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Evaluating and Exploring the MYO ARMBAND

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***Abstract*—Electromyography (EMG) is a technique that studies the electrical activity of the muscle. EMG is the basic component of Myo armband. The MYO ARMBAND is a device which can be used by humans to interact with computers. The myo armband involves the interaction of devices in VE (virtual environment). Working and characteristics of Myo are studied and analyzed. This paper surveys the work on visual analysis of gestures by using Myo armband and the input from keyboard and mouse. We have also performed two tests where participants are allowed to play a game, first by using keyboard and other by using MYO. Discussion and conclusion are also written at the end of this paper.**

Keywords: Myo, Virtual Environment, EMG, IMU, Human Computer Interaction

I. INTRODUCTION

Myo is the basic concept of Human Computer Interaction (HCI) which is the study that how people interact with computers. Hence Myo is a new way to merge the real world and the digital world together. The structure of Myo consists of the EMG (electromyography) sensor and an IMU which comprises of a gyroscope, accelerometer and a magnetometer. EMG are to be processed for multiple hand gesture and movement recognition. EMG monitors the electrical signals under your skin that are produced by your muscles. The Myo has no cameras, no keyboard and mice, it just involves the hands. The Myo is able to detect any tiny electrical activation that the muscle produce. In short, Myo Armband act as a shortcut between your brain and the devices or the technology. It is similar to a thought being implemented into a command for any device and the standard price of Myo armband is USD $199 [13].

Myo Armband was developed by Thalmic Labs in summer 2014 [11]. MYO is an armband that can be worn on the forearm below the elbow which is controlled by our gestures and movements. The Myo involves five basic gestures wave left, wave right, Double tap, fist and fingers open.With the help of MYO you can make your task easier and faster like controlling of fans, tube lights and change slides of your presentation by just waving your hand. With the help of Myo armband people can control movies, music from anywhere in their homes. Myo can be used to connect to YouTube[18], operate iTunes and VLC media player just by their gestures and hands movement. Myo has also found a career in the medical field, it can be used by doctors to examine the EMG reports and control their electronic devices.

In this paper we will discuss the working of MYO Armband which begins with a MYO Connect through which the devices are connected to the Myo. In the further sections we will study the working of Myo, proposed method and results.

II. RELATED WORK

The Myo Armband was released in 2014 and had a huge impact on human computer interaction. Soon after its release lot of applications were developed for it and many research work was done for the same.

In November 2014 Amatanon *et al.*[2] published a work where he developed a system to transform the sign language into alphabet spelling based on EMG signals produced by the muscle. Sathiyanarayanan [1] in the year 2015 made an Unmanned Ground Vehicle(UGV) controlled by Myo. He also published the same work in one of his research papers. Sumit A. Raurale [3] evaluated EMG signals for prosthetics hands. Nymoen[4] developed a prototype instrument: MuMYO and explored Myo for Musical instruments. Yadira GarnicaBonome [5] evaluated myo if it was a suitable device in virtual environment. An interesting technique was proposed by Liu and Lovell [7] for real-time tracking of hand capturing gestures through a web camera and Intel Pentium based personal computer.

In 2014, Auberson published, a blog using an IPhone, a myo armband and an Oculus Rift [16]. He is the founder of Lumacode [6] who is specialized in development for the web and mobiles. Currently, he is investigating a better way in which we can navigate and interact in a Virtual Environment. On November 27 of 2014, Thalmic posted a blog about their new innovating application of Myo in the medical area.

In April 2015, Thalmic published a blog[11] about one of his game Icarus Rising released for free, for playing this game you need a Myo armband and an Oculus Rift[8]. In this game you just need to spread your fingers wherever you want to take a flight. Hence, Myo till now has been used by many people and is a great area of research. MYO is also working with Bluetooth beacons to control specific devices in each room, and it's featured in the Logitech booth at CES2015.

III. Methodology/ Working of MYO

The Myo Armband is a wearable device that the subject needs to wear on the forearm i.e just below the elbow. The armband is adjustable as it contains an expander that can be added or removed. The Myo consists of stainless 8 EMG sensors that is processed for recognizing hand gestures and movements. It also consist of a 9 axis (IMU) Inertial Measurement Unit used to detect arm movements. The IMU consists of a 3-axis gyroscope, 3-axis accelerometer and a 3-axis magnetometer. Fig. 1 shows the Myo Armband.

Fig. 1: [12] Myo Armband

The Myo begins with a MYO connect which helps to set up your Myo Armband and connect the devices through Bluetooth. With the help of Myo connect you can set and feed all the features you want the Myo armband to do and hence you can explore the Myo armband capabilities.

The Fig. 2 shows the physical structure of the Myo armband which includes a lithium rechargeable battery, an ARM processor, Bluetooth 4.0 LE, a micro USB port for charging. The USB charging port allows you to charge the internal battery of the Myo Armband by using a USB charging adaptor. The logo LED of the Myo shows its Sync state, it shows the current state of Myo. The LED lights blue when the Myo is connected to the device, whereas the LED lights orange when the battery is low and green when charging. Data from Myo is communicated to the computer via Bluetooth [17].

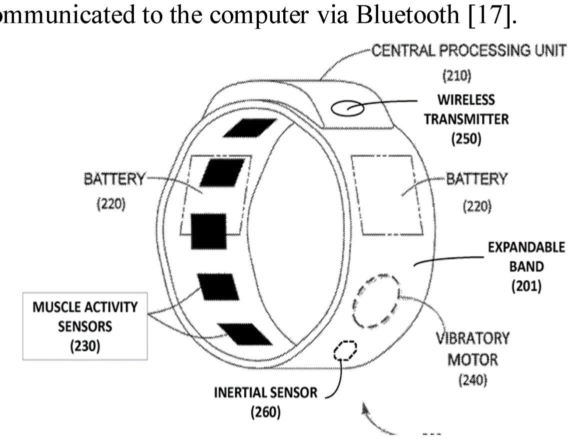

Fig. 2: Physical Structure of Myo

The Myo uses five gestures to interact with the environment shown in Fig. 3, these five gestures include fist, double tap, finger spread, wave left, and wave right.

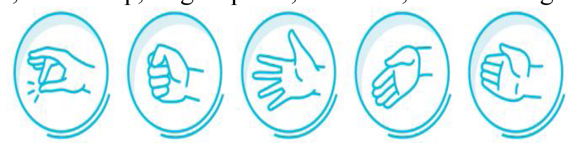

Fig. 3: [18] Gesture Recognized by Myo

By setting up the connection via Bluetooth 4.0 [17], users are able to map each gesture into a particular input event in order to interact and communicate with the paired devices. The low level details related to Bluetooth connection and data transmission are taken care of by the SDK (software development kit). According to the Myo SDK[15] the Myo provides gestural and spatial data to the application. The data is provided to the application by three types of events spatial [9], gestural and auxiliary event. The work of spatial data is to provide information to the application about the orientation and arm movement of the user, where the orientation points to the way in which thearmband is pointing. Thus, the Myo SDK provides several kinds of spatial data: orientation in terms of pitch, yaw and roll, acceleration vector data which represents the acceleration of the armband, and angular velocity data provided by the gyroscope.

The gestural event involves the data of what the user is doing with its hands. The SDK provides the gestural data in the form of preset gestures whereas the auxiliary events occur infrequently and corresponds to situations like myo being connected or disconnected by the device. For example [1], this might happen when the MYO armband is moved out of range of the device it has been connected to. All types of events identify the MYO armband from which they occurred and provide a time detail at which the event occurred [5].

The information about which arm the Myo needs to be worn and which way it needs to be oriented is given by the Myo Armband-with the positive x-axis facing either the wrist or elbow. This is determined by a Sync Gesture performed upon putting it on. The Myo armband similarly detects when it has been removed from the arm. An application can provide feedback to the wearer of the Myo by issuing a vibration command. This causes the Myo armband to vibrate in a way that is both audible and sensed through touch. The Myo need to be worn for some time as it gets worm and sense the arm muscle and then we can make the fullest out of the Myo.

IV. Research Methodology

A. Testing Different Inputs

With the objective of testing two different types of inputs in virtual reality [20], we did two tests. The two test constitute of 6 basic set of questions. Each test was performed by 10 participants who were all students of IT i.e. Information Technology [5]. In the first test we asked the participants to play the game Need for Speed: Most Wanted by using keyboard and in the other test by using the Myo Armband. In both the tests the common thing was the use of Oculus. In both the applications the participants were needed to play the same level of the game (NFS: Most Wanted) and the level being Black List #1- Razor.

After telling the participants what they were supposed to do, they were asked to evaluate the 6 questions and what was their experience with the application in both the tests. The questions were:

1. Answer the following question by rating them from 0 to 5 (0 being the lowest and 5 being the highest):
   - It was easier to move forward.
   - It was easier to move backward.
   - It was easier to move right.
   - It was easier to move left.
   - It was easy to use nitrous.
   - It was easy to apply hand breaks.
2. If your rating is 0 in any of the questions before please explain why?
3. If your rating is 5 in any of the questions before please explain why?
4. How comfortable you were to accomplish the task? Support them with the help of a reason.
5. Have you ever played this game before?
6. Did you ever play this game before using Oculus rift?

The same set of questions were asked in the second test except in the sixth question we added if they had any previous interaction with Myo and played the game with the Myo before.

B. *Test 1*

To accomplish this task, we asked the participants to play the game using keyboard and oculus. To play the game in the first test the controls were as follows: forward or accelerate, backward, to the right and to the left with the Arrows keys of the keyboard respectively, apply hand breaks by Space key and nitrous by Shift key of the keyboard.

C. *Experimental Results of Test 1*

After the participants finished playing the game they were asked to answer the 6 questions mentioned above and as a result we saw for most of the people that it was more difficult to interact with the keyboard using the Oculus[19]. And taking in account the average range of result reveals that for most of the people it was not easy to accomplish the task. The average results are shown in Fig. 4. The participants said that it was easier to move arrow keys of the keyboard as they all were close by but there was a huge difficulty in the operating the other controls of the game like applying the hand breaks (using the Spacebar) and especially the nitrous (using the Shift key).

In question 1, most of the people marked 0 as their choice for e and f and only 2 people out of the 10 participants marked 5 as their option for a,b,c,d.

In question 2, when they were asked to explain their answer for their choice as 0 most of the people reasoned that once they had the Oculus on, if they put off their hands of the keyboard it was difficult to find the arrows keys on the keyboard and, it was even more difficult for them to find the other controls on the keyboard.

In question 3,three people evaluated a,b,c and d as 5, they reasoned that they were very much familiar with the keyboard, but as an observation it is important to note that these three people never put off their hand off the keyboard and especially the arrow keys.

In question 4, they answered that it was a good experience, but they faced a lot of difficulties in getting used to the controls.

In question 5, 9 out of 10 answered that they have played this game before.

In question 6, 3 out of 10 answered that they have played this game before using the Oculus, they were the same people who have marked a, b, c, d as 5 in question 1.

As a conclusion of this test we observed that the major problem was at the time when the participant played the game by putting on the Oculus, they lose all the visual feedback of the reality and, of course, all reference of position of keyboard's keys in the real world, making it very difficult for them to find the controls and play the game.

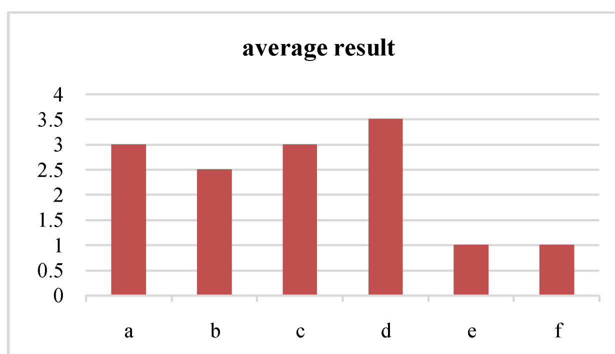

Fig. 4: Average Result of Question 1.

D. *TEST 2*

To accomplish the tasks, on the second test the participants needed to play the game using Myo and Oculus. Before using the Myo we had fed the commands or the controls of the game which were as follows: wave left to reset rest position, wave right for nitrous, spread

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fingers for applying handbrakes, make fist to accelerate and pan for left/right: steer, up/down: acc/reverse.

E. Experimental Results of Test 2

The average results of question 1 was 4 and the average results of the same are presented in Fig. 5. Note that the second question was not answered as there was not a single evaluation of 0 as it was the case in the first test.

TABLE 1

Test 1 (Using Keyboard)	Test 2 (Using MYO)
People faced a problem in finding the shift key and space key while wearing the oculus.	People faced a problem in remembering the gestures in the starting of the game.
The game was played before by many people using keyboard.	Not much people have experienced Myo before and hence not played need for speed game before using Myo.
Only experienced people were able to play the complete level of the game.	All the 10 participants were able to complete the level hence no experienced people were needed.
Playing with keyboard was not so sporty and exciting.	Playing via Myo was more exciting and entertaining.
It was liked by less number of people.	In comparison to keyboard it was liked by more number of people.

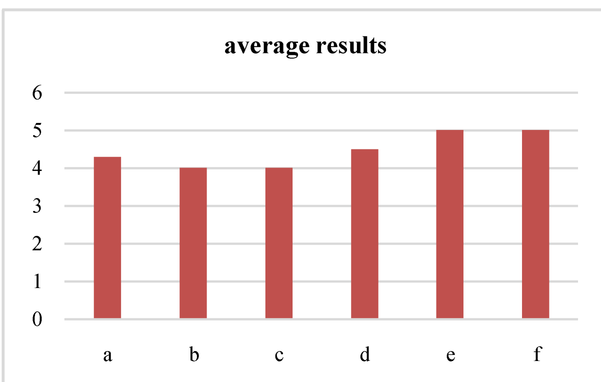

Fig. 5: Average Result of Question 1

In question 1 more than 7 people marked 5 for all the 6 sub-questions which is a total contradictory to test 1 results. These results of test 2 overcome the results of test1 where the participants were asked to play the game using keyboard. In test 1, e and f sub-questions got the least scale where as in test 2 they got the highest. Fig. 6 shows a comparison of results of test 1 and test 2 for question 1.

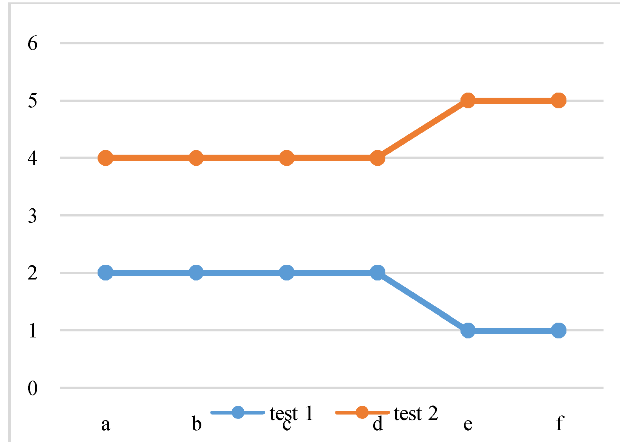

Fig. 6: Comparative Study of Test 1 and Test 2

Hence from the above graph we can conclude that the liking of participants in test 2 i.e. use of Myo was more than that of the keyboard in test 1.

In question 3, they answered in general that initially as they were not familiar with the gestures, they faced a problem in remembering the gestures but after an average time of about 2 minutes they automatically remembered all the gestures and were able to play the Need for Speed: Most Wanted with speed.

In question 4, they answered that they enjoyed using Myo and it was better than playing with the keyboard and they added that the experience was more real-time and fun when compared to playing with the keyboard and the Oculus.

In question 5, 9 of 10 answered that they have played this game before.

In question 6, 3 of 10 answered that they have played this game before along with the oculus, but only one had played this game using Myo although they loved playing the game using Myo.

The below table shows the difference in the two tests:

Figure 7 shows the result that how many people liked playing the game using keyboard, keyboard along with oculus and with Myo along with oculus. Hence we can conclude that Myo is a suitable device for interaction in Virtual Reality Environments and it can be used by people in day to day lives to make their task easier and faster.

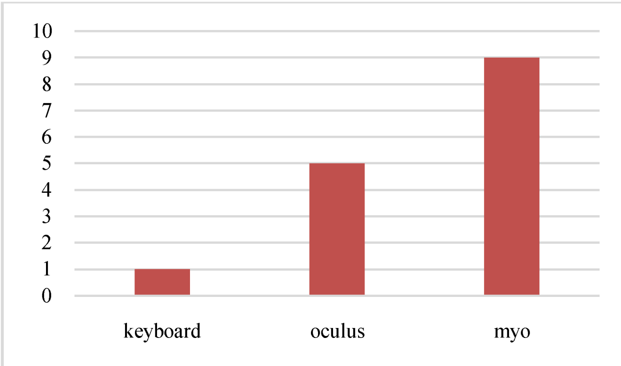

Fig. 7: Shows How Many People Liked Playing Need for Speed Using all Three

V. CONCLUSIONS

Games in today's world are played by almost everyone in the world but its tie-up with MYO is more promising and exciting. This simple wearable band enables us to control and play our games with our gestures. With the birth of Myo the users can interact and play various games without any need of keyboard, mouse or any other kind of controller thus reducing the effort and cost of buying other devices like gun in shooting games etc.., we can simply do our work with our hands. The optimization of the controller's performance of MYO interaction with the environment and the user has been the key to this research.

As Myo is used in gaming similarly this feature of Myo can be very well used by the Defense Department of any country for pointing the enemies and shooting them with the help of Gesture Controlled Robots using MYO [1]. With the help of these robots our dependence on any external tracking system which will first track the happenings of the surroundings, identify the enemy, target them and then shoot, can be reduced.

The MYO is a wearable device which is used to connect to various devices via Bluetooth as discussed earlier in the paper. In Virtual Reality Environments[5], Myo plays a huge role as a data input rather than using the traditional methods for entering data like keyboard and mouse. In the near future Myo will prove to be a complete replacement for keyboard and mouse. For concluding this work we presented two tests in which the users were allowed to play a game named Need for Speed which is the most common racing game using Myo along with Oculus Rift. In the first the interaction we interacted with keyboard as the input device and in the second was the Myo. Based on the results of both tests, the user experience with Myo was much better and exciting than with the keyboard.

Based on all the characteristics of Myo presented here, examples given and the tests performed, we can conclude that MYO is a suitable wearable device as an input data and play games making you feel as if you are playing in real world. Hence as whole world in future will be digitalized hence various researchers have concluded that devices like Myo will play a huge role in technology development. Myo will, undoubtedly bring chances to improve the quality of life of people who can't take advantage of current interfaces and technologies due to physical disabilities [3].

FUTURE SCOPE

MYO technology can be very well implemented in video games using gestures. Myo has eventually led to game console developers release the players from the constraints of using a keyboard and a mouse. They are used in business, defence department and even to fly planes and drones[10]. Myo can be used by students and business people to give presentations in a more effective manner. Besides, Myo makes our life easier, we can easily connect and communicate with various devices and make our work easier. As we live in a technological era, Myo plays a huge role in staying connected with technology.

In the future Myo are expected to play a huge role in medicine. Myo is the future of gesture control which can be used in our day to day lives. For example just by sitting in our room we can switch off our lights, fans and even change the channels of your television without using the remote. Hence, smart homes can also be controlled by Myo Armband and it can also be used to control various other electronic home devices.

In future Myo can also be used to control our robots[14], all the activities of robots can be controlled by our hands. By combining study of robotic with the latest innovative wearable technology like MYO new dimensions of research, experimentation and application can be unlocked [2].

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