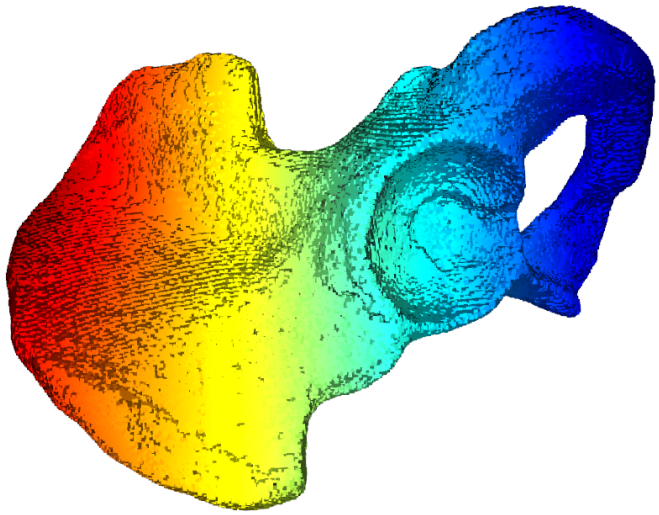

**Figure 1:** High Resolution Pelvis Scan

Documentation: STL PCD Convertor

## 1.3 WatchDog Module Architecture

Sundaram and I froze the watchdog module architecture. We also created a final system diagram and validated the same with stakeholders.

## 2 Challenges

The major challenges in were in converting the pelvis scans. Open3D's current version does not support certain type conversion functions. I have added the errors I faced in our team's error log and resolved it.

## 3 Team Work

Following are the tasks accomplished by the team members since the previous ILR.

- ***Kaushik Balasundar*** set up a simulation environment to serve as a testbed to implement and validate the working of the velocity controller. He then worked closely with Anthony in implementing the new joint velocity controller in simulation with singularity damping and joint limit avoidance. He further helped validated the controller's performance and tune the gains for the real robot arm.
- ***Parker Hill*** worked with Sundaram and Anthony to finalize the CAD for the new linearly actuated end-effector design and sourced, printed out, and assembled all components for the first version of the design. He also developed an outline and began sourcing parts for the electrical subsystem. Finally, he spent some time with Kaushik learning more about the software aspects of the project to be able to help more with the user interface in the future.
- ***Anthony Kyu*** worked with Kaushik to implement a basic joint velocity controller on both simulation and on the real arm, implementing inverse kinematics, singularity damping, and joint limit avoidance algorithms. He also worked with Kaushik to test the performance of this controller, testing how well it could track a pelvis marker and tuning the PID gains to do so. Furthermore, Anthony worked with Parker to help finalize the CAD design, sourcing key components such as the motor, load cells (and load cell electronics), and the linear motion mechanism. He also helped Parker calibrate his 3D printer. Lastly, Anthony also put together a knowledge sharing session with the team to explain the math and algorithms behind the Task Prioritization controller to be implemented.
- ***Sundaram Seivur*** worked on finalizing the watchdog architecture and started implementing features for the watchdog. He made changes to the architecture based on the feedback provided by our sponsors. He worked on creating the wireframes for the User Interface and conceptualized the critical components that need to be visualized on the UI. He also assisted Parker in finalizing the design for the end-effector and helped evaluate the performance of the 3D printed assembly.
- ***Gunjan Sethi*** developed the necessary script to convert STL-filetype pelvis scans to PCD format to facilitate usage in the current system pipeline. Further she worked on assessing the feasibility of using RQt and Open3D for the UI development. Gunjan also began development on the watchdog module.

## 4 Plans

For future work, the following (individual) tasks have been planned for the MRSD project.

### 4.1 Develop UI Version 1

Next week, I will be developing the UI version 1. The first verison will be a simple wireframe that will show all metrics and outputs. It will be developed using RQt. I will first start with building out the simple wireframe and then adding labels and images to building out the first version.