Design and Implementation of Electro-Oculography

Prof. Saima Zareen Ansari
CSE, ACET, Nagpur
(Maharashtra), India
saima_ansari16@yahoo.com

Prof. Farheena Shaikh
CSE, ACET , Nagpur
(Maharashtra), India
farheenas4u@gmail.com

Prof. Naisha Taban Khan
CSE, ACET, Nagpur
(Maharashtra), India
naishataban@yahoo.com

Prof. Qudsiya Naaz
CSE, ACET, Nagpur
(Maharashtra), India
naaz0389@gmail.com

Abstract**—** Electric impulse is transmitted all over the body by the brain for sending the information to operate different parts of the body. The increase and decrease in the resistance near the eye take place when the person rotates its eye ball. Electrodes or Myoelectric sensors can be used to measure the variation in electric impulse. By implementing the signals processor we can interface different devices to control the operation on demand. The system is designed will detect the emotions of the person with the help of smiley's using brain waves electric signals strength through voltage level near the eye area. The different EOG signals obtained by placing electrodes at four different places around eye; (right, left, up, down) have led to show the different emotions of the person. Those four signals and one another signal used as ground signal correspond to different emotions like happy, sad, sleeping, confused and normal.

Keywords**—***Brain-computer interface (BCI), electroencephalography (EEG), mind-machine interface (MMI), brain-machine interface (BMI), electro-oculography (EOG), electromyography (EMG).*

*****

I. INTRODUCTION

A brain-computer interface (BCI), often called a mind-machine interface (MMI), or sometimes called a direct neural interface or a brain-machine interface (BMI), is a direct communication pathway between the brain and an external device. BCIs are often directed at assisting, augmenting, or repairing human cognitive or sensory-motor functions. A brain-computer interface (BCI) is a device that enables severely disabled people to communicate and interact with their environments using their brain waves. Most research investigating BCI in humans has used scalp-recorded electroencephalography or intracranial electro-oculography. The use of brain signals obtained directly from stereotactic depth electrodes to control a BCI has not previously been explored.

The bio-potential signal also is one of the examples of human-machine interface using of nonverbal information such as electro-oculography (EOG), electromyography (EMG), and electroencephalography (EEG) signals [5]. The EOG and EMG signals are physiological changes; but here we are focusing the mainly on EOG signals for the human-machine interface. The overall project idea is to study and implement the EOG signal and transform them into the digital form to detect the emotions of the person with the help of smileys. The below given figure. 1 shows the placement of electrodes.

Fig. 1 Placement of Electrodes

project has investigated that different EOG signals obtained from placing electrodes at four different places around eye; (right, left, up, down) have led to show the different emotions of the person. Those four signals and one another signal used as ground signal correspond to different emotions like happy, sad, sleeping, confused and normal. There are many researches that have concentrated in making use of the eye movement signals for tetraplegia [1], [2]. Despite of all the complexity that arises when analysing the eye movement signals. In this case the constraints are made such that the eye movement is assumes to be very limited to; (happy, sad, sleeping, confused and normal), the issue of other eye movement patterns.

II. RELATED WORK

An interface that allows people to interact with computers using their eye movements is bestowed [3]. The system uses electro-oculography (EOG), so as to observe eye movements. EOG detects the eyes movement by measuring, through electrodes, the distinction of potential between the cornea and therefore the retina. EOG has been employed in previous works to interact with different devices.

However, few or none research groups are developing a whole system that features physical support of electrodes, electronics and the communications with the computer [4]. They include the dry EOG electrodes, the electronic circuitry to acquire and send the EOG signals and therefore the batteries. This system might be used (put on and removed) easily and very quickly (avoiding the use of plasters to manually fix the electrodes). Furthermore, it might allow the popularization of the EOG technology to move an interaction with devices.

The interface presented in this paper uses a new processing algorithm to observe eye movement that improves the characteristics of a previous work. The new algorithm is ready to detect the gaze direction of the eyes (right, left, up and down) also because the user's blink. This algorithm is more robust and efficient than the old one. Additionally, it decreases the time needed to get the stare direction. Using time windows of 1, 0.5 or 0.25 seconds, the algorithm works. Even the algorithm is developed in such the simplest way that it will observe the attention of eye movement performed between two processing windows by algorithm. The set of glasses and therefore the new processing algorithm has been tested intensively by many volunteers. The experimental result has shown that the whole system has high reliability.

The EOG measures the electrical difference that exists between the cornea and the retina, known as resting or standard potential of the eye [9], [8]. The cornea is almost 6 m positive with respect to the retina [9], which changes with clashing retinal illumination. The potential of the eye is generated mainly by the transepithelial potential across the pigmented epithelium of the retina.

Electro-oculogram change under totally different states of retinal illumination. The EOG is employed to assess the function of the pigment epithelium. In dark adaptation scenario, resting potential drops slightly and reaches a minimum ("dark trough") once many minutes. Once light is switched on, a substantial increase of the resting potential happens ("light peak") [7], which drops off after many minutes when the retina adapts to the light. The ratio of the voltages is known as the Arden ratio [10]. The measurement is similar to eye movement recordings. The patient is asked to modify eye position repeatedly between two points. Since these positions are static, an amendment in recorded potential originates from a change within the resting potential. EOGs are most appropriate when diseases that affect the retinal pigment epithelium may be present. Fishman (1990) outlines those dystrophies of the pigment epithelium that may give rise to EOG abnormalities [6]. The only one disease that consistently associated with abnormal EOGs, however, is Best (vitelli form) macular dystrophy. Autosomal-dominant macular degeneration is a best disease that may be congenital or may have an onset of up to 7 years of age.

Recording of eye movements and eye position provided by the difference in electrical potential between two electrodes placed on the skin on either side of the eye. The electrooculogram comprises of two potentials: the standing potential that is elicited by moving the eyes within the dark and originates from the retinal pigment epithelium and therefore the light potential (light rise) which is evoked by moving the eyes in a lighted environment and originates from the photo receptors .The common magnitude ratio between the light and no light potentials (sometimes conjointly known as the Arden index or Arden ratio) is assessed. If that ratio is less than 1.8 it reflects a malfunction of the structures from which the potential originates.

A method of automated measurement of the EOG amplitude is described. The advantages are as follows:

The mean of amplitudes, at a series of time dots within a single EOG deflection recorded with DC-amplification, are automatically measured.

Artefacts due to blinks [9], overshoots or other irregular eye movements are automatically eliminated.

A base line drift is automatically compensated.

The Lift to Drag ratios acquire in 80 eyes with this method was essentially equal to those obtained by a manual measurement.

III. PROPOSED SYSTEM

The proposed system implements a human-computer interface based on electro-oculography (EOG) that permits interaction with a computer using eye movement. The EOG stores the movement of the eye by measuring activity, through electrodes, and therefore calculating the difference of potential between the cornea and the retina. Human brain mainly works on electric signals transmitting all over the body to send the information in order to operate the entire body structure, even with rotating eye ball, body increases or decreases the resistance near human eye [10]. This change in electric signals can be measured using ECG electrodes.

It consists of designing and building a myoelectric signal or electrodes generated signal detector circuit. It will detect the variations in electric signal strength through voltage level near the eye area and generates wireless radio frequency signals in order to detect the emotions of the person with the help of smiley's. This system aims at developing a signal amplifier circuit AD 620, which will then amplify the electrode signals. By implementing this, the system can be further extended to bio enabled human body parts to control through brain waves. Here the user can control the computer cursor and the applications using electric signals. This will enable the disabled patients to have good access over the computer system. To implement this there will be a Windows Sound API which will convert the analog signals into computer understandable signals (digital signals). Next is designing and developing an embedded program to convert these signals into particular code. Fig. 2 shows the three different types of signals as EEG, EOG and EMG [5] respectably. Likewise, Fig. 3 and Fig. 4 show the overview of the system and the five electrodes with the Signal Detector Chip respectably

ISSN: 2321-8169
363– 367

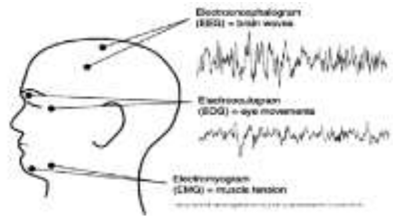

Fig. 2 Three types of signals EEG, EOG, and EMG.

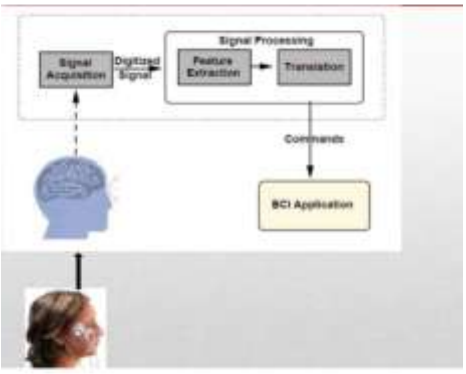

Fig. 3 System Overview

Fig. 4 Designed Stereo Amplification Circuit with Connecting Cables Which Is Responsible For the Amplification of Left and Right Movement of Eyes

IV. METHODOLOGY

Body consist of static electricity in the form of analog signal. This static energy changes when the body parts movement occurs. When we move the body part then the variation occur in the form of analog signal.AD620 amplifies this analog signal. For converting this analog signal into digital signal Microsoft provides various API's. Here we are using Windows Sound API. Fig. 5 explains the input signals received from the eye movement.

The generation of the Electrooculogram (EOG) signal can be understood by envisaging dipoles located in the eyes with the cornea having relatively positive potential with respect to the retina [3]. This EOG signal is picked up by a two channel signal acquisition system consisting of the Horizontal (H) and Vertical (V) channels. The placement of electrodes is shown in the Figure 1, above. We are using disposable ECG electrodes for our experimental setup due to the availability and the low price. The acquisition system employs Ag - AgCl surface electrodes for signal pick up which requires application of sufficient electrolyte gel to reduce the skin impedance.

High pass filter of 0.1 Hz is used to remove the noise from the signal. After removing noise, if the range of the signal decreases, then the second amplifier is used to amplify the signal to the desired range. Active Low Pass Filter is used to improve the efficiency by checking if there is any kind of noise persisting in the system. Finally, the Analog to Digital converter i.e. the Windows Sound API, is used to convert the analog signal received from Active Low Pass Filter to digital signal as the output. Figure.6. is the circuit diagram of signal detection showing the electrodes input, instrumentation amplifier, high pass filter, ope-amp, low pass filter and AD620.

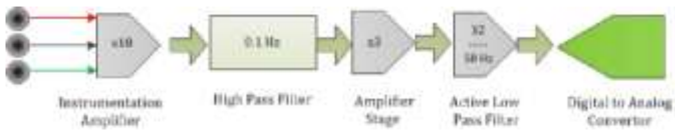

Fig. 5 Flow of Signal

The EOG signal has a frequency range between DC and 38Hz and amplitude between 10 to100mV. Current literature states that the EOG signal amplitude is merely dependent upon the position of the eye balls relative to the conductive environment of the skull [1], though the signal has been found to be dependent on few other factors in the recently conducted research. The EOG signal, like the other bio-signals is corrupted by the environmental interferences and biological artefacts [6]. Therefore the primary design considerations that have been kept in mind during the design of the EOG bio potential amplifier are proper amplification, sufficient bandwidth, high input impedance, low noise, stability against temperature and voltage fluctuations, elimination of DC drifts and power-line interference.

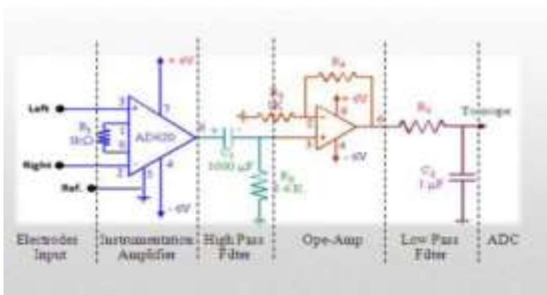

Fig. 6 Circuit diagram of Signal Detection

etection As shown in Fig. 6 an instrumentation amplifier is a type of differential amplifier that has been outfitted with input buffer, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable

ISSN: 2321-8169
363– 367

for use in measurement and test equipment. A high pass filter is an electronic filter that passes high-frequency signals but attenuates signals with frequencies lower than the cut off frequency. A low pass filter is a filter that passes low frequency signals with frequencies higher than the cut off frequency. The actual amount of attenuation varies depending on specific filter design.

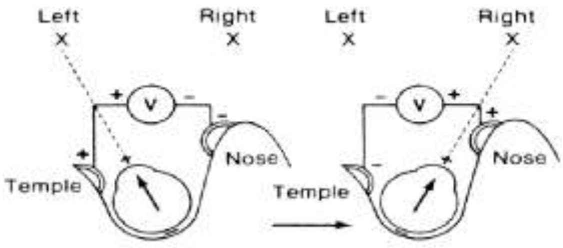

Fig.7 Measuring of Signal

The eye can be cnsidered as a dipole with the interior part relatively more positive than the posterior part [2]. EOG electrodes have become fixed for the outer and inner canthal of the left eye. On the left of the diagram as the eye moves to the left, the outer canthal electrode (being closer to the positive pole of the eye) becomes more positive than the inner canthal electrode. This change in potential can then be recorded on a voltage meter. When the eye moves to the right side direction, the inner canthal electrode then becomes positive and again a change in potential can be recorded but with opposite polarity.

V. RESULT

The below given figure shows the emotion detection system in its ideal state. This figure shows the normal i.e. the default working of the system when no eye movements take place. It shows the trigger value settings where there is a upper left positive value bar, upper right negative value bar, lower left positive bar and lower right negative value bar respectively. The start and stop eye detection tab is used to start and stop the eye detection system respectively. Close tab is used to close this default system. The green waves show the electric impulse generated from the brain. As every human body generates different impulse values, so the values shown on the L.H.S varies accordingly. When the device is not worn by the any person, the readings on the left side shows the values of the surrounding environment. Otherwise it shows the values generated by the electric impulse. The below given figure is showing the values generated by the electric impulse of the range 4441 and 621 respectively.

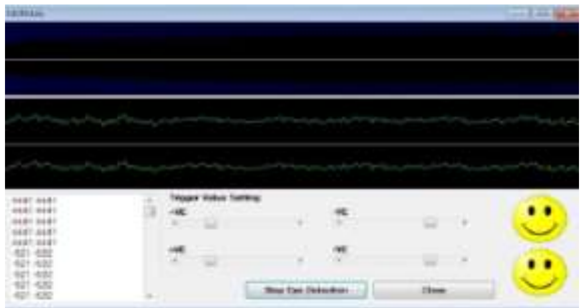

Fig.8 Emotion Detection System in its Ideal State

The below given Fig. 9 Explains the condition when the movement of the human eye is in the right side. When the impulse reading generated by this right movement of the eye exceeds the average noise value, then the laughing emotion is generated.

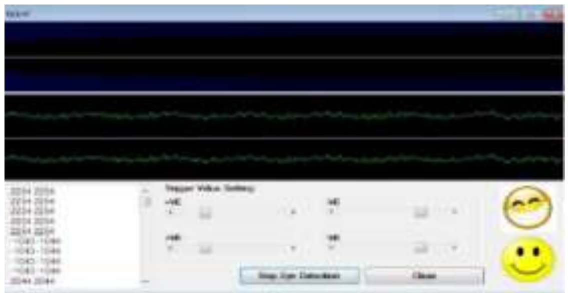

Fig.9 Emotion Detection System showing Right Eye Movement

The below given Fig. 10 Explains the condition when the movement of the human eye is in the left side. When the impulse reading generated by this left movement of the eye exceeds the average noise value, then the crying emotion is generated.

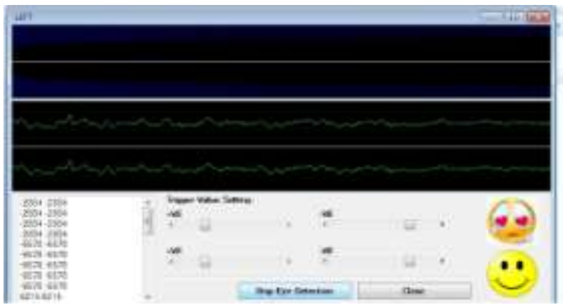

Fig.10 Emotion Detection System showing Left Eye Movement

The below given Fig. 11 Explains the condition when the movement of the human eye is upward. When the impulse reading generated by this upper movement of the eye exceeds the average noise value, then the confused emotion is generated.

ISSN: 2321-8169
363– 367

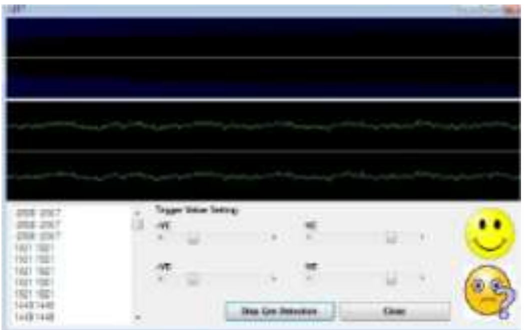

Fig.11 Emotion Detection System showing Upward Eye Movement

The below given Fig. 12 Explains the condition when the movement of the human eye is downward. When the impulse reading generated by this upper movement of the eye exceeds the average noise value, then the sleeping emotion is generated.

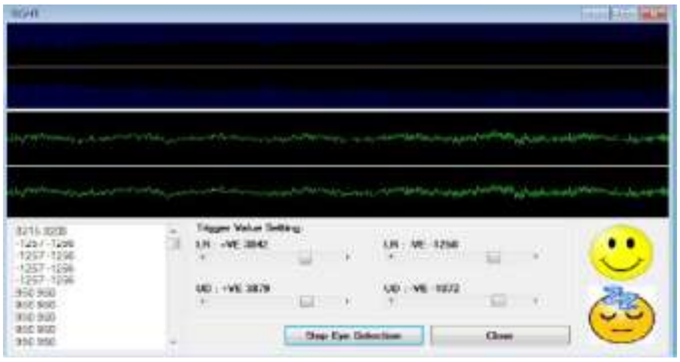

Fig.12 Shows when Downward Moment of Eye is Active

VI. CONCLUSIONS AND FUTURE SCOPE

Thus a human-computer interface based on electro-oculography (EOG) that permits interaction with a computer using eye movement is implemented. The emotion detection system using brain waves electric signals with four electrodes, left, right, up and down are developed successfully. Also one additional electrode is used as ground signal corresponding to different emotions like happy, sad, sleeping, confused and normal is also developed. Every system has its disadvantage so as this system. This system is dependent on different factors such as human body fat and body heat. Every human body varies regarding these factors. Thus this system has some complexity and the ease of the system can only be achieved by improving the system in such a sense that these factors in future doesn't vary from person to person.

REFERENCES

[1] Andreas Bulling, Jamie A. Ward, Hans Gellersen, and Gerhard Troster, "Eye Movement Analysis for Activity Recognition using Electrooculography", IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.33,Issue 4,pp.741-753, April 2010.

[2] Robert J.K. Jacob, "Eye Movement-Based Human-Computer Interaction Techniques: Toward Non-Command Interfaces", Human-Computer Interaction Lab, Naval Research Laboratory, Washington, D.C.

[3] Yash Shailesh kumar Desai, "Natural Eye Movement & its application for paralysed patients", International Journal of Engineering Trends and Technology (IJETT), vol.4, Issue4, pp. 679-686, April 2013.

[4] Chin-Teng Lin, Li-Wei Ko, Che-Jui Chang, Yu-Te Wang, Chia-Hsin Chun, Fu-Shu Yang, Jeng-Ren Duann, Tzyy-Ping Jung, and Jin-Chern Chiou, "Wearable and Wireless Brain-Computer Interface and Its Applications", Augmented Cognition, HCII 2009, LNAI 5638, pp. 741–748, 2009, Springer-Verlag Berlin Heidelberg 2009.

[5] Anupama.H.S, N.K.Cauvery, Lingaraju.G.M, "Brain Computer Interface and its types - A study", International Journal of Advances in Engineering & Technology, May 2012.IJAET, Vol. 3, Issue 2, pp. 739-745. [6] Bernhard Graimann, Brendan Allison, and Gert P Furtscheller, "Brain–Computer Interfaces: A Gentle Introduction", Brain–Computer Interfaces, the Frontiers Collection, Springer-Verlag Berlin Heidelberg 2010.

[6] Chin-Teng Lin, Fu-Chang Lin, Shi-An Chen, Shao-Wei Lu. Te-Chi Chen, Li-Wei Ko, "EEG-based Brain-computer Interface for Smart Living Environmental Auto-adjustment", Journal of Medical and Biological Engineering, 30(4): 237-245.

[7] Reinhold Scherer, Günter Moitzi, Ian Daly, Gernot R. Müller-Putz, "On the Use of Games for Non invasive EEG-Based Functional Brain Mapping", IEEE Transactions on Computational Intelligence and AI in Games, vol. 5, no. 2, June 2013.

[8] Xin Yi, Jun Jia, Simin Deng, Steve Guofang Shen, Qing Xie, and Guoxing Wang, "A Blink Restoration System With Contralateral EMG Triggered Stimulation and Real-Time Artifact Blanking", IEEE Transactions on Biomedical Circuits and Systems, vol. 7, no. 2, April 2013.

[9] Jie Liu and Ping Zhou, "A Novel Myoelectric Pattern Recognition Strategy for Hand Function Restoration after Incomplete Cervical Spinal Cord Injury", IEEE Transactions on Neural Systems and Rehabilitation Engineering, vol. 21, no. 1, January 2013.