Application of Myo Armband System to Control a Robot Interface

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Keywords: Myoelectric Signal, PeopleBot, Human Machine Interface, Myo, Inertial Measurement Unit.

Abstract: This paper discusses the application of myoelectric signals to control electronic devices aiming the development of a digital controlling interface with Myo Gesture Control Armband System. Through this interface it is possible to control the movement of a robot and its interaction with the environment, in this case the robot being PeopleBot, a robot designed for home necessities. Thus, allowing an assessment on the operation of controlling devices with myoelectric signals and Inertial Measurement Unit (IMU), the advantages and disadvantages of working with this technology are discussed.

1 INTRODUCTION

Nowadays, it is impossible to imagine a world without technology. The use of mobile devices such as mobile phones, tablets, among others, has constantly evolved in many fields of society such as health, transportation, communication and security. However, with the increased integration between technology and humans, studies of flexible and bendable electronic equipment such as roll up displays and wearable devices, have attracted the public's attention (Gwon et al., 2011; Futurecom, 2015). Some of these devices operate through myoelectric signals, like Myo Gesture armband. Myo is a wearable device that uses the concept to create a controlling platform to other electronic devices with preset gestures.

The myoelectric signal is a biological signal produced by the electrical activity in a muscle during its contraction, and it can be detected through electrodes applied on skin. The use of these signals is very feasible for analysis of movements and controlling of some electronic devices, since for each movement it has different modes of muscle activation, which are reflected in different signatures or patterns for device control. This technique could be use in the rehabilitation of people with motor disorders, to control prostheses, robotic devices, biomechanical and human machine interfaces (HMI) (da Silva, 2010).

Myo system has been used as a control platform for TedCube in (Caballero, 2015). According with the author, into operating rooms, when doctor needs to rotate a 3D image to see some exam detail, he has to tell for some assistant do it. In that case, Myo can help the doctor manipulate system's interface and see any detail touchless.

At current market, system for gesture recognition exists on many different platforms. The most popular between them is Microsoft Kinect which is in your second version. This device works with two cameras and a infrared sensor. This technology calls Time Of Flight (TOF – 3D tracking through lighting pulses) which, recognizes gestures to execute some action on software (Canaltech, 2014).

TedCube also uses Microsoft Kinect for gesture recognition. However, there are many disadvantages when it compares to Myo system. As TedCube needs to use commands through gesture, the system focus on Myo gestures make possible a simple approach without barrier like Microsoft Kinect could be. Beyond that Myo system could offer a most precise capture for short movements and less aggressive for surgery center environment which, turns it safety (Caballero, 2014).

Another application for Myo system is to monitor Parkinson disease development. Usually, doctors use three different exams, Positron Emission Topography (PET), Magnetic Resonance Imaging (MRI) and DaTSCAN (exam to detect functional images of the brain used on nuclear medicine). These exams are expensive and have to be done on specialized image centers. Tremedic, developed by (Song, 2014), make the monitoring of patient in real time through Myo device. Current electromyography data are compared with old ones to identify disease symptoms. It allows that treatment with levodopa (antiparkinson medicine) could be analyzed for confirming or contesting the diagnostic.

Morais, G., Neves, L., Masiero, A. and Castro, M.
Application of Myo Armband System to Control a Robot Interface.
DOI: 10.5220/0005706302270231
In *Proceedings of the 9th International Joint Conference on Biomedical Engineering Systems and Technologies (BIOSTEC 2016) - Volume 4: BIOSIGNALS*, pages 227-231
ISBN: 978-989-758-170-0

Comparing to others gestures recognition system, Myo has some disadvantages to define the depth. Device's algorithm works with data acquired through eight electromyographic sensors, divide on inertial sensors and rotational sensors. But this information cannot generate object reference in a 3D world like Microsoft Kinect does. But it helps to work with another devices as smart-phones, personal computers, wearable gadgets, even robots (Bullok, 2015).

In this paper, we focus on the application of Myo Armband in the development of a controlling interface for PeopleBot robot. This kind of application could be used in many ways like reaching bio-infected or radioactive places or any place that would be harmful to human beings. Also, another application is to control a robot for helping elderly or disabled people on tasks involving motion and drag and drop objects, for example. In that way, we chose PeopleBot because its hardware is made to human-robot interaction problems. It has wheels to move and a grip to get objects on the top of a table.

To integrate Myo and PeopleBot, we use ROS (Robot Operating System) which allows the connection of the commands interpreted by Myo and sent to the robot controller. This study shows the advantages and disadvantages of working with myoelectric controlling devices and what improvements are need to make it better as a HMI for helping people on daily life.

2 METHODS AND DEVELOPMENT

At start, it was necessary to study the general operation of Myo. Initially, we used the Myo Connect software, developed by Thalmic labs, that deal with the events of sensors and was used to control softwares like media players, slide show presentations programs and on-line games. Scripts were made in Lua programming language as interface (Labs, 2015).

To identify movements through Myo software needs a classifier to determine the best combination of the eight existing sensors. To understand how it works, figure 1 presents sensors raw data for movements from wave-out to wave-in. On figure 1 has the best combination of the sensors to classify the movements. It can note on graphics the inverse relationship between two sensors located on main muscles to make the movement. At last graphic the electrodes have a minimal influence for the movement. The other graphics are too embracing and it cannot conclude anything relevant.

Aiming the application on the ROS platform, the use of the Myo Connect and programs developed in Lua script were not sufficient to create communication between computer and robot. There are many factors that influence on it like incompatibility between operating systems. Thus, the script should be able to access directly raw information from sensors (hexadecimal matrix information) to use it in such manner to control the robot.

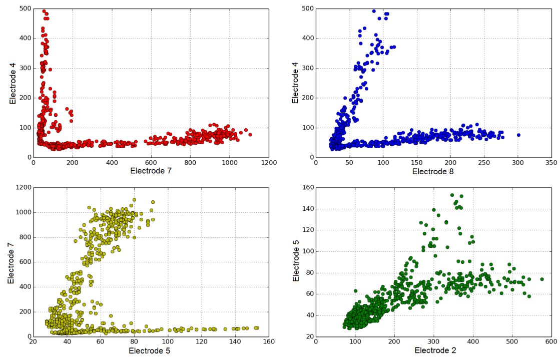

Figure 1: Relationship between the data electrodes to a muscle activating for a movement.

Methods to communicate the Myo platform, that was developed for Windows and MacOS operational systems, with the ROS, developed for Linux operational system which controls the robot should be addressed. The communication between operational systems, which require a network with at least two computers was aborted due to its low flexibility and possible delays in the communication. The alternative that was chosen receive data from the sensors of Myo directly on the same platform of the robot.

For signal acquisition, the script developed by Danny Zhu, under license from MIT (Dzhu, 2015) was used. Raw data is read from the sensors of the armband and allows its visualization and the manipulation to be used for PeopleBot controlling (figure 2).

Figure 2: PeopleBot (TelepresenceRobots.com, 2015).

2.1 Publishing Myo's Information

With raw data, a simple algorithm was written to get then and publish to the robot with the action to be executed. Figure 3 shows the system architecture. There are four algorithms (or topics, as they are called on ROS) to communicate with the robot:

- The topic `arm-myo` returns data from the sensors, received as integer numbers of eight bits; to keep the algorithm functional independent of which arm is being worn, or how it was positioned, the topic "armmyo" was created, publishing data in eight-bit integer numbers;
- To obtain the linear speed of the robot, the `qy-myo` was written, which converts the information from the IMU (pitch, roll and yaw) from the built-in gyro in the armband into numbers for the speed publisher; to control the linear speed in the PeopleBot's x axis, a method to normalize the data from pitch, roll and yaw (specific orientation in space) was defined, publishing only the pitch on "qymyo" topic, as the x position of a 3D vector (x,0,0), in which the maximum value assigned was 1 and the minimum -1. When passing by 0 it stops the robot;
- `yy-myo` allows to combine gestures, because without it, there are the limitation of five gesture controls. Combining the IMU with the gesture recognition gave a greater flexibility to increase the range of control. The technique was the combination between gesture and position of the arm. It publishes 64 bit float data to keep the script aware of the angular position of the arm;
- In order to send the original gestures, preset by Thalmic labs, the topic `gest-myo` publishes them into integer numbers of eight bits to the robot.

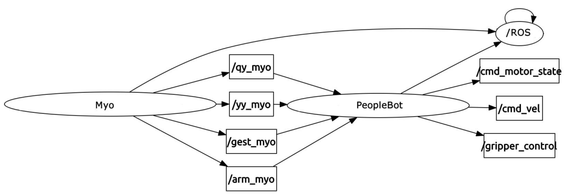

Figure 3: Operating flowchart between nodes of Myo and PeopleBot.

2.2 Robot Control

To allow the controlling of the robot, is necessary for Myo to be synchronized. This is done with the standard gesture from Thalmic Labs. The movement of the robot depends on the state of the motors, so for activate them we defined the fingers-spread gesture with angular information under 0.5. All the controlling of the robot depends on the angular position of the user's arm, defined by: Above 0.5: robot's gripper control, below 0.5: robot's movement control.

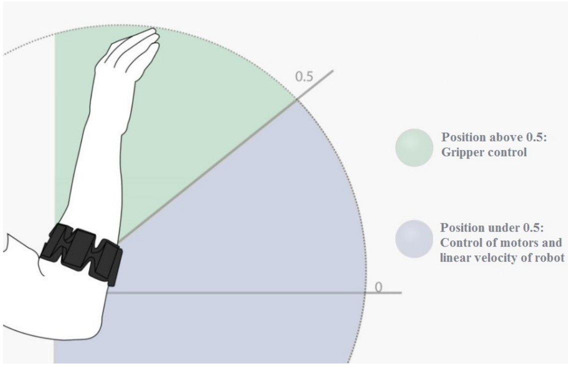

Figure 4: Illustration of the control area.

The movement of the robot was set through gestures as shown in figure 6:

- Fingers spread – enables and disable of motors;
- Fist – stops the robot;
- Wave in – turns the robot clockwise;
- Wave out – turns the robot anticlockwise;
- Double tap – enables linear movement of the robot. Figure 5 shows how to move the arm to control the robot velocity.

Gripper movements:

- Fingers spread – opens the gripper;
- Fist – closes the gripper;
- Wave in – raises the gripper;
- Wave out – lowers the gripper;
- Double tap – stops all movements.

3 RESULTS

With the study of PeopleBot's operation and the ROS platform, allied to the knowledge about Myo, it was possible to create a functional interface to the robot using the myoelectric technology. PeobleBot could be controlled to perform movements and grips.

One of the advantages of controlling computational applications with Myo is that the controlling response is very fast, furthermore, having a gyroscope, accelerometer and control of its raw data, despite the lack of gestures, can create combinations that overcomes some of this limitations, and is very practical/comfortable for user.

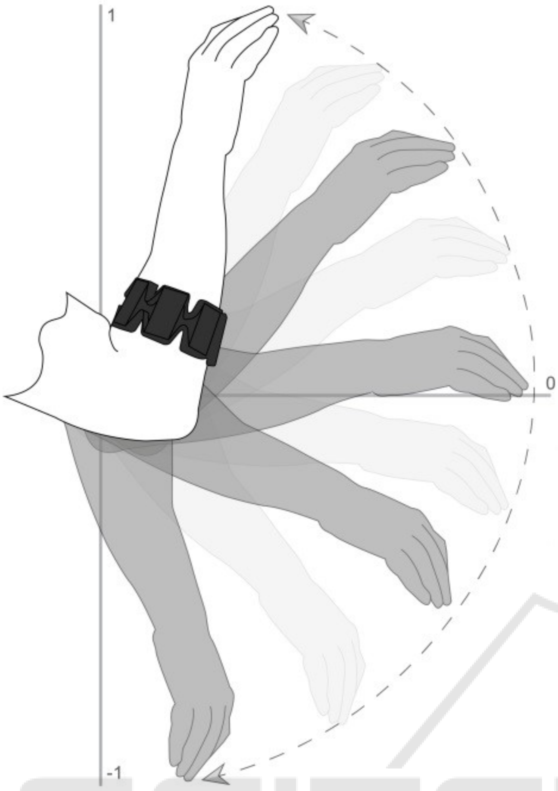

Figure 5: Example of arm motion to control the linear velocity.

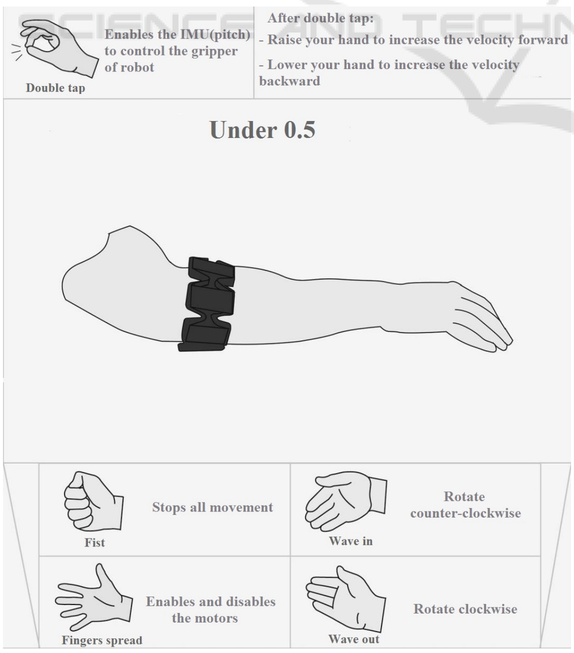

Figure 6: Illustration to control PeopleBot's motors and its movements.

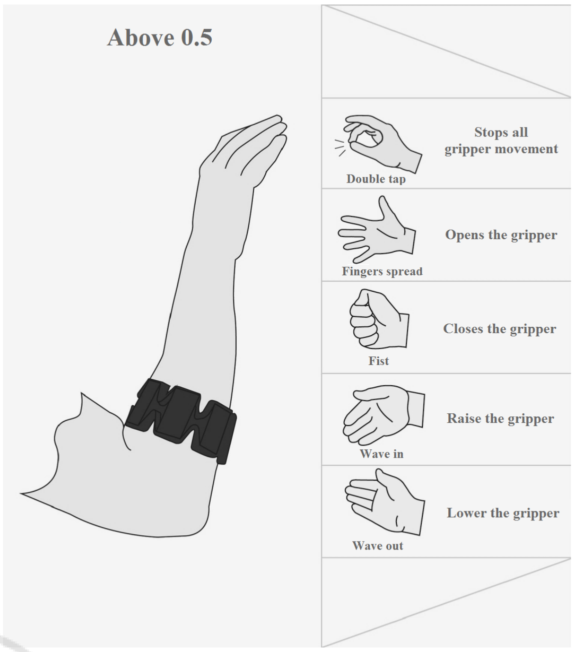

Figure 7: Illustration of gripper control.

To analyze how precise are the detection of movements by the software, some tests were executed on five volunteers. Before test begins, volunteers make the gestures a few times to be familiarized with movements and also to get the timing for performing each gesture. It needs a interval from one second between each one. After training time, users made 20 times each gesture in a random sequence. The mean classification rate to distinguish among movements was 93,6% which, determining an efficient scan of myoelectric signs by the hardware also due to feedback interaction with the robot.

During the creation process and the studies of the interface, we found some difficulties: For the number of tasks performed by the robot, we had few gestures available. Thus, it can be concluded that the gestural options offered by Myo are limited for controlling more complex devices. Another point noted was that the continuous use of the equipment can cause some muscle discomfort due to fatigue generated by the repetition of gestures, which also causes problems in the recognition of the data. Apparently, muscle fatigue causes different myoelectric signals to the gesture performed or just turns it more difficult to be recognized by the algorithm. Physical activity before the use of Myo seems to cause difficulty on determining the gestures as well.

4 CONCLUSION

This work was just one example of a huge range of things the Myo armband can do. Even considering the "young age" of this device, it is very useful, has an excellent acquisition and processing of signals, moreover, in the future it is possible that new gestures will be implemented and used to open a wider range of options for the user. Furthermore, the research should generate new information about the continuous use of myoelectric detection devices, the effects on the user and its limitations.

For next steps, we have more 15 volunteers to help us for creating new gestures recognition system using the same hardware Myo with a different classifier algorithm to improve its capabilities adding other gestures and after that apply it on another systems.

ACKNOWLEDGEMENTS

This study was produced with FEI, CAPES and FAPESP funding.

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