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Electro-oculography in the Field of Assistive Interaction Communication

Nupur C. Tupkar
Mtech VLSI Electronics Department
GHRCE, Nagpur.
tupkar.nupur@gmail.com

Prof. Trushna G. Deotale
Electronics Department
GHRCE, Nagpur.
trushna.deotale@raisoni.net

Abstract— There is sufficient evidence about feasible use of electrical bio-signals in field of Substitute Communication. Additionally, they are particularly suitable in the case of people with physical disorder, for example bedridden patients. Developing solutions for them involves different ways of using sensor that decides the user's restrictions & needs, which in turn converts the user's intentions into commands. The system should be assessed with an appropriate solution. This paper submits alternative communication techniques used for communication using electrooculography technique.

Keywords- *Electro-oculography, Assistive technology (AT), Alternate Communication.*

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I. Introduction

Much researchers have been worked in the past years in field of developing assistive technology (AT) devices for interaction, to aid communication and mobility of elderly and/or disabled persons with the aim of improving their quality of life and allowing them a more self-directed and independent lifestyle. These devices are operated by man-machine interface with sensors receiving data provided by the people with disabilities to pilot a graphical user interface [1]. There are three main types of bioelectrical signals used for controlling the assistive device, namely the electromyogram (EMG), the electro-oculogram (EOG), electrocardiography (ECG) and electro-encephalogram (EEG).

A. *Electro-Oculography*

Testing of patients with retinal disease initiated in clinics and hospitals, the electro-retinogram was being separated into components and electrode studies were used to give information about cells/cell layers which give rise to various components. EOG had advantages over ERG is that here electrodes did not touch the skin area of the eye. Changes in the potential across the eyeball were recorded by electrodes during simple eye movements. After some years ERG recording techniques have become gradually more refined in clinics.

B. *Scientific Principle*

The movement of each eye ball in its path is produced by the shrinkages of voluntary muscles attached to the surface of the eyeball. Four of them run straight from and remaining two muscles are attached to the eyeball surface. Contractions of the recti-muscles are controlled by way of motor pathways in the brain and pairs of cranial nerves. Electrooculography is the measurement and interpretation of electro-oculogram, which are the electroencephalographic tracings obtained while the user, without moving his/her head, moves only their eyes from one point place to another.

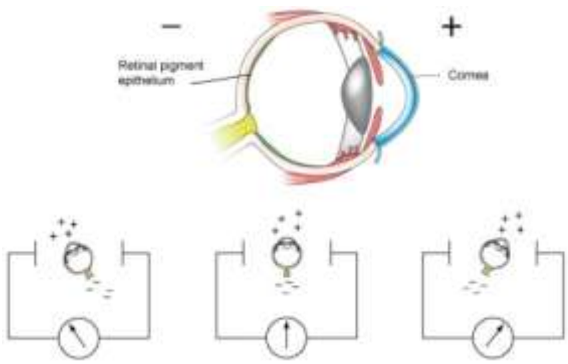

Figure 1.0 an illustration eye structure

C. *Signals Measurement*

The EOG is one of the methods for recording eye movement which does not require a direct contact to eye itself. For such reason, the EOG was preferred for recording eye movements in sleep, dream research. Recently, this technique has become standard for evaluating reading ability, visual fatigue of user. Figure 2.0 illustrates the measurement of horizontal eye movement by the placement of a pair of electrode at the outside of the right and left eye area. With the eye at rest the electrodes are effectually at the same potential and no voltage difference is recorded.

The moment of the eye to the right results in a difference in potential, whereas with the electrode in the direction of eye movement becomes positive in potential as relative to second electrode. The reverse results are generated from an eye movement towards left, as shown in figure 2.0. The calibration can be done by having the user look repeatedly at two different fixation points located at some known angle apart and then recording the appropriate signal. Typically signal magnitudes range from 5 to 20 microvolts per degree. The signal polarity is positive at the electrode to which the eye is moving.

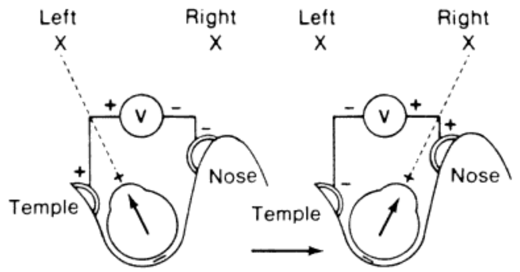

Figure 2.0 An illustration of the electro-oculogram (EOG).

II. LITERATURE SURVEY

Various researcher studies show that electrocardiography (ECG), electromyogram (EMG), electroencephalogram (EEG), the electro-oculogram (EOG), and can be used for different assistive and diagnosis applications. Several people are not able to do their daily activities due to disability. This leads to increase in researches in the field of assistive technology. Past years many researchers work in communicating devices to interact with computers, such as a mouse or keyboard. In these cases, computer commands must be generated without using arms or hands, by using recognition of voice [2], brain-computer interface (BCI) [3]–[4] or eye movements[5]- [8].

Electro-oculogram can be used for the study of the effects of prolonged eye fixation; [6] author has discussed the method which analyses the modifications in autonomic reactions due to prolonged eye gaze with the help of with electro-oculogram (EOG), electro-cardiogram (ECG), pulse plethysmogram (PPG) and electro-dermal activity. Researcher has suggested that the changes in autonomic responses with the mental effort produced by eye gaze were distinct and thus provides a good platform for the development of human computer Interface.

EEG with EOG can also be other way of communication channel for mouse control along with determination of subject's control state i.e. whether the EOG system works according to patients mind or just a misjudgment. But by using EOG along with EEG there is unnecessary increase in complications and time due to EEG judgment. [7][8].Recently researchers proposed an approach of interface that allows people to interact with computers using their eye movements is presented as the eye movement is the easiest way of communication [9], Study and capturing of the Natural eye movement detection for assisting application for paralyzed patients with motor disorders.

In order to detect eye movements, system uses electro-oculography (EOG). EOG detects the eyes movement by measuring, through electrodes, the difference of potential between the cornea and the retina [5]. EOG is used in previous works so as to interact with different devices. Considering the characteristics of EOG signals, EOG-based HCI systems have become more popular in recent years [11]–[13]. For instance researchers used EOG to control a robot arm moment [17], guide a wheelchair [15], or a key- board [14].

Such a system which provides both ease and communication for disabled people, particularly when there is some physical restriction that avoids them from using other Human Computer Interface.Some researchers work came with the problematic condition due to involuntary as well as voluntary blink signals, to overcome this problematic condition author proposed the new method by varying the position of the electrodes varying in position there is change in output voltage, difference between involuntary as well as voluntary blink signals to remove effect of such false trigger [17] [9].

As shown in Figure 3.0 the basic blocks consist of the instrumentation amplifier and filers stages, this can be implemented with the help of different RC filter stages so as to remove the noise.as the output is analog signal this is given to ADC circuit so as to convert it to digital signal.

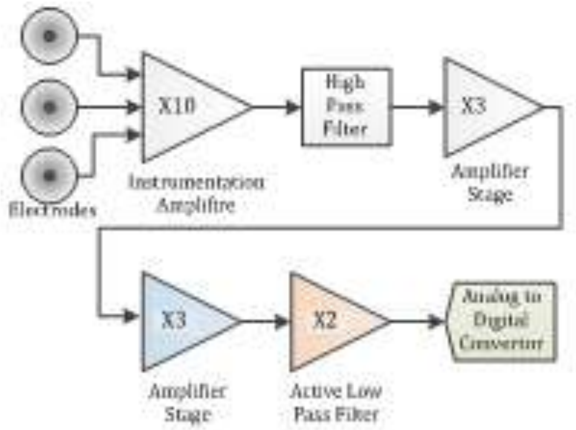

Figure 3.0 Basic building blocks for acquisition of EOG signal.

III. CIRCUIT DESIGNING

For the acquisition and the amplifier circuit, there are many instrumentation amplifiers are available in the market, conventionally the instrumentation amplifier used is the IC 741, but as the EOG signals are concern the frequency as well as the voltage difference is so small that it is difficult to achieve the amplification with conventional 741 instrumentation amplifier, thus we have simulated the results by using different instrumentation amplifiers which are used in the biomedical instruments such as INA126, INA122, INA118, AD620 etc. so in our design we have used the AD620 instrumentation amplifier IC which is three op-amp design with a good accuracy, whose output is amplified with just the single external resistor.

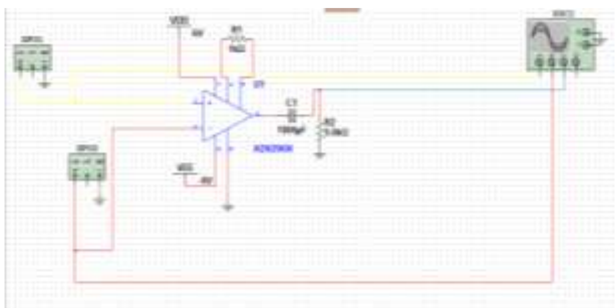

Figure 4 .0 Schematic of AD620 Amplifier circuit

As shown Figure 4.0 illustrating the basic design of the circuit in the simulating software, which will be used for the synthesis of the results whether the circuit should be used in the proposed system and thus we are getting the simulations results as shown in figure5.0 given below

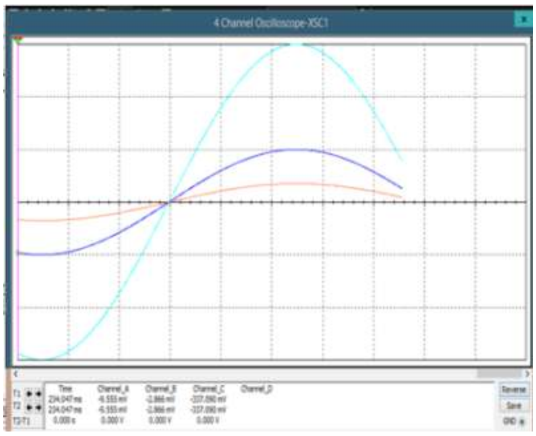

Figure 5.0 Simulations result of AD620 Amplifier circuit

As shown in fig 5.0 the circuit is implemented on the breadboard and the results are observed with the help of the Oscilloscope, the inputs are generated with the help of two signal generator and the working of circuit is verified, the output is the amplified version of difference of two inputs. The basic RC filtered output is also noticed.

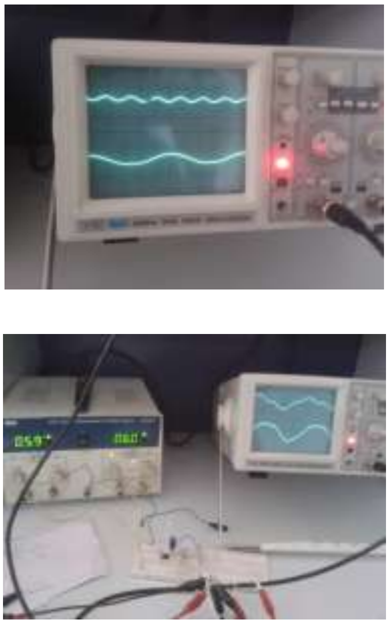

Figure 6.0 Implementation result of AD620 Amplifier circuit on CRO

For the future work as the power supply is concern, the proposed work needs the bipolar power supply of 6V. To obtain the supply there are different options such as make use of regulator ICs, combination of batteries etc. as shown in simulations results in fig.7. But as the hardware requirement is of bipolar 6V supply, it is suitable to make use of batteries than that of any regulator ICs and RC circuits. So to make it a shock free circuit we make use of the eight 1.5V batteries as it is easily available in market

IV. CONCLUSION:

Many researchers work has been done in the development of interactive device. Compared with the all studied process the electro-oculography offers us the advantages as compared to EMG, EEG and ECG in terms of cost, linearity and ease of implementation. However, very few researchers are developing a device which includes physical total assembly of electrodes, electronics and communication interaction with computer. A new device which comprises of dry EOG electrodes can be designed as a future work with the help of design using AD620 acquisition and filter circuit as discussed in the paper, which is making a advancing step in the approach to obtain a marketable EOG interactive device. Different filter circuits can also be designed which will again improves and smooth's the result, so as to again improve the results and improve the accuracy.

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