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MS Project Report

Myo Armband Controlled Gaming for Task Specific Stroke Rehabilitation.

Submitted in partial fulfilment for the degree of

Master of Science (MS) in Mechatronics and Robotics

by

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Abstract:

The aim of the project is to provide stroke patients with task specific rehabilitation using a Myo armband sensor- an EMG sensor. A home-based therapeutic treatment can be more of convenience to the stroke patients and to the therapist. The approach is to build an exergame which will help in stroke rehabilitation using modern devices which can track progress of the patient. The focus of the project is to understand the working of the Myo armband and its integration with a game developed in unity game engine. The application of this knowledge is used to develop a game which can be controlled using the modern device like the Myo armband which will motivate the stroke patients to do regular therapeutic therapy.

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1. Introduction:

The report describes the work of a gaming interface developed for stroke patients to perform specific tasks. The project aims to develop a gaming interface for stroke patients. This project utilizes a Myo armband- an EMG sensor- a product of Thalmic Labs and an exergame to provide therapeutic exercise to stroke patients.

The Myo armband is equipped with 8 pods of EMG sensors which provides with muscle activity in real time. The armband is also equipped with an inertial measurement unit which captures the accelerometer, gyroscope and magnetometer data in 3 principal axes.

A gaming interface is developed on Unity game engine. The game is a FPS (first person shooter) game. The game is developed to be an exergame. The game utilizes the acceleration and orientation data from the Myo armband to control the game. The Myo armband communicates with computer via a Bluetooth adapter.

The stroke patient must perform yaw motion of the hand and continuously make fist gesture to play this game. This task will enable the user/stroke patients to regularly practice therapeutic exercises at their home.

The performance of the patient depends on the rate of destroying the enemy objects in the game. The patients must perform the yaw motion of the hand to aim at the enemies. Making a fist gesture will destroy the enemy object. The score and level counters determine the progress of the patient.

The final stage of the project describes about the user testing and user evaluation results. The reliability and the efficiency of the system is reported through user testing. Different aspects like comfort, system stability, level of engagement, potential fatigue and the statistics of the game were evaluated through user feedback. The user opinions as well as test results were collected to evaluate the aspects involved in this project.

2. Hardware:

The project makes use of several essential hardware devices and accessories. Myo armband developed by Thalmic Labs (currently represents itself as North) with all its accessories. The detailed description of the device is as below:

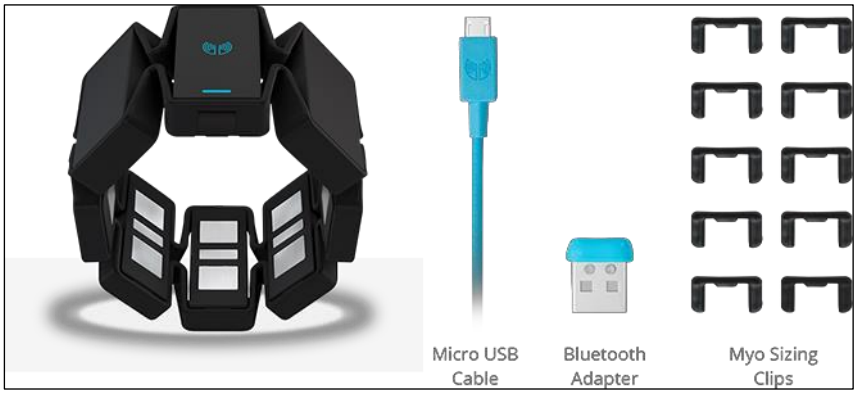


Figure 1(source: support.getmyo.com)

The product consists of:

- 1 Black or White Myo Gesture Control Armband
- 1 USB Bluetooth adapter for Mac and Windows computers
- 1 Standard micro-USB cable
- 10 Myo Sizing Clips

2.1 Myo Armband

The Myo armband developed by Thalmic Labs is a gesture control device that enables the user to control the virtual interfaces such as video games, presentations, media center navigation, etc. wirelessly using various hand gestures. It uses eight electromyography (EMG) sensors that senses electrical activity in the forearm muscles, along with a 9-axis inertial measurement unit (IMU) sensor to recognize gesture. It also encompasses ARM cortex M4 processor compatible with many platforms.

It is an electrically safe device with low voltage battery and Bluetooth LE protocol, eight sEMG sensor working at a frequency of 200 Hz and a 9-axis IMU sensor working at 50 Hz. EMG signals are already filtered through notch filters at frequencies of 50 Hz and 60 Hz in order to take out any powerline interference. Thalmic Labs also provide with a SDK, which must be used for the development of standalone applications.

Detailed image of Myo armband:

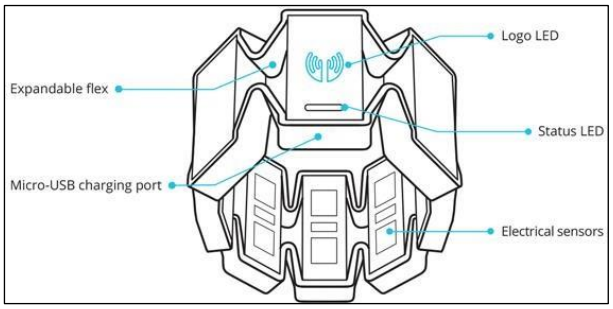


Figure 2 (Source: support.getmyo.com)

Myo armband detects five gestures and has a highly sensitive motion sensor

Figure 3 Hand Gestures detected (Double tap, Finger spread, Wave out, Wave in, Fist respectively)

(Source: support.getmyo.com)

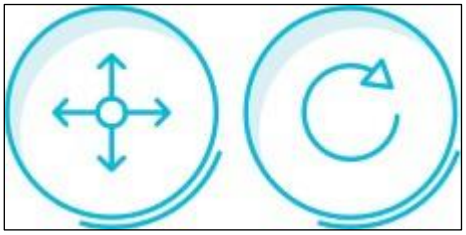


Figure 4 Motion sensor

(Source: support.getmyo.com)

The LED beneath the logo shows the sync state of the Myo armband. It pulses when the Myo armband is not synced. The LED becomes solid when you perform the Sync gesture successfully and the Myo arm band is synced to your arm.

The status LED shows the current state of the Myo armband. It lights up in blue once the Myo armband is connected to a device. The various LED glow shows the different status of the Myo armband.

The Myo armband also consists of haptic feedback with three different vibration range of short, medium and long vibrations

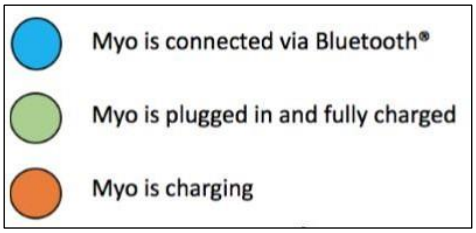


Figure 5 Myo LED and different status.

(Source: support.getmyo.com)

2.2 Micro- USB Cable

The USB charging port allows you to charge the battery of the Myo armband using a USB power adapter or a conventional USB port on a computer. The standard micro-USB cable is used to set up initial connection between the armband and Myo Connect software.

2.3 Bluetooth adapter

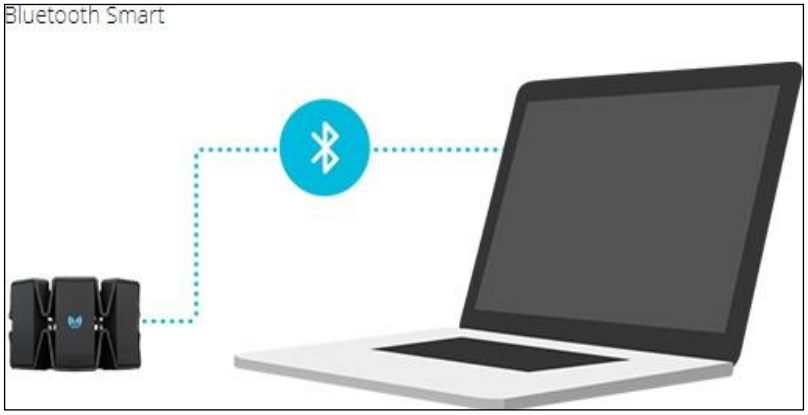


Figure 6 Bluetooth Connection

(Source: support.getmyo.com)

The Myo armband is connected to a device using Bluetooth 4.0 Low Energy. The SDK takes care of all the low-level details related to Bluetooth connections and data transmission.

2.4 Sizing clips

The sizing clips are used for best fit of the product on the wearer's arm.

3. Software:

In this project different open-source software and libraries were used. They are as below:

3.1 Myo Connect

The Myo connect specifies the details about the status of the Myo armband. In addition to this, it also provides user with some basic control features and helps to setup the Myo armband through Bluetooth protocol.

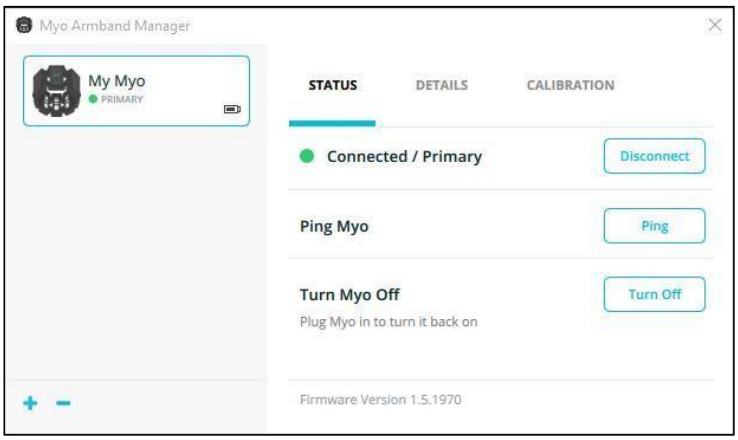


Figure 7 Myo connect armband manager

3.2 Unity

Unity is a cross-platform game engine developed by Unity Technologies, used to create three-dimensional, two-dimensional, virtual reality and augmented reality games as well as simulations and other experiences. Unity 2018.3 was used for developing gaming interface for this project on windows 10 platform.

4. Experimental Setup:

The user must wear the Myo armband in his hand that needs the therapeutic treatment with the X-axis of the armband towards the wrist (i.e. away from the elbow)

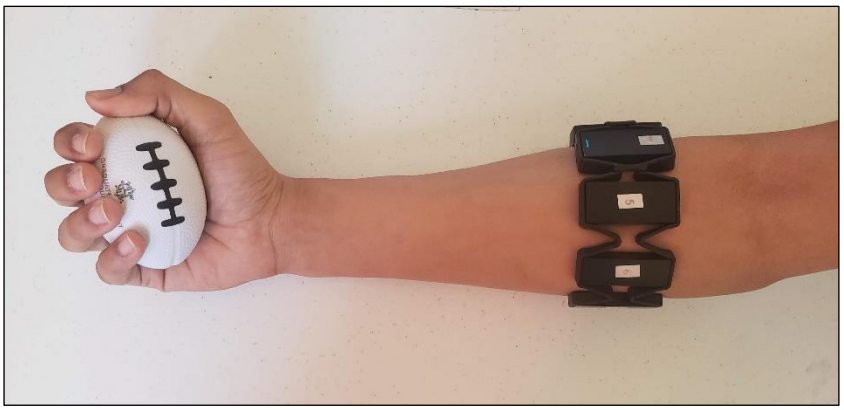


Figure 8 Placement of Myo armband

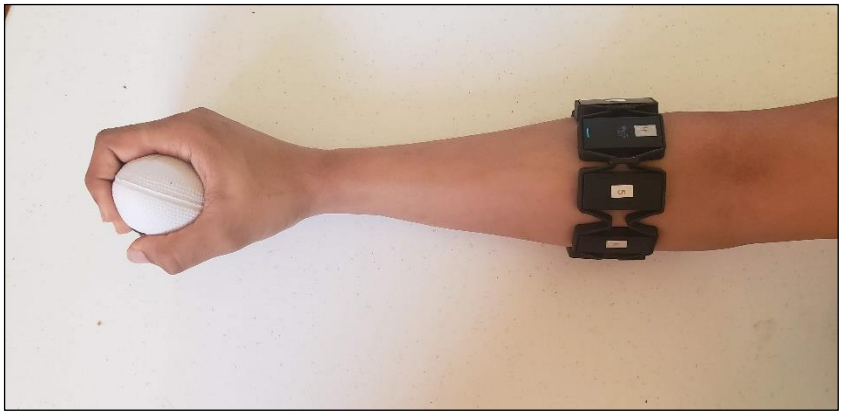


Figure 9

The user must install Myo application manager for communicating Myo armband with the system (i.e. computer/mobile). The user/patient must wear the Myo armband on his/her left/right hand. The user must wave out to sync the armband with the system. Once the armband is synced it gives a haptic feedback which tells the user that the device is ready to use.

Once the armband is synced with the system, go ahead and launch the gaming interface to start playing the game.

Figure 10 Updating reference orientation before starting the game.

The game setup consists of four levels where in level zero the user must make a wave out gesture to update the reference orientation of Myo armband with the game. The user should move his/her arm in yaw motion to check whether the user can move around in the gaming environment so that user can comfortably play the game.

In the next three levels the difficulty of the system goes on increasing. Each level has a countdown timer of 30 seconds each. The user must score maximum points by destroying maximum targets in the given span of time. The cumulative score of all the three levels decides the progress of the user.

Figure 11 Gaming interface

For killing the enemies, the user must make yaw motion so that the user can move and aim from one target to the next. Once the target is aimed the user must make a fist gesture to spawn the bullets towards the enemies. Spawning the bullet makes it to move in the direction of the target and destroy the target on collision.

Figure 12 Display of final score to the user

The user scores the points once the target is destroyed. The user must accumulate the score of all the levels and will be able to see the final score at the end of the game. The score decides the progress of the user.

This game can be played with empty hand as well as with a stress relief ball/object. It was found that playing the game with stress relief object was comparatively more effective than playing the game with empty hand.

Figure 13 Playing Empty handed

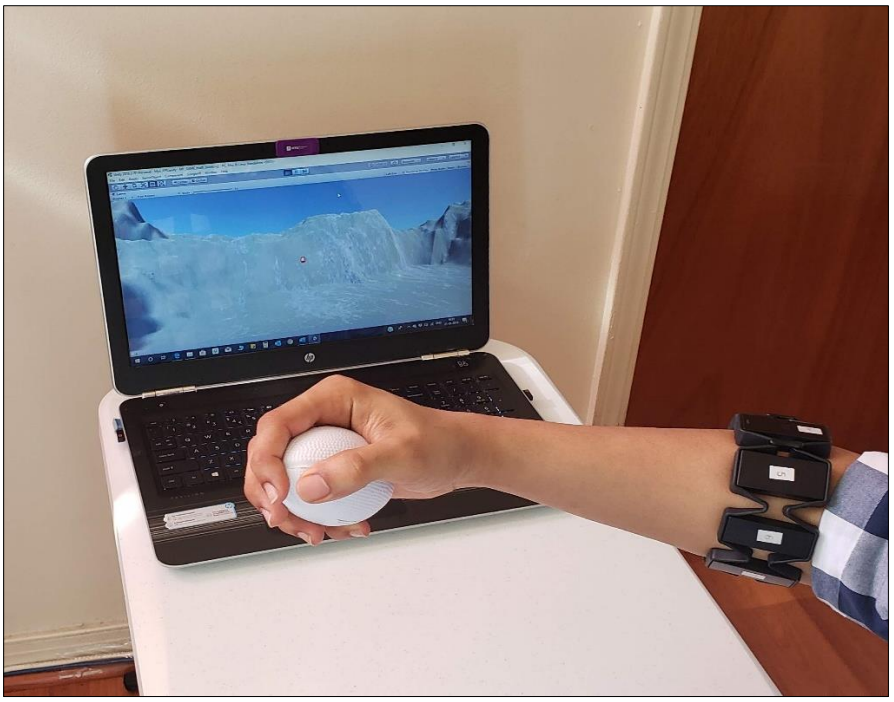


Figure 14 Playing with a Stress relief object

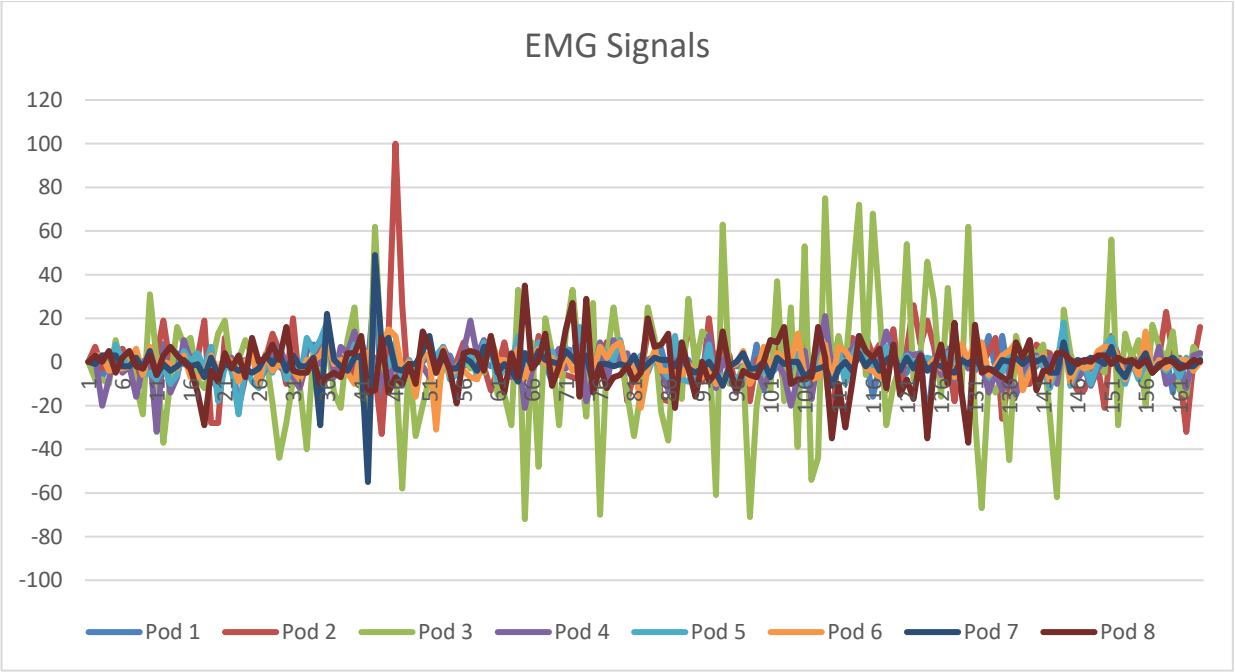
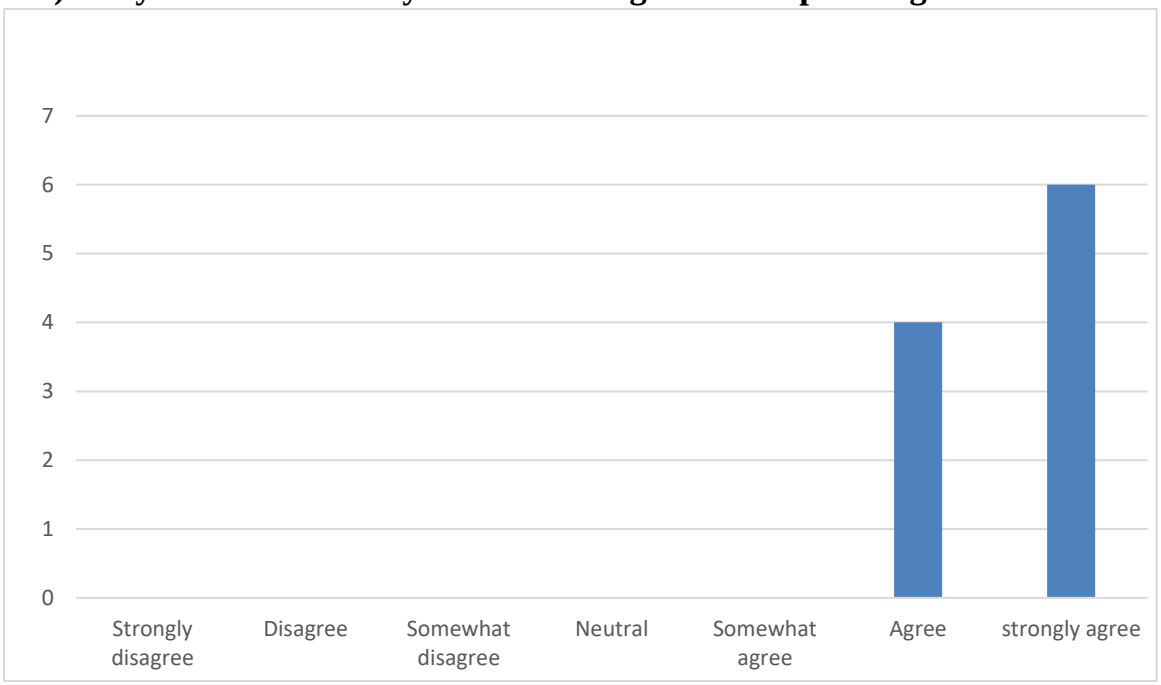


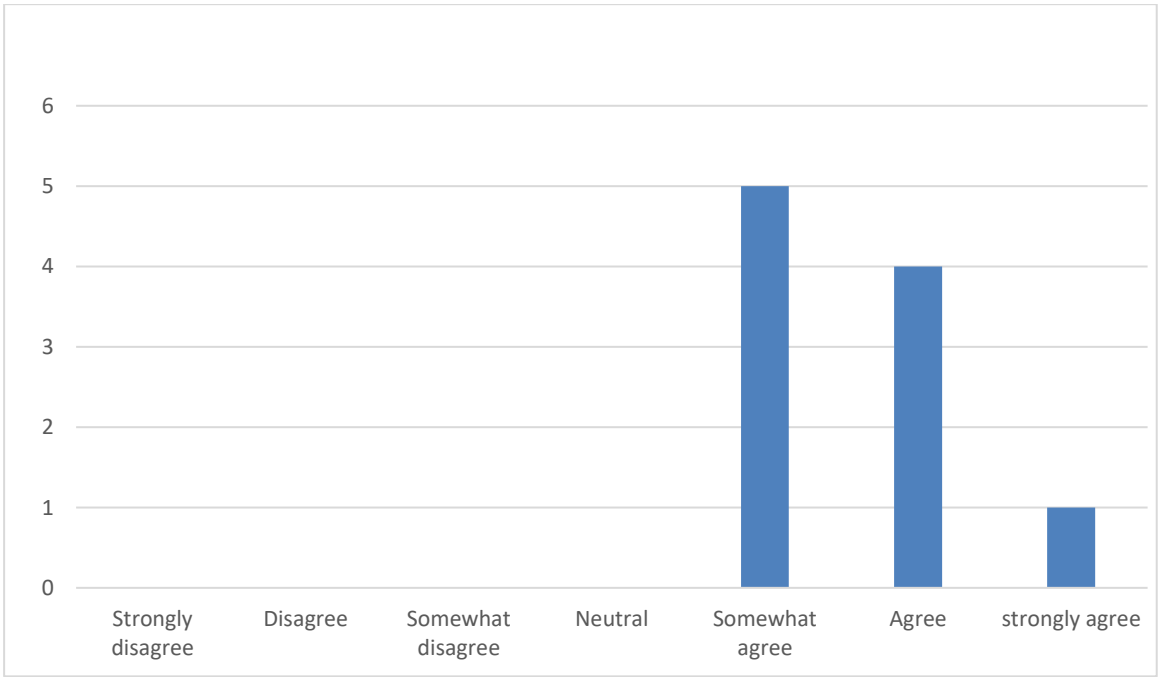
Figure 15 The emg data from the myo armband is captured in the form of .csv file while the gaming exercise

5. Subjective Evaluation:

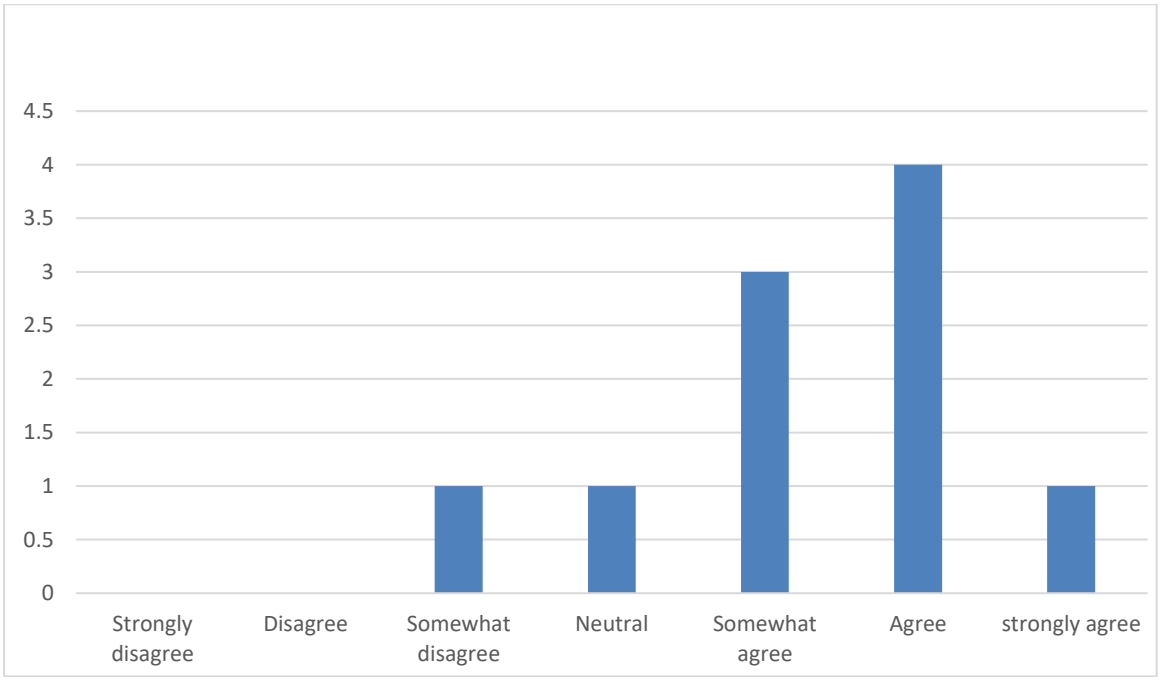
1) Do you need to acutely aim at the target before spawning the bullet?



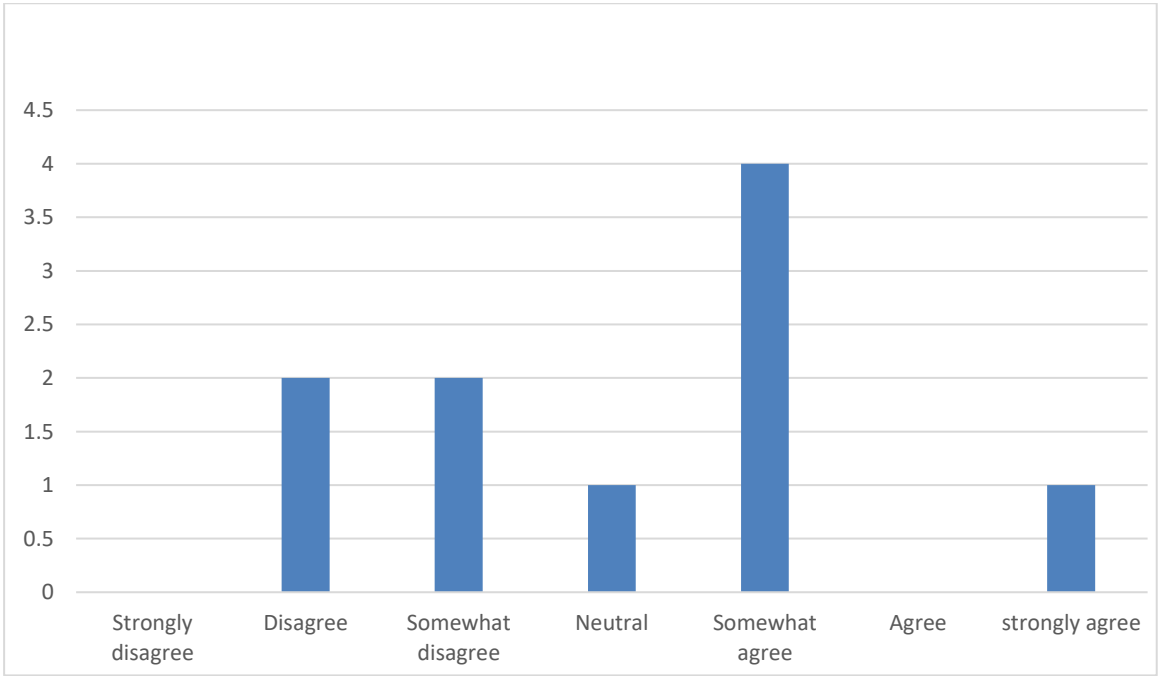
2) The device is not so heavy to wear and use



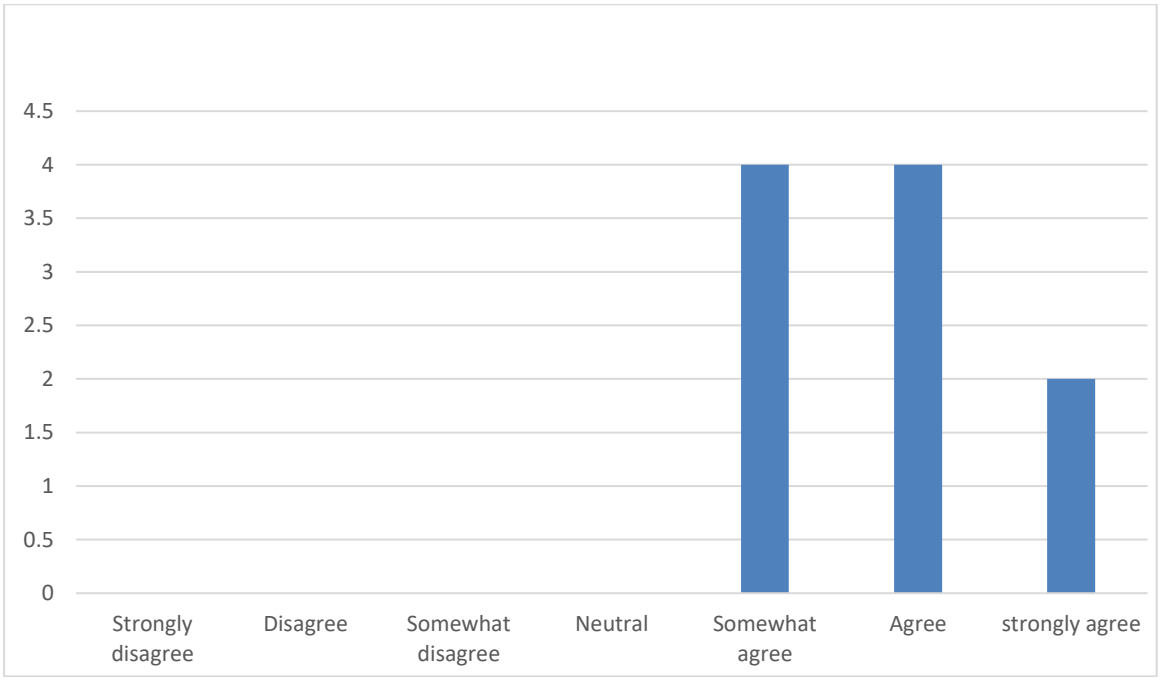
3) The device is not so tight to wear and use



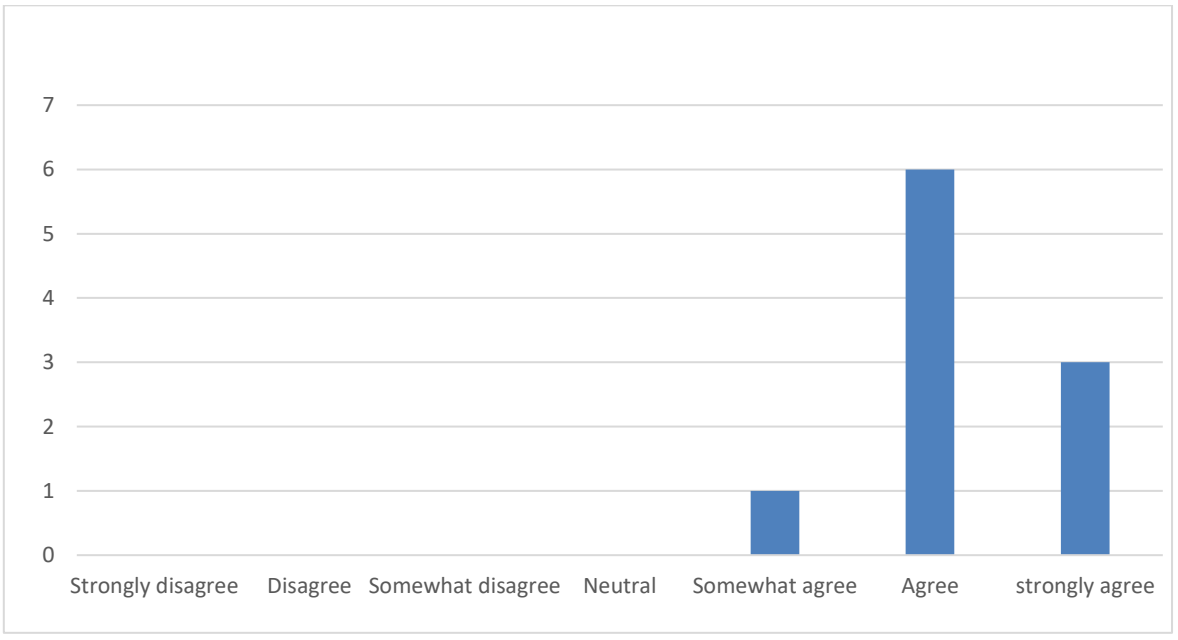
4) The device may cause fatigue if used for longer time (say 30 minutes)



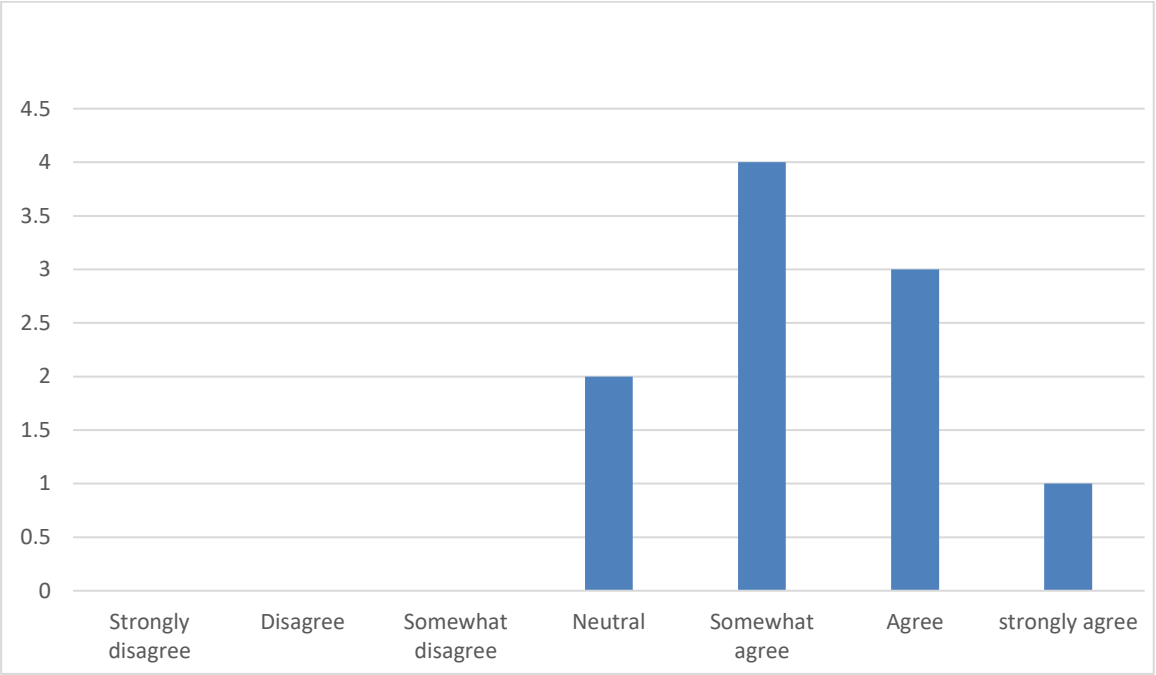
5) **Is the gaming interface interesting enough to be played for more than once?**



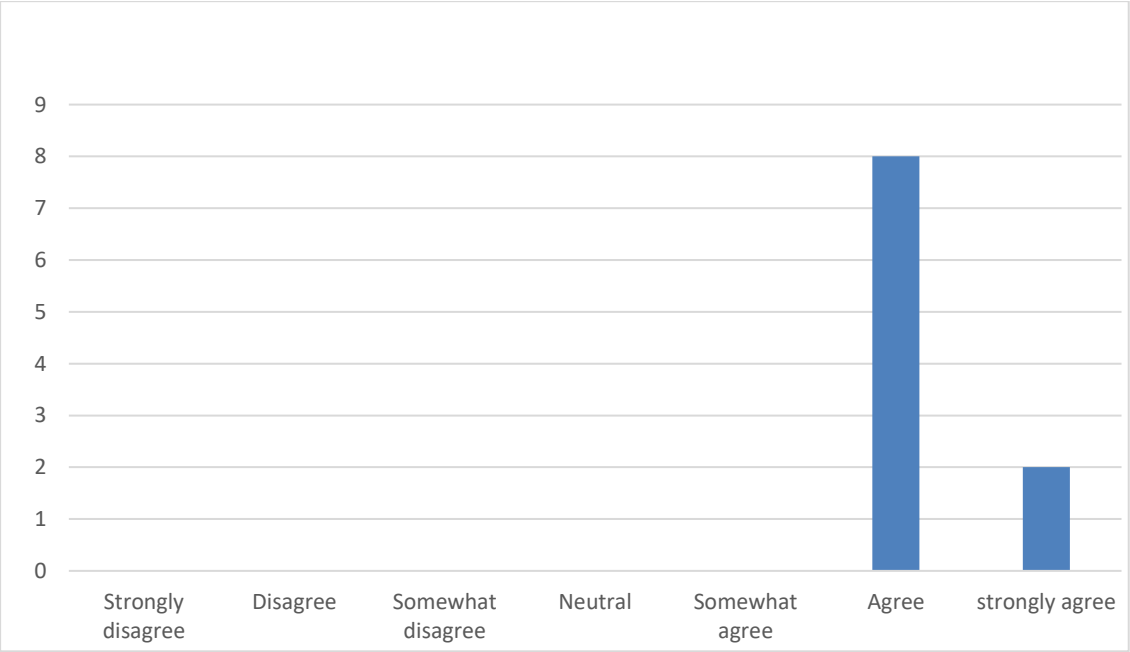
6) **The entire system kept me attentive, concentrated physically and mentally till the end**



7) **The entire system is stable**



8) **The overall system and practice including the gaming interface can provide potential benefits to stroke patients in their rehabilitation in the home-based setting**



9) Which is easier to perform?

6. Conclusion:

Exergames developed with modern devices are highly helpful in stroke rehabilitation. The above project makes use of one of such devices i.e. Myo armband which has been integrated with games for therapeutic treatment of stroke patients. A much advance exergames can be developed for stroke rehabilitation which can be controlled using modern devices.

The learning from this project has been all about studying and using Myo armband- an EMG sensor- which is used to control a game using hand gestures. The EMG signals from the sensor can be a helpful tool to evaluate the progress of the stroke affected people using exergames. Subjective testing results can be used as an input for the future work.

7. Reference:

1) Mithileysh Sathiyanarayanan ; Sharanya Rajan, "MYO Armband for Physiotherapy Healthcare: A Case Study Using Gesture Recognition Application", 2016 8th International Conference on Communication Systems and Networks (COMSNETS)
2) Achmad Alfian Hidayat ; Zainal Arief ; Heny Yuniarti, "LOVETT scalling with MYO armband for monitoring finger muscles therapy of post-stroke people", 2016 International Electronics Symposium (IES).
3) Seema Rawat ; Somya Vats ; Praveen Kumar, "Evaluating and exploring the MYO ARMBAND", 2016 International Conference System Modeling & Advancement in Research Trends (SMART).
4) K. Kefer, C. Holzmann, and R. D. Findling, "Comparing the placement of two arm-worn devices for recognizing dynamic hand gestures," in Proceedings of the 14th International Conference on Advances in Mobile Computing and Multi Media ACM, 2016, pp. 99–104.
5) Unity scripting API reference. (www.docs.unity3d.com/ScriptReference/)
6) Myo SDK documentation. (https://support.getmyo.com/hc/en-us/articles/360018409792)