Neural Prosthetic Hand Project Executive Summary

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This project was to create a prosthetic hand that responds to an Electromyography (EMG) sensor's recording. An EMG sensor reads electrical signals from muscle contractions and outputs those to a system. The goal was to create a prosthetic hand that works with ongoing research in the Information Processing Group (IPG) at Oregon State University (OSU). The target consumers of the project would be below-elbow amputees who wish to purchase cheap but advanced prosthetic technologies to improve their quality of life. The users of this project will have the ability to control individual finger movements from their residual limb. By reading and deciphering signals from the arm, the hand will be able to move in a manner similar to if it was connected to the body. Current research will strive to smooth out the movements of this hand. The hand will be controlled by EMG signals and moves with the use of motors in each degree of freedom (DOF). These DOF's include each of the five fingers and the wrist. The hand should withstand a measurable force without breaking.

This is primarily a research project with mechanical assembly. The main contributors are those in the Information Processing Group (IPG) and this Senior Design group. Development and management processes were handled by setting goals and timelines each term that we strove to meet. Timelines had as much detail as possible about what things we worked on and what issues we expected to come across. Extra things that we may add were included in the timeline. Every part was laid out in advance so that we could move forward easily. The main phases for the project included hand assembly, PCB design, individual sensor testing, complete hand testing, and combining the hand with current related IPG work. The PCB for this project was made to allow the pressure sensors to sit in the fingertips on the system and then connected them to the microcontroller, an Arduino Mega. The hand was assembled and tested to ensure durability and the finger movements were smooth. The system responded quickly to the sensor readings, for example, if the sensor had detected a muscle movement, the corresponding finger moved within 50 milliseconds. When all individual components had been tested, the system as a whole was tested again to ensure each component was working properly with each other. Finally, the system was set up to work with current software that is being developed from the Information Processing Group.

Some ongoing evaluations and future areas of revision include the making of the 3D printed hand, the editing of the python code associated with the decoder, and the securing of all connections. We have noticed that the hardness of the silicone and the 3D printed material affect the durability and functionality of the hand more than was expected. Softer silicone would improve the hands ability to grip objects and withstand forces applied to the hand. The current python code for the decoder still has some errors that persist which in the future should be worked out to allow for easier use. Lastly the connections to protoboards and the Arduino Mega were not secure enough for the movement of the hand and rotating of the wrist. A future revision could include finding a way to secure these connections so they do not repeatedly come undone.

Project Timelines

TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	Fall Term WEEKS										
					1	2	3	4	5	6	7	8	9	10	11
Project Design															
Block and Task Division	All	10/5/20	11/5/20	30											
Requirements Creation	All	10/8/20	11/26/20	48											
Block Diagrams	All	10/29/20	12/3/20	34											
Build First Hand	Sienna	10/19/20	11/23/20	34											
Initial Sensor Testing	Lindsey	11/5/20	12/11/20	36											

TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	Winter Term WEEKS										
					1	2	3	4	5	6	7	8	9	10	11
Block Checkoffs															
Block 1: Sensing	Lindsey	1/4/21	1/30/21	26											
Block 1: EMG	Sienna	1/4/21	1/30/21	26											
Block 2: Power	Lindsey	1/30/21	2/21/21	21											
Block 2: Hand Assembly	Sienna	1/30/21	2/21/21	21											
Block 3: Arduino Code	Lindsey	2/21/21	3/14/21	23											
Block 3: Decoder	Sienna	2/21/21	3/14/21	23											

TASK TITLE	TASK OWNER	START DATE	DUE DATE	DURATION	Spring Term WEEKS										
					1	2	3	4	5	6	7	8	9	10	11
Block Checkoffs															
Initial System Testing	All	3/29/21	4/22/21	23											
Final System Testing	All	4/22/21	5/13/21	21											
Reassembly of Hand 2	Sienna	4/22/21	5/13/21	21											
Code	Lindsey	3/29/21	5/13/21	44											
Decoder	Lindsey	4/22/21	5/13/21	21											

Key Lessons Learned:

- Start testing out materials ahead of time
- Print 3D printed parts in sections to ensure each part fit each other before printing the full print
- PCB should be made for all connections to motors instead of protoboard to minimize time debugging the circuits
- 3D print orientation is crucial to the durability of the prosthetic hand
- The parts that broke most frequently are: wrist, palm, and thumb motor mount.