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Android application for mobile phones to communicate with Glove pattern and the FUM BIONIC HAND

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Abstract---**Ferdowsi University of Mashhad "FUM Bionic Hand" was built in the FUM robotics lab. This prosthetic hand is intelligent and has the ability to communicate wirelessly with computers. We have recently added new features, including a glove pattern to train the hand for shape grasping and also Android app for mobile that is an interface to transmit signal from the Glove and EMG received signal and to communicate with the prosthesis.This application is designed for disabled people to communicate and control their EMG signals received by the prosthesis. Thus disables can determine the threshold of incoming signal. As the EMG signal is variable and dependent on various conditions; in this method the disables can determine two ranges for the system: full contraction and relaxation. And to according to the condition the thresholds of the opening and closing of the fingers is determined by the software.**

Keywords: FUM Bionic hand; hand prosthesis; the glove pattern; Android App; EMG

I. INTRODUCTION

In the course of evolution of prostheses, using the DC motor has replaced the communication cable. They initially enjoyed a DoF but with the advancement of science, the degrees of freedom were added, and to move the optional finger, EMG signals were used [2]. Recently, artificial hands with the

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ability to move each finger independently are marketed. The first supplier of artificial hands is Touch Bionics Company whose product I-Limb is the design of Limb finger capable of independent movement. After this, RSL Steeper Company introduced the bionic hand. This hand is very similar to the I-Limb in terms of design, but its price is less than that of I-Limb and the company also launched software that interfaces with computer [3] [4]. On the other hand, in the area of research on prosthetic hand a lot of Work has been done. One example of such investment in research on these products belongs to the DARPA organization. In the past few years, the organization has decided to hugely invest on research prosthesis to help a large number of soldiers on the battlefield with disabilities. As a result of these investments was two hands of DEKA and APL. These two examples almost duplicate more things that a normal human hand can do to, they also have interface software with the prosthesis [5] [6]. The application recently added products and now used in prosthesis by users. So that each one has its own unique features. The “my I-limb™” mobile application will enable you to quickly and easily access and change features On I-limb devices, It can be noted that its features: here you can assign groups of grip patterns and triggers a single name to make them easily Accessible with a single tap You may also customize certain grip patterns by selecting “feature options“. For example, see Fig. 1, Also It should be noted that this software has ability to display the received signal and wireless communications with prosthesis [9]. Unfortunately no mobile app is used to control the BeBionic prosthesis. But the BeBionic prosthesis has a software to communicate with a computer. In addition, this app is functionally like previous app see Fig. 2, [10].

In the field of research projects And non-commercial sample used to record a sequence of forearm EMG potential signals through a PC sound card and a novel 3D electromagnetic positioning system together with a data-glove mounted with 11 small electromagnetic sensors used to acquire corresponding hand pose in real time. The synchronized measurements of hand posture and associated EMG signals stored as prototypes embody a numerical expression of the current hand shape in the form of a series of data frames, each comprising a set of postures and associated EMG data. This allows a PC generated graphical 3D model Fig.3, combined with synthesized EMG signals, to be used to evaluate the approach. This graphical user interface(GUI) could also enable handicapped users to practice controlling a prosthetic hand using EMG signals derived from their forearm muscles[11][12][13] and another used method of interface program is designing GIU by using of MATLAB[14][15].

Another group have designed skeleton arm and moving it in VRML and MATLAB [16].

In this method Motions supported by the current version of The system are: arm flexion/extension, arm adduction / Abduction and forearm flexion/extension. It’s present the Differences between VRML and Matlab. A computer System has been developed where a set of forces done by The muscles are parameterized and the limb motion Animation, in real time, is achieved through Biomechanics equations Fig.4, [16].

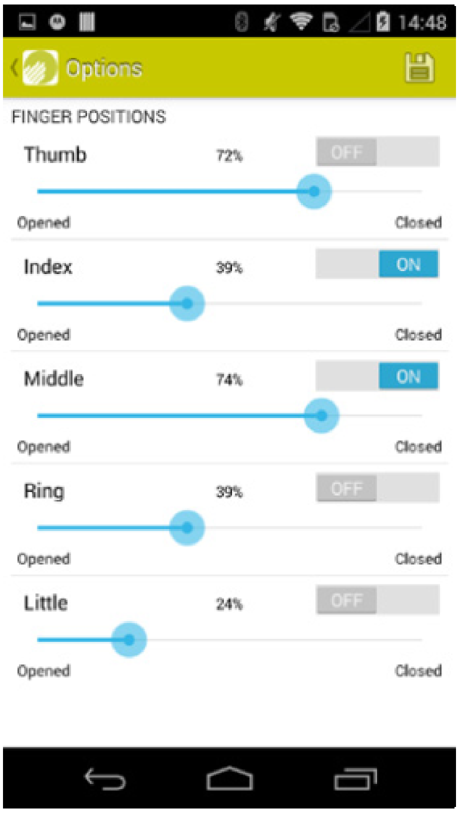

Fig.1.An example of I-limb mobile app

Fig.2.An example of BeBionic mobile app

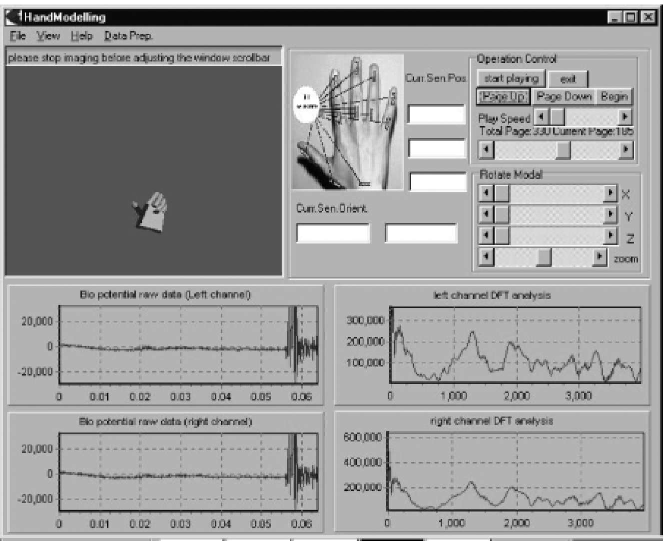

Fig.3. Graphical user interface of the simultaneous data recording

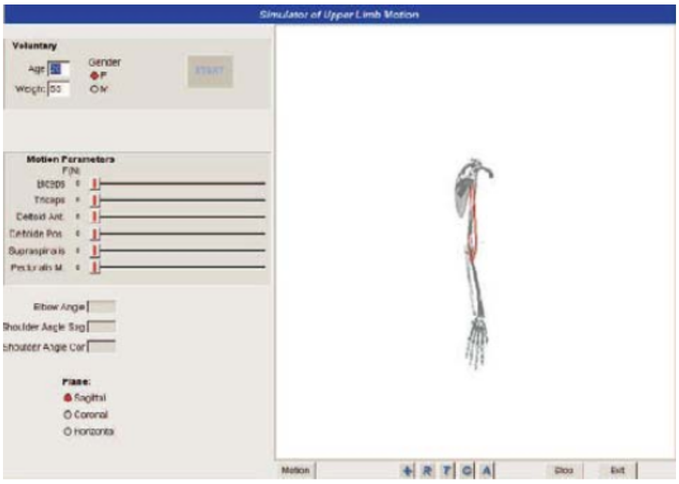

Fig.4. Human Upper Arm in a System Graphical User Interface.

II. Method

Prosthetic hand of FUM Bionic Hand has six DoF. Each finger has one DoF and another degree of freedom is to rotate the wrist. One of the most important features associated with their design is that all motors and electronic boards have been allocated in the palm and fingers are designed as two-knuckle. To couple the two knuckles of each finger, tendon mechanism is used. The thumb is designed in such a way that to be a degree of freedom and fixed base. To design a hand with dimensions close to those of human, the statistical data with measurements obtained from different parts of the hands were used. In the case of the DC motor required torque and speed in each fingers, the design was done in reference to relevant articles. In this case, the angular velocity of each joint of human hand is about 3 to 4 radians per second (approximately between 28.6 to 38.2 rotations per minute). Also a torque of approximately 193 (m N.m) was mounted in the DC motor [5]. One of the priorities when choosing the DC motor was its embedded functionality in the palm. Therefore and according to field research conducted, DC motor model series ZGA12 Zheng, a DC motor that almost has all our important criteria such as weight, torque, DC motor speed and optimal size, was selected to be used in the finger. This type of DC motor has a simple transmission of its output. The main advantage of this DC motor market is cheap and abundant. Tendons made from Nylon monofilament is selected. Certain types of Nylon monofilament to name monofilament as tendons are used. This type of fishing yarn made from plastic fiber. Monofilament in different thicknesses and tensile strength are made by extrusion [7] [8]. Electronic circuits made of artificial hand, is composed of two main parts, the first part of the main processor DC motor is the second part of the driver. In this circuit, because a lot of computational strain on the CPU, the processor must be used to be compatible with Multi-Tasking and to handle all the tasks. That's why STM32F407VGT6 controller that can process 210 million instructions per second is selected. One of the biggest challenges for circuit design, put 5 for 5 DC motor driver and measurement of them. L293 was used to solve the problem of drivers, these drivers that are on the market as SMD, compared to the smallest possible dimensions are the same. Muscle activity by measuring electrical potentials, is called EMG electromyography. EMG has long been a problem for medical research and diagnosis of neuromuscular been used. FUM Bionic Hand in Hand for hand-to-body relationship and take command of neuromuscular hands of a single-channel EMG module is used. In this report we discuss how to design artificially intelligent electronics systems. The system is composed of several different parts will be discussed in detail. Obviously this is still in the research stage. The ultimate goal is an electronic system designed to achieve an integrated electronic system for receiving electrical signals from muscles and strengthen and optimize it, and ultimately control the movement of the fingers of the artificial implant is proportional to the signals from the muscles. One of the ideas implemented in this system eliminates the extra wire for data transfer is Bluetooth used for communication so that we In general, designed an electronic system to follow the following procedure Fig. 5,

Fig.5. Connections of hand prosthesis

III. The performance of pattern learning system:

To implement this, bending sensors is used to detect the bending of fingers. So, for each finger two bending sensors were placed one at the top and one at the bottom of the finger so that we can extract the exact position of the finger and we sampled it for later use. Obviously, this sensor information must be passed to another system for storage and later use. For this purpose, we've stored all positions and pattern through FUM Bionic Controller software. A unique code is generated for each new model and it allows the users to store a large number of tags for this hand pattern via their NFC mobile phones or the main processor circuit. And then every time hand gets closed to the tag for which this unique code is stored, artificial hand recognizes object and change the fingers to its relative position so that the user is able to take and move the intended object by the artificial hand. Smart Glove and related software are shown in Fig. 6, and Fig. 7,

By using this method, one of the main problems of prosthetic hand which is adding arbitrary pattern to artificial prosthesis disappears, and users can save a specified pattern for each object depending on conditions and environments with which they work, so they are able to use it easily in later use. For the convenience of the user, this glove is designed to be fully portable so that it is fed through a 3.7 volt lithium polymer batteries, and information transmission is done via a high-speed Bluetooth module to establish a uniformity between mobile and Glove and in addition the technique makes the tool user friendly and will be of great help to people with disability. Bending sensors are used to detect finger bending, this sensor due to its resistance, which is variable from the 0 to 200 KΩ, provides a proper accuracy in detecting the position of the fingers. In addition to extending battery life STM32F103CBT6 Glove Low consumption from a microcontroller is used. This speeds up to 72 MHz micro can operate, speed and accuracy to the user will see the total devastation caused by long time reduced. View of the application can see in Fig. 8.

Fig.6.Glove and its relationship with the mobile app

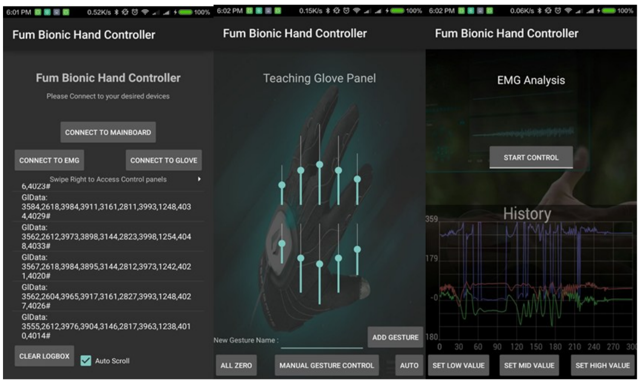

Fig.7. screenshot of mobile app in the above image

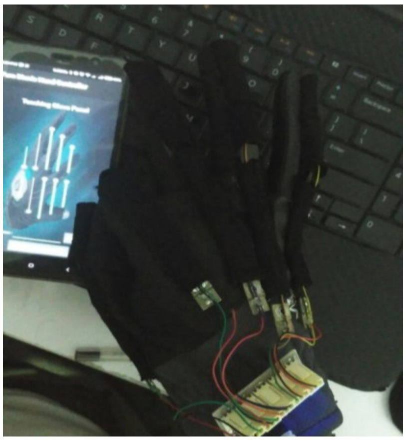

Fig.8.View of glove and the application

IV. CONCLUSION

To create a smart prosthesis, initially we require detailed studies on different scientific fields. After our time in about 14 months to design and implement paid prosthesis. Prototypes will appear in many of the flaws that an important factor in making the final samples with minimal error. With a simple comparison is obvious that prostheses are almost stable trend and FUM Bionic Hand is also in the process of constant and original. After designing the prostheses, it is time to design interfaces with prosthetic parts that can be more convenient, programmable and efficient. Therefore, the best option is to use the equipment and the bond between them. Due to the increasing proliferation of smart phones, using this technology to enhance various systems is the best option.

REFERENCES

[1] Haqqani, M. F., Factors related to the quality of life of people with disabilities with lower limb amputation. Iran Journal of Nursing, 32-44. 2012

[2] MIGUELEZ, J. Upper Extremity Prosthetics. In Care of the Combat Amputee, 611-613. 2009

[3] Advanced Arm Dynamics. BeBionic V2. Retrieved from: Advanced Arm Dynamics: http://www.armdynamics.com/caffeine/uploads/files (2012)

[4] Touch Bionics. I-Limb Features. Retrieved from: touchbionics: http://www.touchbionics.com/products/active (2012).

[5] Skyler A. Dalley, Tuomas E. Wiste, Thomas J. Withrow, Michael Goldfarb, "Design of a Multifunctional Anthropomorphic Prosthetic Hand with Extrinsic Actuation", IEEE/ ASME Transactions on Mechatronics, 2009

[6] DEKA Research. The DEKA Arm. Retrieved from DEKA Research: http://www.dekaresearch.com/deka_arm.shtml, 2009.

[7] Dillow, C. DARPA's Brain-Controlled Robotic Arm Fast-Tracked, Could Be Available in Just Four Years. Retrieved from PopSci: http://www.popsci.com/science/article/2011-02/darpasbrain-controlled-robotic-arm-could-be-available-just-four-years (2011, 2 10).

[8] Saranjam, A. A. Construction of the possibility of using natural fiber composite materials instead of fiber glass. The Sixth National Conference and the International Conference on Waste Management, p. 268-277. Tehran: Civilica, 2012

[9] Touch Bionics Inc" .My i-limbt ", part 2,Touch Bionics Inc, 57-1, 2015. <http://www.touchbionics.com/sites/default/files/files/my20% I_limb20%revolution20%Andriod20%guide20%March20201 5%_0.pdf>.

[10] BEBIONIC STEEPER" .BIBIONIC TECHNICAL MANUAL ".*BIBIONIC TECHNICAL MANUA*T PART 2, SAN ANTONIO: STEEPER, 40-1, 2015 HTTP://BEBIONIC.COM/UPLOADS/FILES/TECH_MANUAL_MEDIUM_AND_LARGE_HANDS.PDF

[11] SATYAJIT BHOWMICK, RAJESH BAG,SK MASUD HOSSAIN.MODELLING AND CONTROL OF A ROBOTIC ARM USING ARTIFICIAL NEURAL." IOSR JOURNAL OF COMPUTER ENGINEERING (2013): 49-42.

[12] Y. Su, C. R. Allen, D. Geng, D. Burn, U. Brechany, G. D. Bell, and R. Rowland, "3-D motion system ("data-gloves"): application for Parkinson's disease," *IEEE Trans. Instrum. Meas.*, vol. 52, no. 3, pp. 662–674, Jun. 2003

[13] J. S. Bladen, "Imaging medical endoscopes in 3-D using magnetic fields," Ph.D. dissertation, Sheffield Univ., Sheffield, U.K., Sep. 1995

[14] I.M. Rezazadeh, M. Firoozabadi, H. Hu and M. Reza Hashemi Golpayegani, "Co-Adaptive and Affective Human-Machine Interface For improving training performances of virtual myoelectric forearm Prosthesis", IEEE Transactions on affective computing, Vol. 3, No. 3, 2012, pages 285-297.

[15]A ".Valentin Grecu, Luminita Grecu, Mihai Demian and Gabriela Demian ".Virtual System for Simulation of Human Upper Limb 2009, *WCE*london: Proceedings of the World Congress on Engineering, 2009.

[16] Yu Su, Mark H. Fisher, Andrzej Wolczowski, G. Duncan Bell, David J. ".Towards an EMG-Controlled Prosthetic Hand Using" .Burn, and *IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT,2007*