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EOG Based Low Cost Device for Controlling Home Appliances

Aswin Raj V[#1], Karthik Raj V [#2]

[#1]Department of Biomedical Engineering, SRM University, Kattankulathur, Chennai, Tamilnadu, India.

[#2]Department of Biomedical Engineering, SRM University, Kattankulathur, Chennai, Tamilnadu, India.

ABSTRACT—Paralysis is one amongst the major neural disorder that causes loss of motion of one or more muscles of the body, wherein depending on the cause, it may affect a specific muscle group or region of the body, or a larger area may be involved. In pursuit of rehabilitation, the eye can be regarded as one of the organs that can help a paralyzed person to communicate suitably. Eye movement can be used by the paralysis patients and armless persons to perform simple tasks. This paper describes the acquisition and analysis of EOG signals for activation of home appliances for paralysis patients. The proposed method here uses a minimum number of electrodes for signal acquisition thereby reducing the occurrence of artifacts, further following a simple circuitry for implementation of signal conditioning which is also cost effective from the user point of view. The standing potentials in the eye can be estimated by measuring the voltage induced across a system of electrodes placed around the eyes as the eye-gaze changes, thus obtaining the EOG. And this EOG signal can be used as an input for a microcontroller in order to control home appliances.

KEYWORDS— Paralysis, EOG, Electrodes, Artifacts, Microcontroller.

I. INTRODUCTION

Paralysis has been commonly referred to the complete or partial impairment of the body function due to the loss of mobility of the muscles or nerves of the body. The predominant causes of paralysis range from stroke, cerebral palsy, multiple sclerosis and spinal cord injury that prevails the rest. According to a study, there are 1 in 50 people living with paralysis that approximates to be around 6 million people.[1] It means that we all know someone a brother, sister, friend, neighbour, or colleague, living with paralysis. In order to regain the function and independence following the disease, different mobility aids and medications have been brought into light in hands with the technology.

In the past few decades, various classes of bio signals have been used which have contributed a key role in the rehabilitation of the disabled. From these, for the purpose of communication and control, especially for those with eye motor coordination, Electro-oculogram is considered to be the most convenient signal over the others due to many factors.

EOG signal is based on the dipole within the eye. It is commonly known as the electrical signal produced from

the potential difference of the cornea (positively charged) and the retina (negatively charged).There is a steady corneal-retinal potential from the back of the eye to the front of the eye. This steady dipole may be used to measure eye potential by placing surface electrodes around the eyes.When the eyes are looking straight , the electrodes spaced equally from the eyes will be at right angles with the eye's electric field which will result in the output to be zero. Due to movement of the eyes, there is a direct current voltage shift experienced which gives the EOG signal.[2]

The most important factor that makes EOG far better than the other modalities is a linear relationship of EOG signal over the eye movements that makes it suitable for the application. The other reasons include better face access, good accuracy and resolution, great range of eye displacements, and more importantly economical. [3]

This paper outlines on the development and implementation of a low cost eye movement detection device for controlling home appliances for paralyzed patients. The device also incorporates an alarm system that alerts during an emergency.

II. METHODOLOGY

The block diagram of the proposed system is as shown below:-

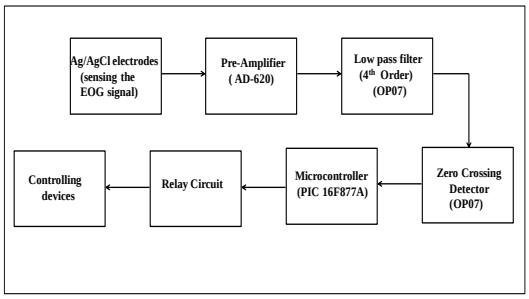

Fig 1. Block Diagram

A. Electrode placement

Here the EOG signal is acquired with the help of Ag/AgCl electrodes. These electrodes are comparatively inexpensive and help in reducing the drifts by careful application, also prevents the motion artifact and contact with the eye. The number of electrodes used here are three and the reference electrode is placed on the forehead (Fig 2). These electrodes will pick the EOG signal.

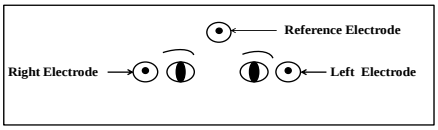

Fig 2. Electrode placement

B. AD620 Instrumentation Amplifier

AD620 is a low cost, high accuracy instrumentation amplifier that requires only one external resistor to set gain. It offers low power that makes it a good fit for battery powered portable applications. This instrumentation amplifier receives signals from electrodes, other features include low DC offset, low drift noise and very high common mode rejection ratio that play a key role when great accuracy and stability of the circuit for both short and long term are required. [2] Thus, these features make it more convenient for medical applications.

The external resistance R_G is defined as,

$$R_G = \frac{49.4k\Omega}{G-1} \qquad (1)$$

where G is the Gain.

C. Filtering

Two second order active low pass filters are cascaded with a cut off frequency of 30 Hz. The filter is realized using the IC OP07.

The cut off frequency f_c of the low pass filter is given by,

$$f_c = \frac{1}{2\pi RC} \qquad (2)$$

where R is the Resistance and C is the Capacitance of the filter circuit.

D. *Zero Crossing Detector*

The Zero Crossing Detector is used to interface with the PIC microcontroller and the filter circuit. It is implemented using the IC OP07. The circuit diagram for the signal acquisition is as illustrated in Fig 3.

E. PIC16F877A Microcontroller

PIC16F877A is one amongst the popular form from the family of PICMicro family Microcontroller. The ease of use, flash memory technology that can write/erase until thousand times makes it more efficient for application purpose. The low cost, low power consumption, easy handling and flexibility make PIC applicable in areas where microcontroller were not previously considered.

Other features that characterises PIC16F877A are 10 bit upto 8 channel A/D Converter, data EEPROM retention greater than 40 years and single power supply (5V) in serial programming. The wide operating voltage range (2.0V - 5.5 V) is one of the contributing factors that has motivated us to implement PIC16F877A in our application

The PIC168F77A Microcontroller is programmed in order to control the devices. The input high value is considered as the count. Each of the device here is being assigned with a target count. For example, count 3 for alarm and count 5 for fan. To activate a device, the user has to achieve this target count by performing a horizontal movement looking at the LCD screen. The device is activated once the count corresponding to it is reached. The same count can be used for deactivation also.

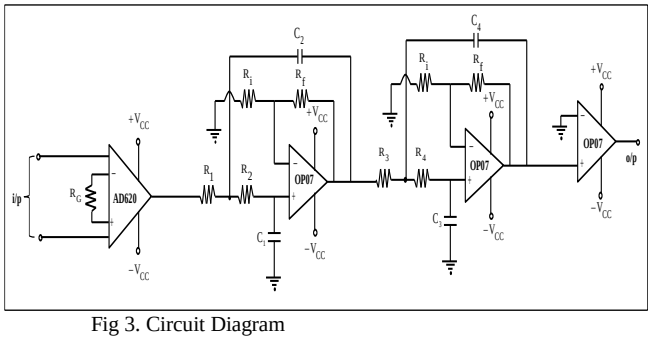

Fig 3. Circuit Diagram

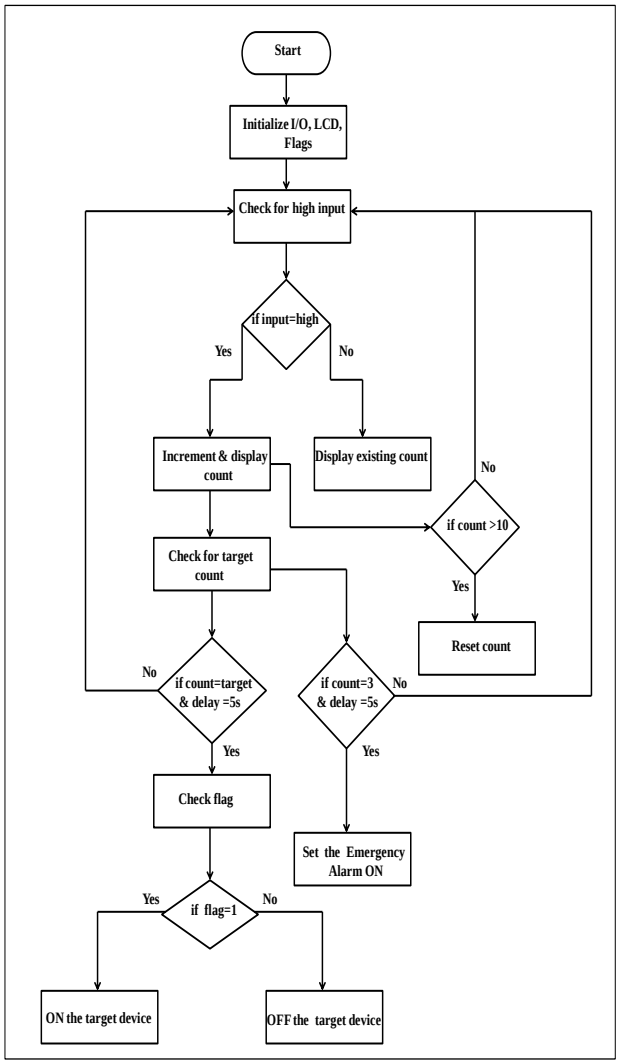

Fig 4. Flowchart

F. *Relay Circuit*

Relays play a key role in switching between two circuits that are completely separate. This property of the relay makes it more convenient for our application. They are applied to interface a low voltage electronic circuit (5v) to an electrical circuit which operates at a very high voltage (230v). In our application a Darlington pair formed from two transistors are used to interface microcontroller with the relay (5 pin), thus driving the appliances conveniently.

III. RESULTS

With the eye movement, a linearly varying EOG signal is obtained in the output of the signal conditioning circuit. Using this signal, the devices are controlled with the help of the microcontroller and relay circuit .The devices used here are alarm, fan and light and the count assigned for these devices are 3, 5, and 7 respectively. The figure below illustrates the outputs obtained from the same.

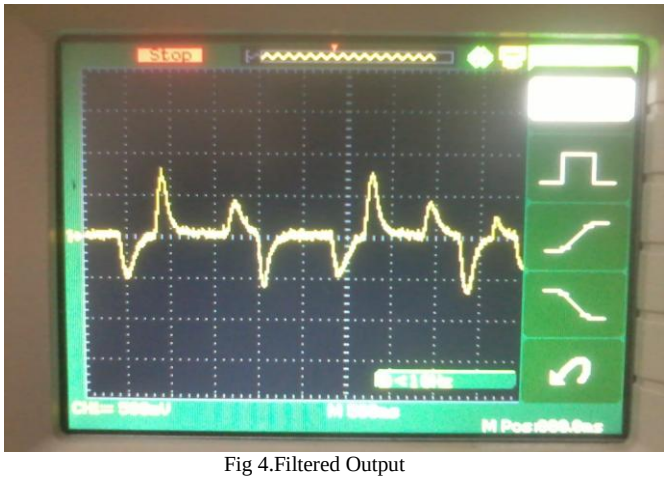

Fig 4.Filtered Output

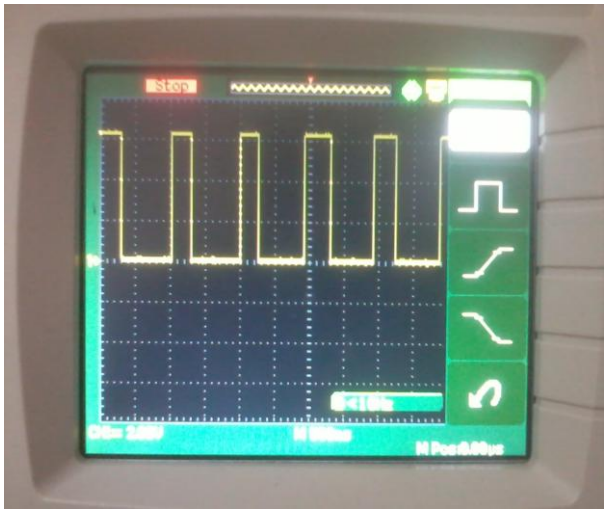

Fig 5.Comparator Output

Fig 6. Controlling an electric bulb

The proposed method was carried out on 10 subjects with normal vision. All the subjects could conveniently control the appliances using the eye movements.

IV. DISCUSSION

A low cost eye movement based detection device for controlling home appliances has been discussed in this paper. The device is developed mainly for the paralysed people, for whom mobility is a point of concern. The

device is based on the acquisition of EOG signal which is comparatively inexpensive, efficient in terms of linear relationship of the signal over the eye movements that makes it suitable for the application. The device here incorporates activation and deactivation of appliances such as fan, bulb and alarm. Towards the future, this method can be extended by employing a RF Transmitter and Receiver that will help to operate in a wider area.

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BIOGRAPHIES

Aswin Raj V, is a M.Tech Final year Biomedical Engineering student at SRM University. He has completed his B.Tech in Applied Electronics and Instrumentation, from Government Engineering College, Calicut in 2011. This paper is being prepared in accordance with his Final year Project on EOG Based Low Cost Device for Controlling Home Appliances.His research interests include Biomedical Instrumentation and Control systems.

Karthik Raj V, is currently working as Assistant Professor in Department of Biomedical Engineering, SRM University. He has received M.E degree in Medical Electronics from College of Engineering, Anna University in 2011 and B.Tech in Biomedical Engineering from Sahrdaya College of Engineering and Technology, Calicut University in 2008.His B.E project on Voice Controlled Wheel Chair was recognized as the Best Project of Department of Biomedical Engineering in Sahrdaya College of Engineering and Technology in 2008. His research interests include Bio Instrumentation and MEMS.