Microcontroller Based Data Acquisition Card Design and Implementation for Disabled People Using sEMG

Hasbi APAYDIN, Şükrü KİTİŞ, Rüştü GÜNTÜRKÜN

***Abstract* — In this study, data were collected from the muscle cheeks and cheeks around the eyes with using three sEMG electrodes which are known as analog sEMG sensor. These analog data were converted to digital data with designed microcontroller based data acquisition card. Digital data were evaluated with Visual Basic in each case separately when eyes were open, eyes were close, eyes were blinking, eyes were twice blinking, eyes were three times blinking.**

***Index Terms* -- sEMG, Blinking, Microcontroller, Disabled People**

I. INTRODUCTION

Human body is an electrical conductor. Chemical reaction in human body will produce a small electrical change. In addition, the characteristics of the electrical signal in the muscle change while electromyograms signal also known as EMG signal is detected [1-2].Electromyography is an experimental technique concerned with development, recording and analysis of myo-electric signals [2].POO and Sundaraj developed a signal acquisition circuit and plotted the pre-processed signal on computer screen for analysis [3]. Motor unit is a group of impulse signals and it is essential for generating an EMG signal. The nerve impulses stimulating contraction are carried through nerve by bundles of wire-like motor neuron from brain to muscle [4].Tepe at all have investigated usefulness of extraction of the surface electromiyogram (sEMG) features from multi-level wavelet decomposition of the sEMG signal [5].

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II. EXPERIMENTAL METHODS

A. EMG (Electromyography)

Bioelectrical signs are observed as a result of electrochemical reactions in cell structure. Normally, there is a potential electrical difference between extracellular and intracellular forms of all cells. This potential difference is used for starting and stimulating cell functions. Stimulated muscle cells form action potential like nerve cells. If a muscle is stimulated while staining, action potential formed in muscle fibrils spreads through the muscle fibrils. Action potential of a group of cell can be detected via various methods. These methods are intramuscular EMG and sEMG [6].

Intramuscular EMG

Intramuscular EMG is a measurement technique which is used for measuring electrical activity of a muscle with a special intramuscular electrode. Intramuscular EMG is specially used when an EMG specialist can not make a proper diagnosis on the patient's motor and sensory conduction such as traumatic spinal cord injuries and muscle illnesses [7-8].

sEMG (surface EMG)

sEMG is a technique which enables straining a muscle, applying faradization. A surface electrode is placed on the muscle and electrical activity equalling to the spasm is measured. Electrical activity on a wide surface can be measured via sEMG [9].

B. EMG Measurements

Instrumentation amplifier, band pass filter, notch filter, precision full wave rectifier and low pass filter [10] are required for EMG measurement [figure 1].Human body produces analog signals. These signals have low amplitude and high frequency. Because of the fact that the signals received through electrodes have low amplitude and high frequency, they are amplified, filtered, rectified, saved and showed on the monitor or papers.

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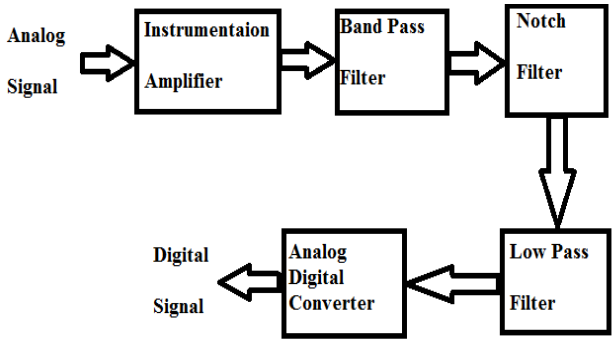

Fig 1. EMG block diyagram.

C. *Analog sEMG Sensor, Designed Data Acquisition Card and Interface*

In the study, sEMG sensors, microcontroller based a data acquisition card and visual basic based interface were used instead of filters and rectifier.

The device designed with three inputs (figure 2) called as sEMG sensors producing analogue signals [17].These sensors are compatible with arduino and microcontroller which is powered 5 V D.C.

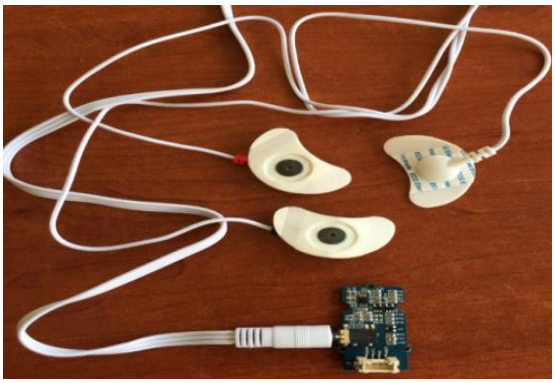

Fig 2. sEMG sensor.

Acquisition Card (figure 3) was designed with microcontroller PIC18F2550 (figure 4) which has analog signals converted to digital signals and USB communication features [12-13-14-15-16]. The card is powered 5 V D.C.

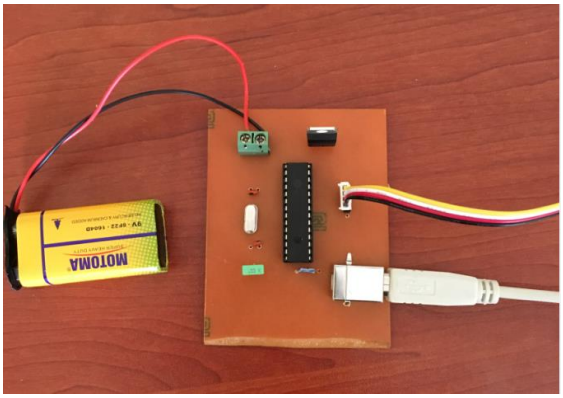

Fig 3. Acquisition Card.

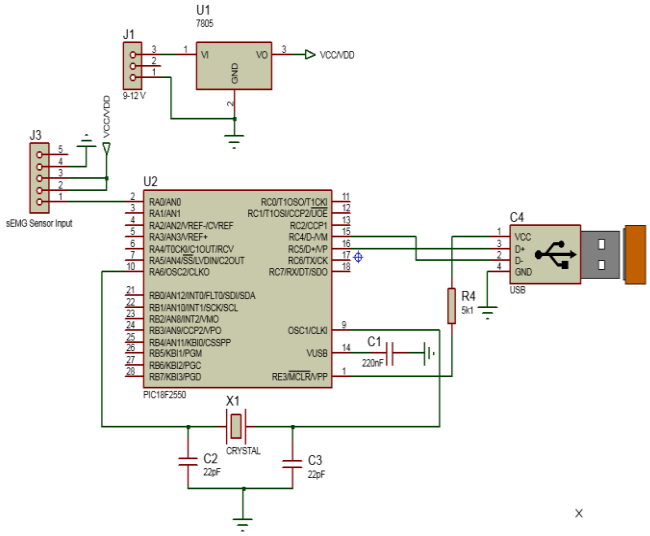

Fig 4. Acquisition Card Design.

Interface (figure 5) was designed with Visual Basic with EMG measurement scale, start, stop, reset and connection buttons.

III. EMG SIGNALS, ANALOG SIGNALS, DIGITAL SIGNALS

EMG signals are high frequency signals which have 10-5000 Hz frequency and 50 µV-30 mV amplitude [11]. There are two types of EMG: surface EMG and intramuscular EMG. Surface EMG assesses muscle function by recording muscle activity from the surface above the muscle on the skin. Surface electrodes are able to provide only a limited assessment of the for muscle activity. Surface EMG can be recorded by a pair of electrodes or by more complex set array of multiple electrodes [12].

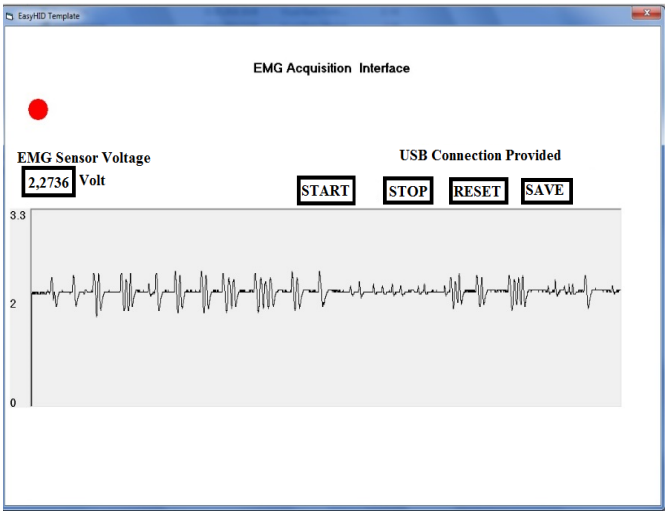

Fig 5. Interface.

IV. FINDINGS AND CONCLUSIONS

Electrodes were placed on the check, forehead and around the eyes (figure 6). The measurements were performed in each case as once blinking, twice blinking, three times blinking, four times blinking and normally blinking (table 1).

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Fig 6. sEMG Measurement.

TABLE I

SYMBOLS AND MEANS

Symbols	Means
a	Once blinking
b	Twice blinking
c	Three times blinking
d	Four times blinking
e	Normally blinking

The results of measurement were saved and showed interface which designed with visual basic (figure 7). Additionally, the data obtained will be used in control panels such as wheelchair controller, light controller, computer controller in further studies.

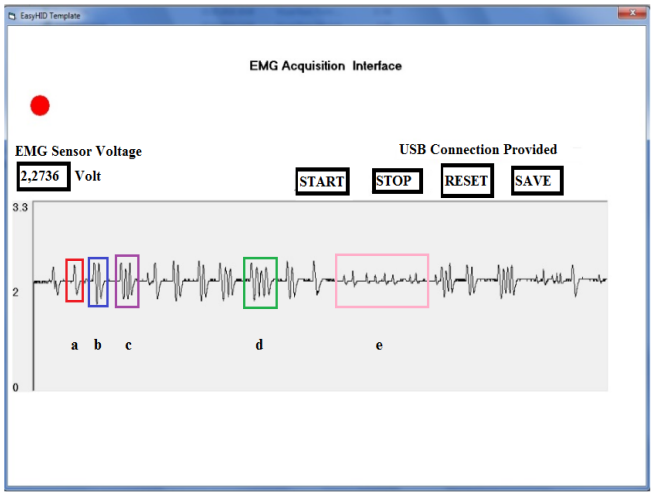

Fig 7. Results of measurement.

REFERENCES

[1] J. D. Bronzino, "*The Biomedical Engineering Handbook, Biomedical Engineering Fundamental*", 3 Group. Pg 25-1

[2] P. Konard, "*The ABC of EMG a practicle introduction to Kenesiological Electromyography*," Noraxon INC.USA, version 1.0, April 2005.

[3] T. S. Poo, K. Sundaraj "Design and Development of a Low Cost EMG Signal Acquisition System Using Surface EMG Electrode", *IEEE Asia Pacific Conference on Circuits and Systems (APCCAS) , Dec, 2010*

[4] W. W. Campbell. *Essentials of Electrodiagnostic Medicine*. Williams & Wilkins, Baltimore, Maryland, 1999.

[5] C. Tepe, İ. Eminoğlu, N. Şenyer, "Feature Extraction of Wavelet Transform for sEMG Pattern Classification", *2014 IEEE 22nd Signal Processing and Communications Applications Conference (SIU 2014).*

[6] U. Mayetin, S. Küçük, Ö. Şayli "EMG Kontrollü Mobil Robot Uygulaması", *Medical Technologies National Conference (TIPTEKNO), 2015, IEEE*

[7] M.S.Baghini, R. K. Lal, D. K. Sharma, "An ultra low-power cmos instrumentation amplifier for biomedical applications.", *Biomedical Circuits and Systems, 2004 IEEE International Workshop , DOI: 10.1109/BIOCAS.2004.1454082*

[8] C.L.Hsu, M. H. Ho , Y. K. Wu , T. H. Chen," Design of Low-Frequency Low-Pass Filters for Biomedical Applications", *Circuits and Systems, 2006. APCCAS 2006. IEEE Asia Pacific Conference, DOI: 10.1109/APCCAS.2006.342101*

[9] M.H.Asyalı, S.Kara,B.Yılmaz, "*Biyomedikal Mühendisligin Temelleri*, NOBEL Akademik Yayıncılık,2014, 978-605-133-943-6

[10] M.H. Khan, A. Wajdan, M. Khan, H. Ali, J. Iqbal, U. Shahbaz, N. Rashid "Design of Low Cost And Portable EMG Circuitry For Use in Active Prosthesis Applications" *Robotics and Artificial Intelligence (ICRAI), 2012 International Conference on IEEE*

[11] B.Noyan, Thoracic Outlet Syndrome Pathophysiology, www.toraks.org.tr/Download.aspx?book=1779

[12] Texas Court of Appeals, Third District, at Austin, Cause No. 03-10-673-CV. April 5, 2012

[13] Altınbaşak O. "*PicBasic Pro ile PIC programlama*" Altaş Yayınları, İstanbul, 2005

[14] Gümüşkaya H. *Mikroişlemciler ve 8051 Ailesi Donanım,Programlama ve Uygulamalar*" Alfa Yayıncılık, 1998

[15] Predko M. "*Programming and Customizing PIC Microcontrollers*" McGraw Hill, 2001

[16] PIC18F2455 Data Sheet. Available: http://ww1.microchip.com/downloads/en/DeviceDoc/39632b.pdf

[17] Grove EMG Dedector. Available: http://www.seeedstudio.com

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