# Incorporation of Visual Feedback with Myoelectric Prosthesis Training

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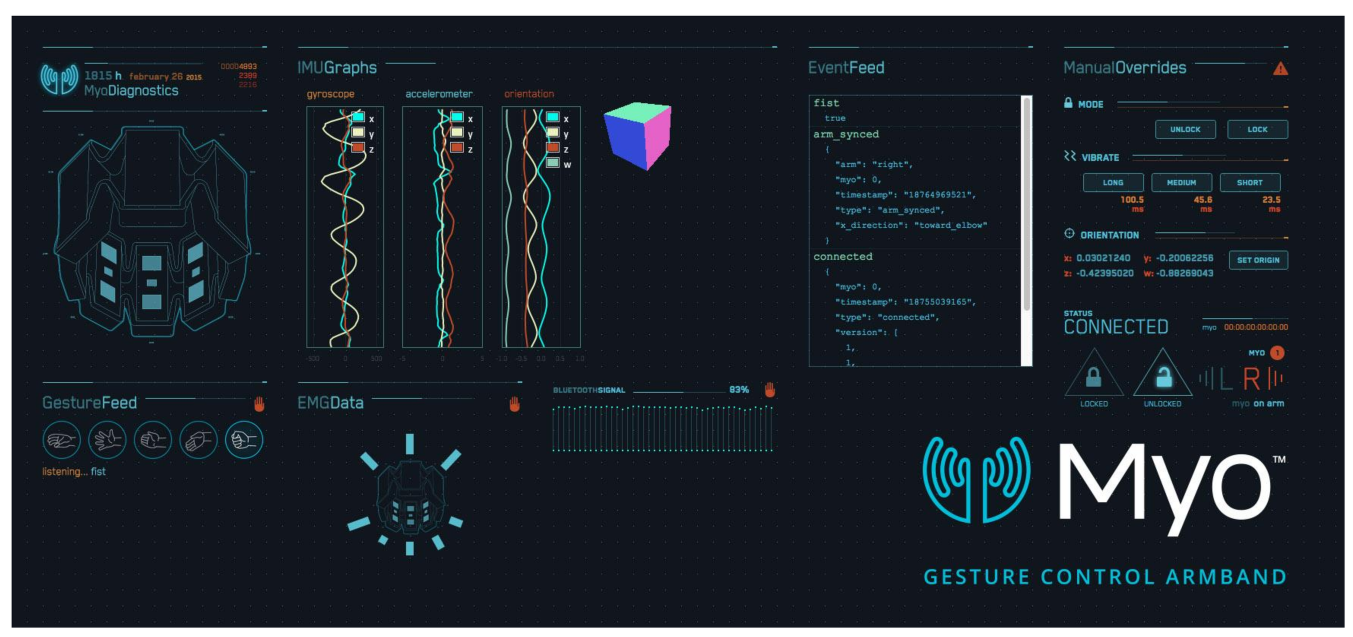
## BACKGROUND

Loss of a limb can be a traumatic experience for an individual. A variety of issues that are related to limb-loss include the financial burden of medical bills, difficulty of maintenance on complicated myoelectric devices, and frustration associated with an inability to properly use a prosthetic limb. In this work, we aim to address the frustration associated with improper training on how to effectively use a prosthetic limb. We propose to create a virtual reality game where users utilize electrical signals from flexing muscles in their residual arm in order to control a virtual limb. Through this training with a myoelectric system, a user can learn to effectively control a prosthesis as an extension of themselves in an engaging virtual reality environment.

Using a combination of open source platforms like Unity and Oculus Go we can facilitate major improvements to the training mechanisms used by myoelectric devices. We have generated a proof of concept, whereby a user can flex their muscles and observe a virtual hand on a computer screen reacting to this flexion. We will map multiple hand functions to multiple muscle poses through integration of a variety of flexion and extension signals from myoelectric detection. By linking successful flexion and extension to realistic virtual hand motions and corresponding point values in a gamified virtual environment, we hope to make the experience of myoelectric device training fun for both adults and children. Through the combination of an open source developed training tool with a 3D printed, highly available myoelectric arm device; expenses for more functional electronic prosthetics would decrease significantly making the technology available to people all over the world

## EMG MYOELECTRIC DATA



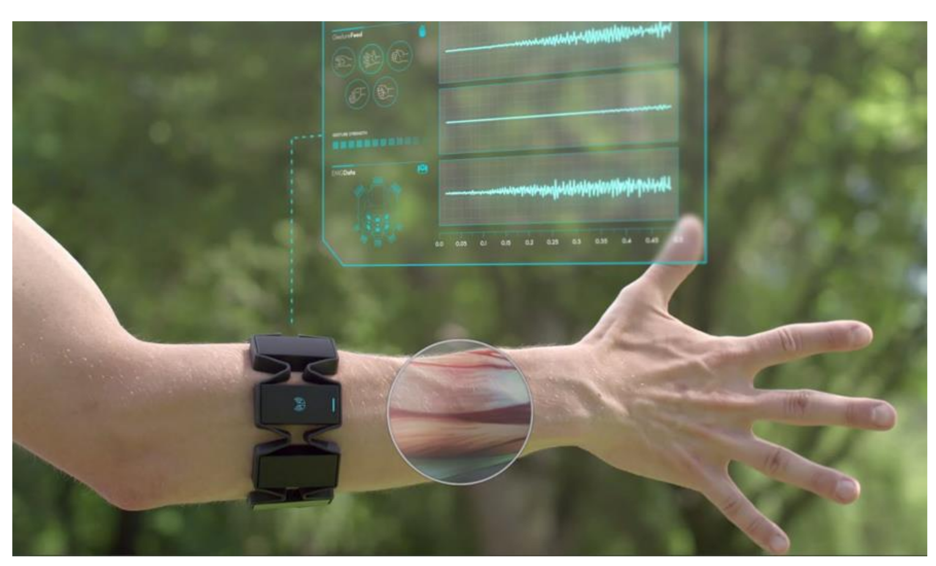



**Fig. 1:** (Top) Example Diagnostics page from Myo.com. This shows the data collected from the EMG sensors located on the myo band. This demonstrates the gyroscope, acceleration, orientation, gesture and gesture strength. (Bottom) From Introductory video from Myo.com. Shows the myo arm band measuring EMG levels resulting in a graph.

## Example of Previous Rehabilatory Virtual Reality Training

**A**

**B**

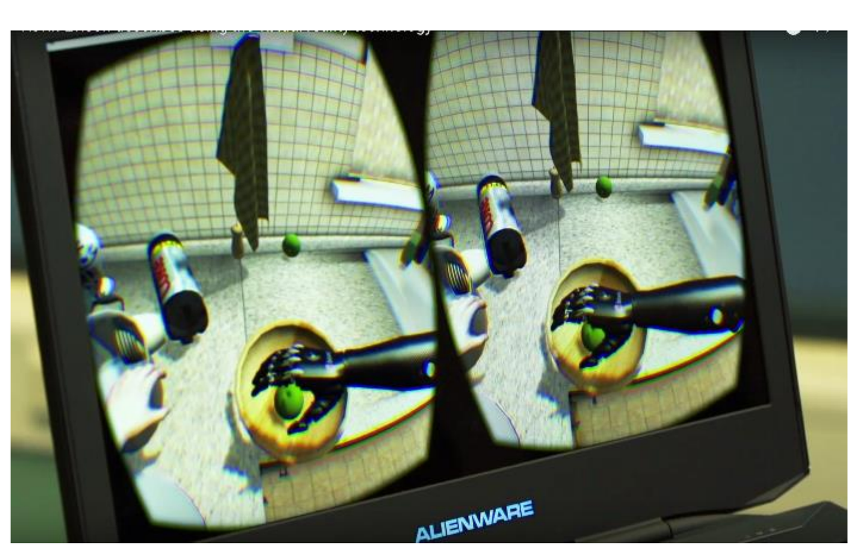


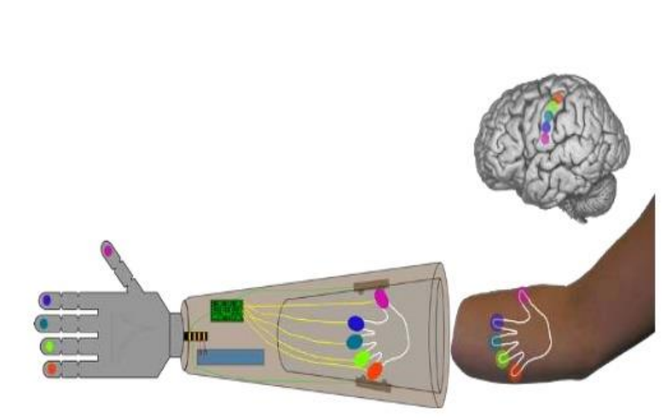

**Fig. 2:** Similar virtual reality training programs to that proposed here are currently being conducted at Sheffield Museum in England. Training takes place as users are placed in a virtual kitchen to interact with appliances with the use of an Oculus VR headset. For example, putting a kettle on the stovetop or picking up apples and smashing plates. All of this is with the same myoelectric armband used in our current research. The brain sends the motor command to the hand to open or close, the eyes tell the brain the virtual hand is opening and closing, and spacial awareness tells the subject where the arm is located in space (Abes 2016).

## Conclusions

- -Combination of Unity and a Myoelectric arm band are possible and can allow the user to see a virtual arm on the screen.
- -Future research could allow for this Unity program to move onto a mobile platform like a phone application or Oculus VR.
- -This would possibly decrease rehabilitation time and allow the user to enjoy the training through VR/ AR games.

## ANALYSIS

RELAYING OF INFORMATION FROM RESIDUAL LIMB TO ELECTRIC ARM VIA CIRCUITRY:



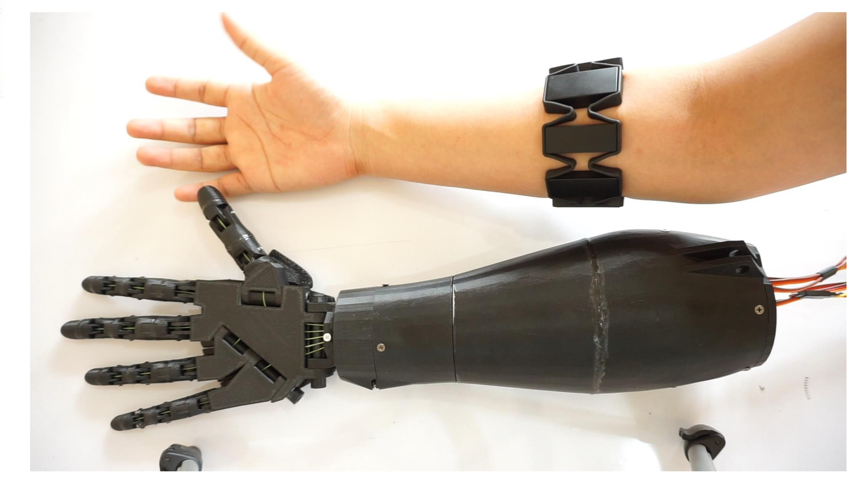
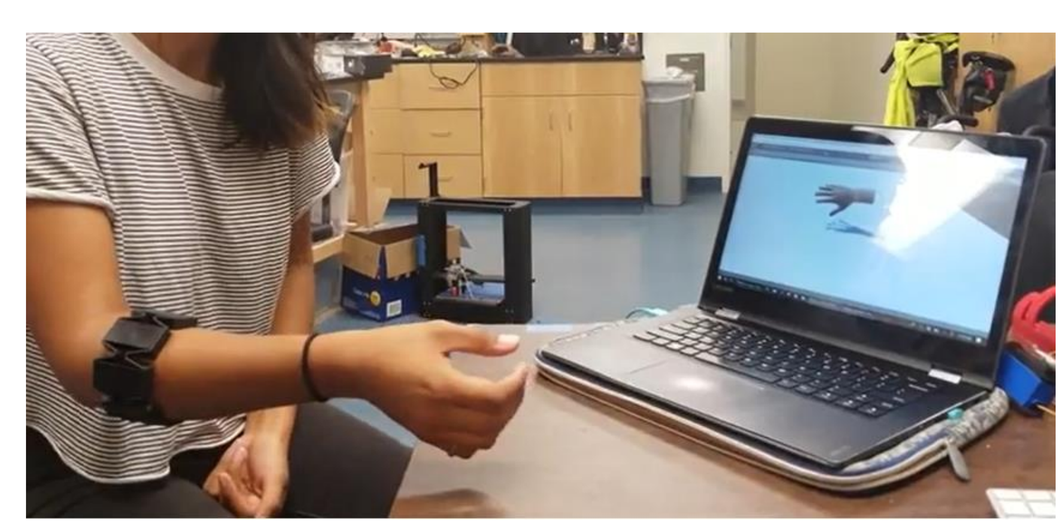


**Fig 3.** Left: Image from Journal of NeuroEngineering and Rehabilitation. Explains the connection between the muscles in the residual arm and how the EMG sensors of the myo armband respond to these signals in order to make the prosthetic move.
Right: Image from IEEE, company dedicated to advancing technology for humanity. Jess Christopher used 3-D printing with myoelectric arm band to produce a low-cost option.

## ANALYSIS

With the presented material, there is evidence to support the need for more virtual reality-based training in order to decrease rehabilitation training failure and increase successful acceptance of a prosthetic. This is especially necessary for children who are at different developmental stages than adults. An app that creates a virtual arm on a screen could bring back the visual feedback that many users struggle with in accepting their loss of a limb. Overall the goal would be to use an Oculus Go virtual reality headset combined with an imaging program that can identify the opposing functional arm and then fill in areas that have been amputated on the adjacent arm. This method would provide a mirror image and give the appearance that the arm is still there. This acceptance is also known as embodiment or feeling whole and incorporating the prosthesis into one's body image allowing the user to perceive the prosthesis as part of themselves. Without embodiment, a prosthesis is seen as an artificial tool attached to the end of the residual limb. Tasks can be more difficult to complete if the user lacks this embodiment. In practice, with acceptance the hand performing the task is easier to control since it is seen as an extension of a user's body and not as a detached tool.

## Unity Application



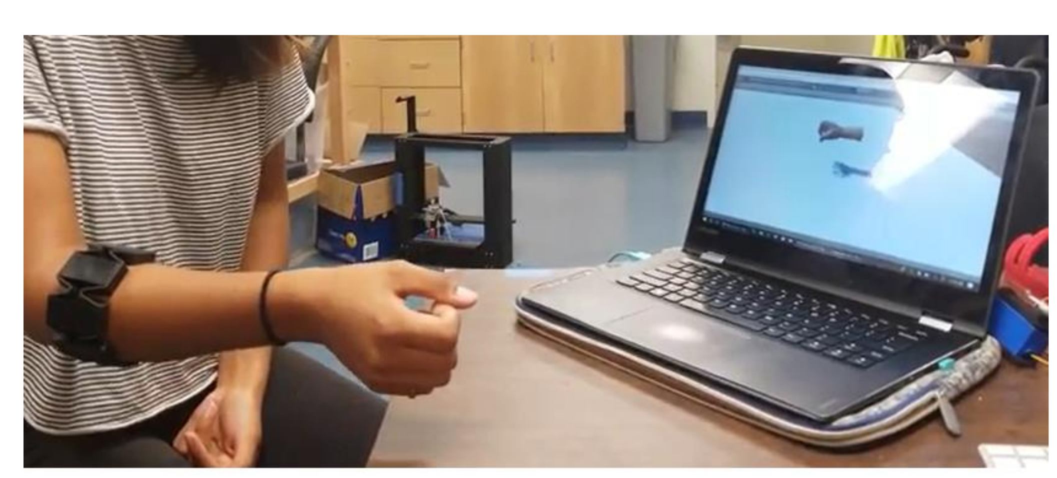


**Fig. 6: Unity application with virtual arm responds to data received from the myoelectric arm band the user is wearing. Top figure shows the hand at rest and bottom figure shows the virtual hand responding to the myoelectric arm band and also making a fist.**