

First Presentation: Progress Report to Supervisor

EE 454: Robotics Design & Professional Practice

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Karissa Barbarevech and myself, decided to design and create an intelligent prosthetic arm for our EE 454 senior capstone project. The idea of this device is to help those who have lost an arm and needs a prosthetic. We want to make the learning curve to be as minimal as possible and the performance per user to be extremely well. So in order for the user to use the arm as intended it would need to be calibrated to the specific user. Therefore, the calibration would come about within the user's insurance policy prior to needing a prosthetic. This calibration will use a Microsoft Kinect to detect and record arm movements and gestures. This program will also be used with PowerLab software to capture the user's EEG/EMG signals for moving their arm. This insurance policy will allow for the user to attach the prosthetic and be able to use it immediately if they shall ever need a prosthetic in the future. Therefore, the prosthetic is tailored to each individual and will have no learning curve. In order to complete this project, the Kinect is needed to act as a bridge to obtain a user's brain signals to move the prosthetic. Once the bridge is made between the user's brain signals and the RaspberryPi, to move the prosthetic, the Kinect can be eliminated.

So far, the prosthetic has been fully assembled, the RaspberryPi and shields were obtained, and the Kinect application is running to record data on a user's right arm movement. The prosthetic is assembled by various servos to control the joints to mimic those on a hand and arm. The shoulder servos had to be replaced by a DC motors with their driver circuits. This allows for the DC motors to act like a servo motor. The DC motors were needed for their high torque to support the arm. The RaspberryPi microcontroller, using Python language, is being used to drive the motors on the arm. An Adafruit 16 – Channel PWM/Servo shield was needed to have enough I/O pins to support the 10 motors. We also obtained a High Precision AD/DA shield that will capture the user's EMG/EEG signals. This is key so FFTs can be calculated to

transfer brain signals to arm and hand movements. Lastly, the Kinect right arm detection application is up and running on the fit-PC. The application captures the user's right arm position in 3-D space and also the angle the shoulder, elbow, and wrist are at.

In order to complete this project various milestones were created for myself and Karissa. My two milestones were first to get the right arm movement detection software running on the Kinect. The second milestone, which has two parts, is to obtain EMG and EEG signals using PowerLab and to detect and save signals using the fit-PC simultaneously from the Kinect and PowerLab. Karissa's milestones are to get the prosthetic moving smoothly and determine the coordinates to match up with the Kinect application. Her second milestone is to obtain a communication between the RaspberryPi and the fit-PC.

Each of our milestones has some progress made, along with a tall pole analysis on how we will approach each. My first milestone is to get the Kinect application running and detecting right arm position. This was rated green because it involved locating the application and to hook up the Kinect to the fit-PC. This milestone has been completed. The first part of my second milestone is to measure EMG and EEG signals using PowerLab. This is rated yellow because it will take time to understand the programs interface and how to detect certain signals. In order to complete this, I will need to simply spend time with the hardware and software. The second part of my second milestone is to detect and save the signals simultaneously from the Kinect and PowerLab. This received a red rating because it involves programming in C# which is a foreign language to me. In order to approach this, I am learning C# through online tutorials and in class workshops. The idea is to capture the data from the PowerLab software and to save it and pair it with Kinect movement detection using the application. Therefore, C# is needed to extract and save the data from each application simultaneously. This is the milestone that will take up most

of my time but it needs to be completed to bridge together the prosthetic arm with brain signals to obtain movement.

On the other side of things, Karissa's milestones are designed to have the prosthetic up and running using the RaspberryPi. Her first milestone, getting the prosthetic moving smoothly and coordinates determined, was rated red by her. This is due to getting the RaspberryPi running which includes the AD/DA and motor shields. Issues arose here due to the set up files being relocated on GitHub. A smooth movement algorithm was created using an Arduino while the parts were ordered. The idea is to have the servo turn 1 degree at a time with a 20 ms delay between steps until the desired position is reached. It needs a little tweaking but displays smooth movement. Her second milestone, communication between the RaspberryPi and fit-PC, received a yellow rating. This is due to having experience communicating between two different languages, but is foreign to the C# language.

Overall, the milestones to complete this project are feasible. The biggest setback will be the C# programming language. The next steps that should be taken are for me to keep looking up tutorials on C# and experiment with PowerLab. Karissa should continue to set up the RaspberryPi and shields to have the prosthetic moving. Then apply an algorithm to obtain smooth movement. This will put us on track to interface the prosthetic and the Kinect.