Project Proposal - sgirdhar

1.
Name: Hand copying robot

Description: This project is using the kinect sensor to gather data about the position of a person's arm and and sending that information over to two three-motor robot arms that will copy the position of the persons arms. This project is inspired by real steel where the main robot copies the main actors robot arms and boxes. The robot arm will be controlled using an arduino, which will be fed a packet of information from visual studio through pyserial. The data for the persons arms will be found using the kinect sensor and a virtual 3D representation of the robot will also be drawn using pyopengl.

2.

1. https://vimeo.com/31698679, This video shows a persons arms being copied by the kinect using a robot arm. This is quite similar to my project as it displays the same functionality that I wish to use, but the key difference here is that this project only uses a robot arm that moves in 2 dimensions which greatly avoids the challenges that arise from using this a more accurate 3 dimensional arm that can display a large range of motions. This project is also coded in processing and uses the OpenNI library
2. http://file.scirp.org/Html/4-7900378_53284.htm, This research group acheived exactly what I plan to do with project and possibly even better as they make use of a robot with 4 motors on each arm, which allows for a greater range of motion for 3 arms. The result of this is a difficulty arising in my project to approximate positions of the robot arm to make it as similar to as the humans as my arm is limited in the motions it can do since it only has 3 motors. They also used the kinect v1.0 for their project, while my project will use kinect v2.0.

3. Final plan structure:
Visual studio code- The visual studio code will be responsible for collecting all the kinect data, processing it, visualizing the virtual robot and firing it off to the kinect through a serial cable. It will follow the following general order in terms of what the code does:

1. Receive data from kinect and identify where persons arms are and their coordinates
2. Scale coordinates down to fit robots range of motions
3. Use inverse kinematics method to find the angles for the motors that will make the arm reach a similar position to the scaled down coordinates
4. Visualize the virtual robot arm in pyopengl using forward kinematics with angles found
5. Send the angles found to the kinect through a serial cable
6. Allow for recording of arm motions to be replayed with the arm

Arduino Code:

1. Receive data from visual studio
2. Send data to motors

4. The most complex part of this project is the inverse kinematics problem, which is to find angles which will manipulate the robot arm, which starts at the shoulder, to reach the position of the humans hand received from the kinect, also called the end-effector. More details can be found here: https://medium.com/unity3danimation/overview-of-jacobian-ik-a33939639ab2 .The steps taken to do this is shown before:

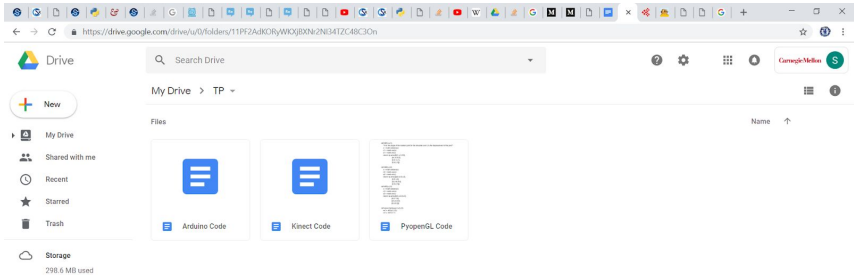
1. Represent the relationship between the robot joints using transformation matrices, this will all be done geometrically and it will be hard-coded in.
2. Compute the jacobian for the transformation matrix with the current joint angles, which is just a matrix of all the partial derivatives for each angle and its impact on the end-effector. The derivatives will be found iterating over angle and seeing how adding a small change will affect the (x,y,z) of the end-effector.
3. A change vector(dO), will be found by multiplying the transpose of the jacobian found with the difference between the current position of the robot arm and where the desired end effector is, this is the change that will be slightly added to the current position of the robot arm and moves it closer slightly towards the desired end effector position. Note: I am not explaining the math behind this as this is beyond the scope of this project, rather I am just focusing on the implementation of it.
4. Steps 2-3 are repeated until the current position of the arm is where the desired end effector is.

Essentially, what this algorithm does is it finds the direction it needs to travel in to move to the robot arm to where its desired to be by using the jacobian, moves in that direction in a small step and iterates this process continuously until it eventually reaches where it desires to be.

5. Timeline:

1. Kinect code: 15/11/2018 - Already Working
2. Visualization code: 22/11/2018 - Work in progress
3. Inverse kinematics code: 26/11/2018 - Work in progress
4. Arduino packet code: 28/11/2018 - Not yet started
5. Construction of robot: 30/11/2018 - Not yet started

6. All code is copied into google doc documents after any main edits are done, this allows for previous versions to be accessed using gdocs edit history functionality.



7. Module list
Pykinect, pyserial,pyopengl

8.