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Interface and display of Electromyography signal wireless measurements

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***Abstract*-This paper had explained an interface and display system of Electromyography signal results from wireless measurements method.the interface by using bluetooth as connection from Electromyography measurement device which used to measure human skeletal muscle activities. Electromyography device display results from human skeletal muscle measurement. The results would be transfered by bluetooth to displayed in gadget application(e.g notebook, smartphone, tablet, netbook, etc.) . The application we were used is Virtual Analyzer on Windows operating system and AED in Android operating system. The use of two application is intended that the results of electromyography signal could be seen and accessed on most operational system platform which used by gadgets. Finally, after wireless interface and the display of Electromyography signal had been described, then conducted experimental measurements toward 10 people in two difference parts of body for example shoulder and stomach .There were sample and proof that human muscle generates electricity when strained or contracted.**

Key words: Electromyography signal, interface, display, measurements

I. INTRODUCTION

In the era of rapid development of technology has great influence in the development of electromedical as a part from biomedical world, especially on *Electromyography(EMG)*.That Influence has changed the system of electromyography device become simpler than before.

Electromyography signal is a biomedical signal that is obtained via electrical response generated in muscles during its contraction representing neuromuscular activities.[1]To obtained a good results of *EMG* measurements there are several steps that must be considered especially the measurements step was important one to attention, commonly surface *EMG* method is the common method of measurement[2]

The usage of wireless measurement interface is based on variety of benefits that have been obtained[3], in this case bluetooth as the connection between Electromyography measurements device and the viewer gadget of electromyography signal measurement results.The main benefits is *Bluetooth 2.0* connection could eliminate the disadvantages owned by cable connection/interfaces[3]

Windows and *Android* were selected as application display of *EMG* signal measurement results because both of them is the operating system mostly used in gadgets(*Windows* had 95% marketshare in PC, Notebook, Netbook operating system, while *Android* had 62.6% marketshare in tablet and smartphone).[4][5]On the experiments that have been done , we used the *VA(Virtual Analyzer)* application for *Windows* operating system platform and *AED(Android Electromyograph Display)* application for *Android* operating system platform.

We have conducted experiments of electromyography signal measurements on several parts of the body muscles with the used of electromyography measurements device that has been made to saw the electrical signals that can be produced by body muscles when contracted.

II. RESEARCH METHODS

2.1. Electromyography

Electromyography (EMG) is a method an experimental technique used to record electric signal which produced by human muscle fiber.[6]*Electromyography* is used to measure the electrical activity generated by movement of substances Na^+ and K^+ inside body muscle tissues[7]There are two methods of *EMG* measurements: surface measurements and intramuscular measurements, we have chosen the method of surface measurements on the experiments we have done with the reason that the measurements on the skin surface of the subject, can be conducted by personnel other than medical Doctors, with minimal risk to the subject.[2] Therefore the measurement steps must be considered, such as skin preparation for measurements and the electrode unit, the preparation of the skin surface prior to measurement by eliminating obstacles such as skin hair, sweat, bacteria, etc. These obstacles can be removed by the use of abrasive cleaning paste, soft sand paper, and alcoholol[2].Then

an electrode itself as considered an electrode consisted a highly conductive metal, silver, interfaced to its salt, silver chloride, Silver–silver chloride based electrode design is known to produce the lowest and most stable junction potentials[6].This electrode is showe on figure 1 is produced by *Biomed* manufacturer.

Fig. 1. Silver-silver chloride based EMG electrodes(on the left side is solid form and on the right side is gel form)

2.2. *Electromyography* measurement devices

The *Electromyography* measurements that had been made, operate in a way, the input signal from EMG surface measurements amplified by AD 620 IC, an operational amplifier with a gain value of the input value 10000 times after the *EMG* signal is amplified by 10000, the signal was then amplified again through OP 07 IC with the use of cermet as a regulator of the value of strengthening in order to smoothing the ripples that appear on the signal wave, resulting from the strengthening of AD 620 IC, so the EMG signal measurement results can look more refined. Both of them located in the *Electromyography* measurement device as the pre-amplifier and supplied by 2x9v batteries and the power supply already regulated by the regulator as required by IC.The input signal must be amplified because the actual input signal from the EMG skin surface measurements typically from a few μV to tens peak to peak[8][9].The EMG recording should not use any hardware filters (e.g. notch filters) because EMG has large signal contributions at these mid-frequency frequencies. The result of notch filtering is the loss of important EMG signal information, so notch filtering should be avoided as a general rule.[2]

The figure 2 shown *EMG* measurements device and the electrode unit that we had made

Fig. 2. *EMG* measurements device

On figure 2 above described about parts inside *Electromyograph* measurements device ,for further explanation of the entire process of *EMG* measurements from electrode unit to the display application unit , described as block diagram process in figure 3

Fig. 3. *Electromyograph* measurements block diagram

On the figure 2 above V1,V2,and ground as the electrode , and the AD 620 as the amplifier to amplified input signal before passed to the filter and then transferred by bluetooth in wireless interface to showed in the display application(*Virtual Analyzer AED*).

2.3. Wireless interface measurements

Wireless interface was selected as the connection between the measurements unit and the display unit because this interface had manny advantages over cable interface as thought wireless interface already had it's own network so without any interference with other networks, then low power transmission needs so can longer life of the device power supply and the time used to perform measurements[10]. *Bluetooth 2.0*(A2DP/Advanced Audio Distribution Profile) were selected as wireless interface due to the reasons that have been presented above, plus the advantages of A2DP networks that can connect a wide range of electronic hardware without specific programming.[11]Figure 4 shown *Bluetooth 2.0* device that is used as a wireless interface

Fig. 4. Bluetooth2.0 (A2DP/AdvancedAudioDistributionProfile) headset

2.4 Display unit

The display unit using *Virtual Analyzer* application has function in addition to the main function is to show electromyography signal measurement results, so that can be read easily by nonmedical person. *Virtual Analyzer* also can filtering the EMG signal measurement results by using the digital filter, in *EMG* signal processing, band pass filter and high pass filter is selected, the band pass filter is selected because the *EMG* signal frequency is dominant in 50-500Hz bandwith frequency spectrum, and then high pass filter is used in order to remove DC noise because any difference in the D/C potential measured at the each of the electrode sensors will be amplified, which can lead to pre-amplifier instability or saturation [9]. In figure 5 would be shown menu to select the digital filter option provided by *Virtual Analyzer* application.

Figure 5. *Virtual Analyzer* digital filter option menu

After the digital filter option is set, then the EMG signal measurement results can look more refined, the figure 6 shown *Virtual Analyzer* display application that runs on the *Windows* operating system platform, the *Virtual Analyzer* was displaying *EMG* signal when body muscle relaxed.

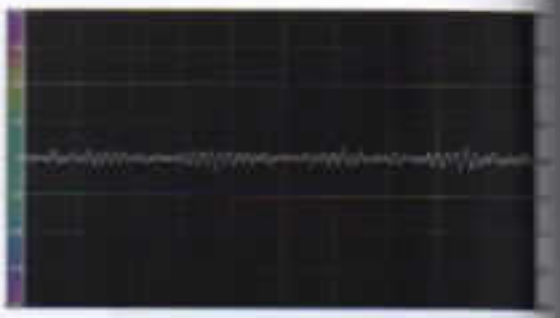

Figure 6. *Virtual Analyzer* displaying body muscle when relaxed

And on the figure 7 shown *Virtual Analyzer* display application was displaying *EMG* signal when body muscle contracted

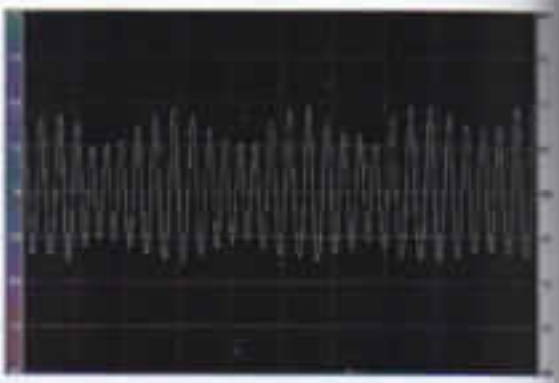

Figure 7. *Virtual Analyzer* displaying body muscle when contracted

EMG signal measurement results are also displayed on *AED* display application that runs on the *Android* operating system platform, in figure 8. shown *AED* display application displaying body muscle when relaxed

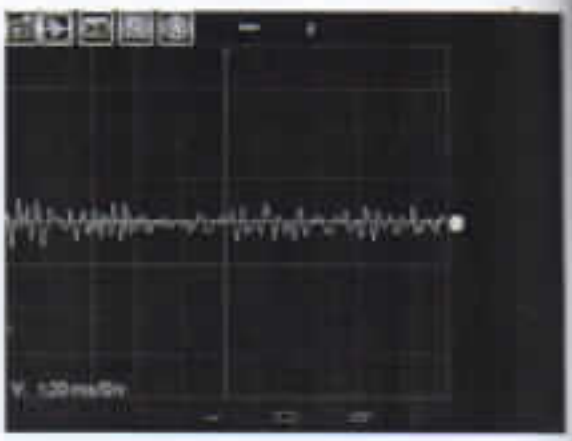

Figure 8. *AED* displaying body muscle when relaxed

Then, the figure 9. shown *AED* display application displaying body muscle when contracted

Figure 9. *AED* displaying body muscle when contracted

III. EXPERIMENTAL RESULTS

Based on the various of research metodologies in that have been described in the previous chapter, we conducted experiments measuring an *Electromyographic* signal, as in figure 9 shown on electromyograph measurements experiments that have been carried out by the method skin surface of the body measurements, first in figure 9 *EMG* measurement experiments conducted on shoulder skin's surface with the electrode placement configurations

Fig. 10. *EMG* measurements on shoulders skin surface

Then in figure 10 is shown the experimental measurements performed on the stomach skin surface, with electrode placement configurations

Figure 11. *EMG* measurements on stomach skin surface

From figures 9 and 10 are shown above, the *EMG* measurement experiment performed on the two parts of the body to the 10 participants in our department, the table 1 shown the results of Electromyography experimental measurement

Table 1. Results of *Electromyography* experimental measurement

No.	Name	Electromyography signal activities measurements (millivolts) in (V)			
		Shoulder		Stomach	
		Relaxation	Contraction	Relaxation	Contraction
1	Participant 1	0.2	2.1	0.6	2.4
2	Participant 2	0.3	1	0.2	0.6
3	Participant 3	0.15	1.8	1	1.6
4	Participant 4	0.2	1.4	1.2	2.4
5	Participant 5	0.35	0.65	0.8	1.3
6	Participant 6	0.3	2.2	1.2	1.8
7	Participant 7	0.6	1.7	0.45	0.85
8	Participant 8	0.3	1.8	0.2	1
9	Participant 9	0.25	1	0.4	1.2
10	Participant 10	0.15	2.6	1	1

From the measurement results in the table 1 above, is influenced by various factors on the surface of the skin condition participantfat thickness, impendance, muscle fatigue, etc.). Experimental results of the EMG measurements is calculated by measuring the difference between the highest peaks and the lowest valleys of the wave signal measurement results are displayed by *Virtual Analyzer* or *AED* display application.Calculation of this *EMG* signal measurement results, based on a variety of reference that have been searched and the research that has been done[2][7][8][9][12]. The figure 11 and 12 are shown the highest peak and lowest valleys of the *EMG* signal measurement results, when the muscle relaxedFig. 11and the muscle contractedFig. 12)

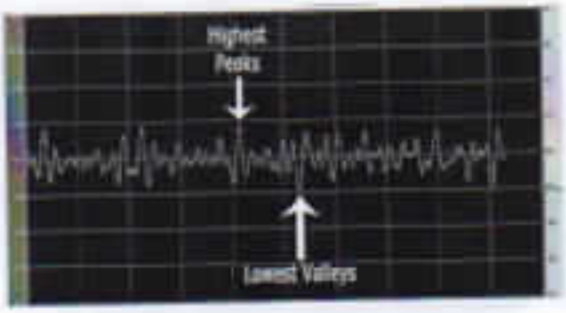

Fig. 12. the highest peaks and the lowest valleys of EMG signal measurement results when the muscle relaxed

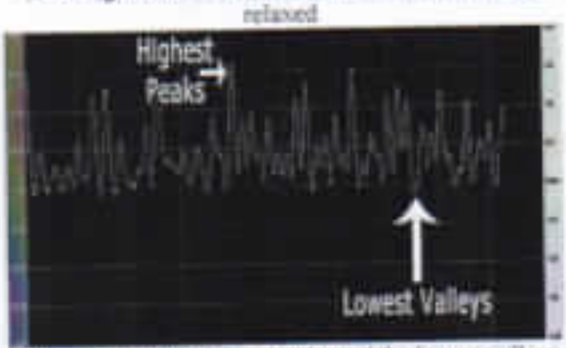

Fig. 13. The highest peaks and the lowest valleys of *EMG* signal measurement results when the muscle contracted

IV. CONCLUSION

From the results of experiments that have been conducted, it can be concluded that the EMG signal measurement results have an average value of the difference between relaxation and contraction is greater, when the EMG measurements were done on the shoulders of the participant compared with the average value of the measurement signal on the stomach, it is proposed to prepare it beforehand the various steps that must be considered before the *EMG* measurement performed, such as on the electrode, the condition of the skin surface of the body and the condition of EMG measurement device to get a good measurement result.

V. ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

Cover
Greetings and Thanks from the General Chair
Foreword from Head of Department of Electrical Engineering,
Foreword from Dean, Faculty of Engineering
Organizing Committee
Steering Committee
Technical Program Committee
Keynote Speaker's Biography
Conference Program
Keynote's Papers
Author Index

KEYNOTE SPEAKERS

I-1 Multi-User MIMO Wireless System -From Theory to Chip Design 1
Prof. Hiroshi Ochi

I-2 Challenges and Opportunities in Designing Internet of Things 11
Prof. Dr. Trio Adiono

I-3 Role of Telecommunication Satellite in Indonesia 13
Adi Rahman Adiwoso

CIRCUITS AND SYSTEMS

CC1 Enhancement of DRAMs Performance using Resonant Tunneling Diode Buffer 14
Ahmed LutfiElgreatly, Ahmed AhmedShaaban, El-Sayed M. El-Rabaie

CC2 Real-time SoC Architecture and Implementation of Variable Speech PDF based Noise Cancellation System 19
Aditya Ferry Ardyanto, Idham Hafizh, Septian Gilang Permana Putra, Trio Adiono

CC3 Application of Supervised Learning in Grain Dryer Technology Recirculation Type Cooperated with Wireless Sensor Network 24
Sidiq Syamsul Hidayat, TotokPrasetyo, Amin Suharjono, Kurnianingsih, Muhammad Anif

CC4 Design of Real-Time Gas Monitoring System Based-on Wireless Sensor Networks for Merapi Volcano 28
B. Supriyo, S.S.Hidayat, A. Suharjono, M.Anif, Sorja Koesuma

CC5 ANFIS Application for Calculating Inverse Kinematics of Programmable Universal Machine for Assembly (PUMA) Robot 33
Hugo Adeodatus Hendarto, Munadi, Joga Dharma Setiawan

CC6 MRC NN Controller for Arm Robot Manipulator 39
Hugo Adeodatus Hendarto, Munadi, Joga Dharma Setiawan

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CC7	Development of Microcontroller-based Stereoscopic Camera Rig Positioning System *Julian Ilham, Wan-Young Chung*	44
CC8	Design of A Digital PI Controller for Room Temperature on Wireless Sensor and Actuator Network (WSAN) System *Bambang Sugiarto, ElanDjaelani*	50
CC9	Display and Interface of wireless EMG measurements *Kevin Eka Pramudita, F. Budi Setiawan, Siswanto*	56
CC10	Accuracy Enhancement of Pickett Tunnelling Barrier Memristor Model *Ahmad A. Daoud, Ahmed A. Shaaban, Sherif M. Abuelenin*	61
CC11	Data Fusion and Switching Function For UAV Quadrotor Navigation System *Muhammad Faris, Adha Imam Cahyadi, Hanung Adi Nugroho*	66
CC12	Data logger Management Software Design for Maintenance and Utility in Remote *Devi Munandar, Djohar Syamsi*	72
CC13	Investigation of Electrical Properties of NanofibrePolyaniline Synthesize as Material for Sensor *Ngurah Ayu Ketut Umiati, Siti Nurrahmi, Kuwat Triyana, Kamsul Abraha*	77
CC14	Reconfigurable Floating Point Adder *Vipin Gemini*	81
CC15	HOVER POSITION CONTROL WITH FUZZY LOGIC *Nia Maharani Raharja ,Iswanto, Muhammad Faris, Adha Imam Cahyadi.*	87
CC16	METHODOLOGY OF FUZZY LOGIC WITH MAMDANI FUZZI MODELS APPLIED TO THE MICROCONTROLLER *Indra Sakti*	91
CC17	Fall Detection System Using Accelerometer and Gyroscope Based on Smartphone *Arkham Zahri Rakhman, Lukito Edi Nugroho, Widyawan, Kurnianingsih*	97
CC18	Design and Implementation of Sensor Fusion for Inertia Measurement on Flying Robot Case Study: Hexacopter *Huda Ubaya, Afdhal Akrom*	103
CC19	Triple Band Bandpass Filter With Cascade Tri Section Stepped Impedance Resonator *Gunawan Wibisono, Tierta Syafraditya*	109
CC20	Temperature Response Analysis Based on Pulse Width Irradiation of 2.45 GHz Microwave Hyperthermia *Imam Santoso, Thomas Sri Widodo, Adhi Susanto, Maesadjie Tjokronagoro*	113

IMAGE PROCESSING AND MULTIMEDIA

IP1	Visual Object Tracking using Particle Clustering *Harindra Wisnu Pradhana*	117

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