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Eye Controlled Human Machine Interface (e-VISION)

Pradeep S G[1], Akesh Govada[2], Kendaganna Swamy[3]

PG Scholar, Biomedical Signal Processing & Instrumentation, Dept of IT, RVCE, Bangalore, India[1]

PG Scholar, Biomedical Signal Processing & Instrumentation, Dept of IT, RVCE, Bangalore, India[2]

Assistant professor, Biomedical Signal Processing & Instrumentation, Dept of IT, RVCE, Bangalore, India[3]

Abstract: This paper presents an implementation of a low-cost aid for severely disabled persons to communicate with computer directly by bioelectricity rather than by physical means. The communication is done through Electro Occulo Gram (EOG) signals generated by the movement of eyes. The blink, left & right commands are used to communicate with computer. We will provide RF interface between acquisition or processing part and application so that it's easy to handle and easy to install in homes and hospitals[1-5].

Keyword*:* Eogprinciple, acquisition system, processing system, instrumentation amplifier

I. INTRODUCTION

Invention of new technology and the use of Computers or machines have been dramatically changing our lifestyles, standard of living and the trend in the society. These kinds of changes benefit some groups in our society but unavoidably create new barriers to a disadvantage minority such as people with physical disabilities who cannot manually access computers with dexterity as able-bodies people do. Therefore, in recent years, there has been an effort to design alternative interfaces for people with disabilities to replace traditional computer input devices such as keyboard and mouse [16].

Bio-based human computer interface (HCI) has the potential to enable severely disabled people to drive computers directly by bioelectricity rather than by physical means [3]. A study on the group of persons with severe disabilities shows that many of them have the ability to control their eye movements, which could be used to develop new human computer interface systems to help them communicate with other persons or control some special instruments.

In this project our objective is to design a Human Machine interface, which can be controlled using EOG Signals and final output is to be used to move cursor on the Graphic Display which has several buttons and each button

On clicking by blinking of eyes activated corresponding appliance or action. We will provide RF interface between acquisition/processing part and application so that it's easy to handle and easy to install in homes and hospitals. Furthermore, this application of EOG-based HCI could be extended to the group of normal persons for game or other entertainments [7]. Nowadays, some methods which attain User's eye movements are developed.

II. ELECTROOCULOGRAPHIC PRINCIPLE

Electro-oculo graphy (EOG) is a new technology of placing electrodes on user's forehead around the eyes to record eye movements. EOG is a very small electrical potential that can be detected using electrodes. Compared with the EEG, EOG signals have the characteristics as follows: the amplitude is relatively high (15-200uV), the relationship between EOG and eye movements is linear, and the waveform is easy to detect. Considering the characteristics of EOG mentioned above, EOG based HCI is becoming the hotspot of bio-based HCI research in recent years. [9]. A survey of eye movements recording methods can be seen in [Glenstup&Engell, 95] where are described the main advantages and drawbacks of each one. In this work, the goal is to sense the electrooculographic potential (EOG) because it presents a good face access, good accuracy and resolution, great range of eye displacements, works in real time and is cheap. The electrooculogram (EOG) is the electrical signal produced by the potential difference between the retina and the cornea of the eye [8]. This difference is due to the large presence of electrically active nerves in the retina compared to the front of the eye (cornea). The EOG ranges from 0.05 to 3.5 mV in humans and is linearly proportional to eye displacement. The human eye is an electrical dipole with a negative pole at the retina and a positive pole at the cornea.

This system may be used for increasing communication and/or control. The analog signal forms the oculographic measurements has been turned into signal suitable for control purposes. The derivation of the EOG is achieved placing two electrodes on the outer side of the eyes to detect horizontal movement and another pair above and below the eye to detect vertical movement. A reference electrode is placed on the forehead.

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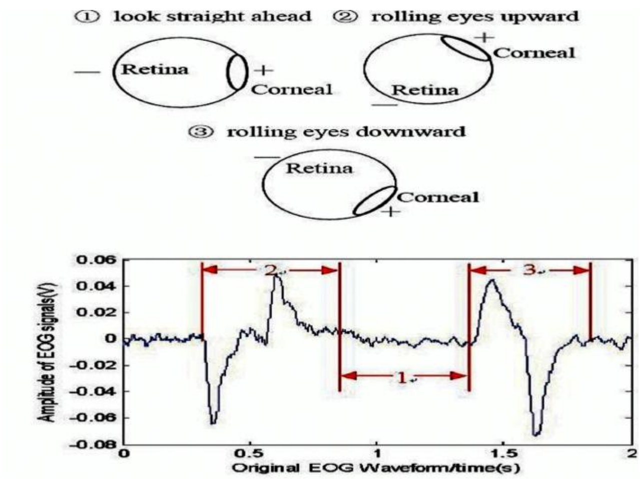

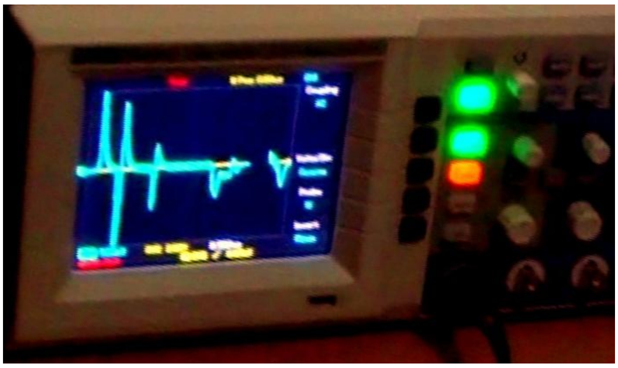

Figure 1.a. EOG waveforms in CRO.

Eye movement will respectively generates voltage up to 16uV and 14uV per 1° in horizontal and vertical way, the signal are sampled 10 times per second [11].

III. METHODOLOGY

In our HCI system, four to five electrodes are employed to attain the EOG signals. Figure 2 shows the electrode placement.

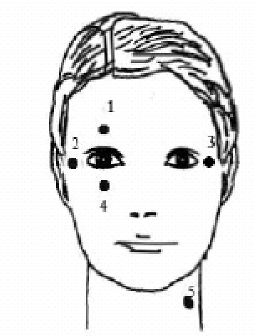

Figure 2: Electrode placements

1 & 4 for detecting vertical movement

2 & 3 for detecting horizontal movement

5 is for reference(can be omitted or place at forehead).

IV. BLOCK DIAGRAM AND DESCRIPTION

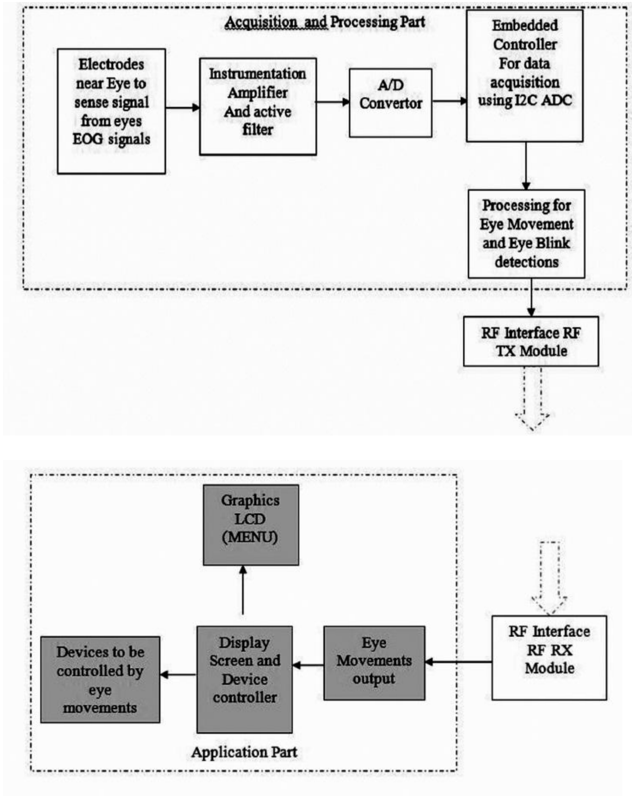

Figure 3: Block diagram of the project

1) Acquisition Part

For four-five different electrodes two separate acquisition electronic circuitry is required.

a) *Electrodes:*

First thing to interface to body is Electrodes here we are using reusable electrodes to connect electronics with human body and these electrodes will pickup signals which corresponds to eye movements signals mixed with some others signals which are noise for us.We are going to use Ag-AgCl electrodes as they are low cost and easily available.

b) Instrumentation Amplifier:

Signals from electrodes are received and sent to InstrumentationAmplifier. An instrumentationamplifier is a type of differential amplifier that has been outfitted with input buffers, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment. Additional characteristics include very low DC offset, low drift, low noise, very high open-loop gain, very high common-mode rejection ratio, and very high input impedances. Instrumentation amplifiers are used where great accuracy and stability of the circuit both short- and long-term are required.We are using AD620 which is precision Instrumentation amplifier.

c) Active Filters and Gain Blocks:

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Opamp based Active filters are used we have low pass filter so that only eye signals are going future in the circuit, cutoff frequency for this filter is 20Hz-40Hz. And high pass filter to block DC and frequencies up to 0.1-0.3Hz. These filters and gain blocks are implemented using LM324 Opamp.

d) *Acquisition and processing microcontroller:*
This is 8051 class of microcontroller and it has to acquire signals from A/D convertor for both chains up-down electrode chain and left-right electrode chain. As our microcontroller is fast and powerful we will process the signal here itself and transmit final eye move outputs to application part wirelessly.

Cmds sent:

01– CR: Right eye movement

02– CL: Left eye movement

03– CU: Up eye movement

04– CD: Down eye movement

05– BL: Blinking of eye

e) RF Transmitter:

Here we can use 315/433Mhz Tx modules along with HT640 Encoder to send eye movement commands to the application part.

2) Application Part

a) *RF Receiver:*
Wireless signals transmitted by our acquisition part are received in this section, here we use 315/433Mhz Rx modules along with HT648 decoder. Output of RF receiver goes to application part directly.

b) *Display and appliance controller:*
This is again a microcontroller which receives eye movements signals (R L U D B) as described above via UART interface. We are using P89V51RD2 from NXP (Philips), this microcontroller is connected to Graphic LCD which is displaying Cursor and 4 buttons

1)TV 2)FAN 3) LIGHTS 4) ALARM

Using eye movements a cursor is controlled and using blink click operation is done, each

V. ACQUISITION & PROCESSING SYSTEM

Electrodes capture the biopotentials from the body but these signals are very weak and very noisy so there is invariable need of advance acquisition system which comprises of precision instrumentation amplifier, active filters, multiple gain block and for interfacing to ADC we have to do dc shifting (or clamping) of signal followed by clipping to avoid any residual negative voltages [12].

1) Acquisition System

Acquisition front end system will interface to the body get the EOG signal, amplify it, filter it and pre process it to suit to ADC PCF8591 I2C Based 4 Channel ADC. Left-right signal is given to channel 0 and up-down signal is given channel-1, this ADC is interfaced to Microcontroller P89V51RD2 which is having I2C communication routines. The microcontroller reads the data from ADC using I2C protocol and starts processing. Once data is processed and if any eye movement was there it will conclude which eye movement was made and decodes which command is given using eye. After decoding it sends the command via RF transmitter module using HT640 Encoder.

1) Processing System

Processing of data to decode the eye movements**:**

Basically we get digital data from ADC for each channel, first we are checking for straight sight to avoid noise and electrode not in use case. This we are doing by checking that signal is not varying much it's in some band near center. After the if signal goes up for sufficient time > 200ms then its right eye movement in case of L-R and Up movement in case of U-D, but if signal goes down then its left or down depending on which channel you are processing. Any of the case if it come back before sufficient time then movement is ignored but in case of up down, if signal is up for >50ms to <100ms then its consider as blink movement[14].

Following are the follow charts to detect left, right, up, down and blink eye movements.

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Flow chart for Left-Right Detection

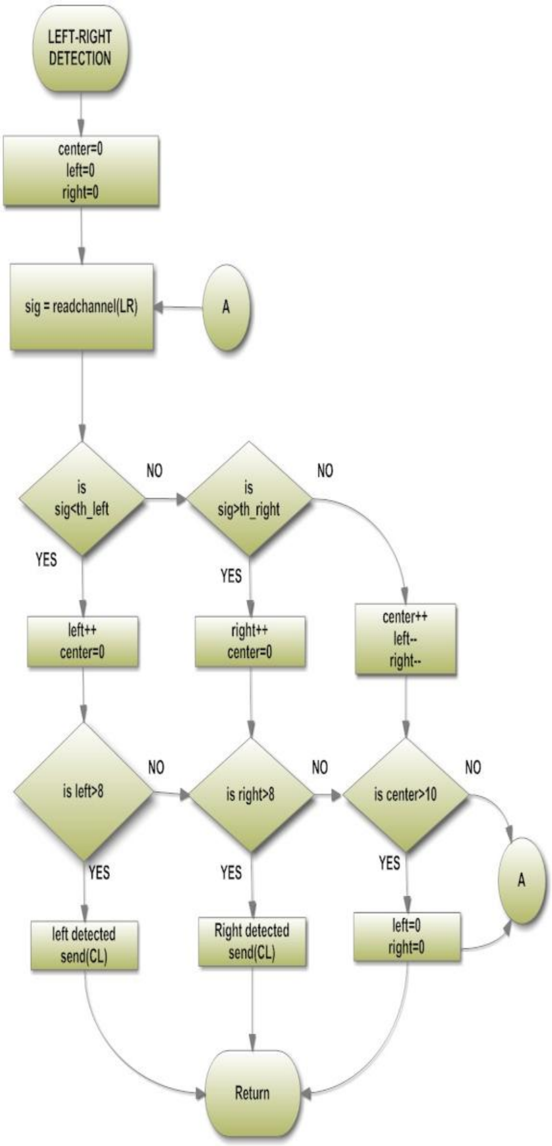


Figure 6: Flow chart for Left-Right Detection.

Flow chart for up-down and blink detections

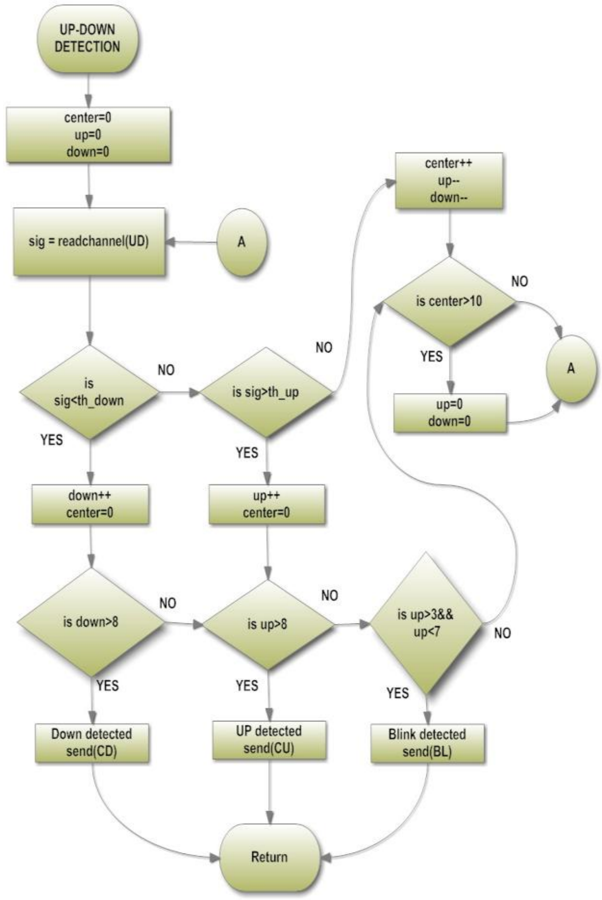
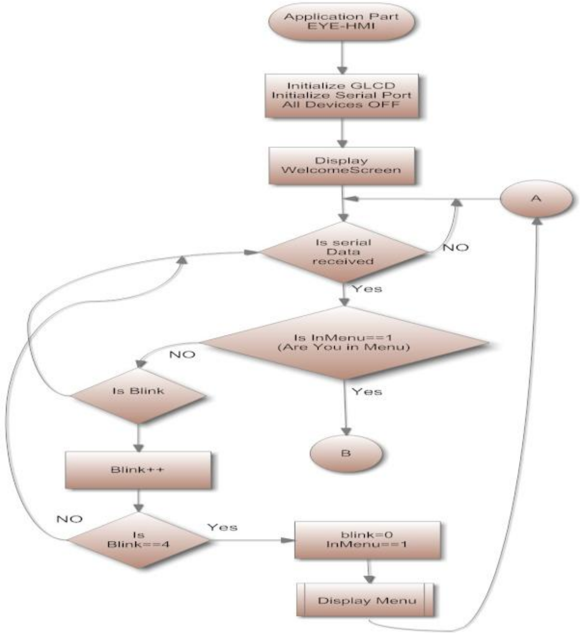


Figure 7: Flow chart for up-down and blink detections.

These commands are sent via RF Tx module at application part end there is RF Rx module which receives the commands and send it to application controller which then drives the cursor and operates buttons on Graphic LCD.

Flow chart for Application



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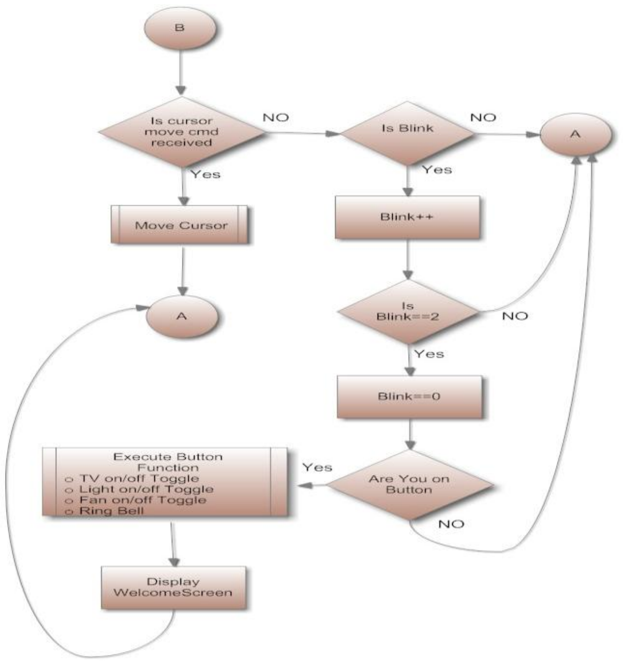

FIG 8: Flow Chart For Application

2) RESULT AND DISCUSSSIONS

The project was tested and following results were obtained:

Intermediate Output of the system is Eye movements and Eye Blinking Commands

CU - Eye up movement detected

CD - Eye down movement detected

CL - Eye Left movement detected

CR - Eye Right movement detected

BL - Eye Blink detected

Above output is sent to application part which interprets and move cursors accordingly and button are clicked using same output and corresponding relay/device is operated and hence appliance is controlled using eye movements, in this project we have successfully controlled appliances using eye movement.

DISCUSSIONS:

- Acquisition module worked well for up,down,left,right and blink commands.
- Acquised data is processed properly andtransmitted wirelessly.
- The receiver module correctly decoded the commands.
- The decoded commands are actioned in synchronization with the eye movements.
- The correct applications are run with the commands.

VI. CONCLUSION

This research project is aimed towards developed a usable a low-cost eyeblink-based communication aid for disabled people and is presented.Experimental results show that it can beused to interact with the computer for people via eye movements.In this work, we presenta system that can be used as a means of controlallowing the severely disabled persons, especially those with onlyeye-motor coordination, to live more independent and sophisticated life. Eye movements require minimum effort andallow direct selection techniques, and this increasethe response time and the rate of information flow.

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