Review on Eye Movement Controlled Wheelchair

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***Abstract* -Eye movement controlled wheelchair is to enable complexly paralyzed patient to make their life more accessible and to provide them opportunity of independence and movement. The idea of eye control is of great use to not only the future of natural input but more importantly the handicapped and disabled. In the paper, we had reviewed about the different eye movement controlled wheelchair. Currently there are different eye based method will be use for wheelchair controlled, available such as EOG based method, eye ball sensing method, camera base method ,etc.**

***Index Terms*—wheelchair, disabled People, EOG electrode, eye ball sensor, camera**

I. INTRODUCTION

Wheelchair is mobility aided device for person with moderate/severe physical disabilities as well as the elderly. In order to take care for different disabilities, various kinds of interface have been developed for wheelchair control: such as joystick control, hands control. However, to steer own wheelchair through a conventional joystick is difficult for people experience total paralysis in all four limbs ,such as muscular dystrophy , spinal cord injury , amyotrophic lateral sclerosis,etc. The idea of eye controls of great use to not only the future of natural input but more importantly the handicapped and disabled.

People who are unable to walk and are using wheel chairs exert great amounts of energy using physical strength to turn a steer the wheels. With eyesight Bering their guide, the disabled would save being their guide, the disabled would save energy and could use their hands and arms for other activates.

II. SYSTEM DESCRIPTION

There are there eye tracking mechanisms to compute the position of pupil.

Electro-Oculogram (EOG) Method-The Electro-Oculogram method obtains the gaze direction by sensing the electrooculographic potential. This is done by measuring the potential using electrodes placed on face where human eye is an electric dipole with a negative pole at the fund us and positive pole at the cornea. One electrode is placed to the side of the left eye and another to the side of the right eye. This pair shall detect horizontal eye movements. One electrode is placed above the left eye and another below the left eye. This pair Detect vertical eye movements. A fifth electrode is attached by the ear to provide reference voltage. These electrodes send the electrical signals to two EOG circuits of similar design to detect the horizontal and vertical movement of the pupil. This Information is sent for computation. The big advantage of this method is the ability to detect eye movements even when they are closed.

Eye ball sensing method- The basic principle of this direction sensing is the colour of the eyes. There are two main color pigments in the human eyes. i.e., black and white. The colures show different wavelengths in the spectrum. The Infrared sensors are placed on either side of the eyes fixed in goggles. Both eyes are lit up by the energy from the Infrared Light-Emitting Diode (IRLED) sections. The silicon phototransistors and the IR sources are mounted in front of the eyes so that the obstruction of the field of view is minimized and the capability to accurately monitor the position of the eye is maintained. The Eye ball position is detected with reference to the Iris.

Camera base method- In this method a non slipping contact lens fits over corneal bulge. The tracking of the pupil is recorded by affixing a magnetic coil or mirror to the lens. The integrated mirror in the contact lens allows measuring reflected light; alternatively, the integrated coil in the contact lens allows detecting the coil's orientation in magnetic field. The big advantage of this method is high accuracy and nearly unlimited resolution in time. Both methods explained so far are obtrusive and are not suited well for interaction by gaze. The third and preferred method for eye-gaze interaction is using video camera.

III. LITERATURE REVIEW

[I] EOG based wheelchair control

The cornea of the eye is electrically positive relate to the back of the eye, the retina. The eye behaves as if it were a single dipole oriented from the retina to the cornea. Such cornea-retinal potentials are well established and are in the range of 0.0.5-3.5mV. Eye Movements thus produce a moving (rotating) dipole source and accordingly, signals that are a measure of the movement may be obtained. The recording and interpretation of the electrical activity of eye is called electrooculography. Its main application is in

Ophthalmological diagnosis and in recording eye movements. Electrodes such as gold surface electrode, Ag-Cl electrodes are used to record the eye potential changes. [1]

The electrodes that we have used here are disposable, disc type surface electrodes, which are of non invasive type. The electrodes are made of silver-chloride since silver has high conductivity. A gel is used in prior to paste the electrodes to the skin. It is nothing bur de ionized water, which favors reduction of skin resistance and allows easy interface of EOG signal with the electrode. A pair of electrodes is placed horizontally to left and right eye. If the eye is moved from the center position towards one electrode, a potential change occurs between the electrodes.The largest variations are usually less than 3.2mV. [2]

The eye movement a paralysis that is caused by serious injuries or illness to a human that lead to a partial or total loss of their lower limb and torso. A person who has such paralysis is highly dependent on an assistant and a wheelchair for movement. It is not always the case where the helper is with the patient all the time, therefore independence is encouraged among the wheelchair users. The signal from the eye muscles that is called electrooculogram is generated at different eye movements' directions and levels. The eye movement signals are acquired using g.USBamp by using Ag/AgCl electrodes. The data is then passed to MATLAB/SIMULINK software for data analysis. [3]

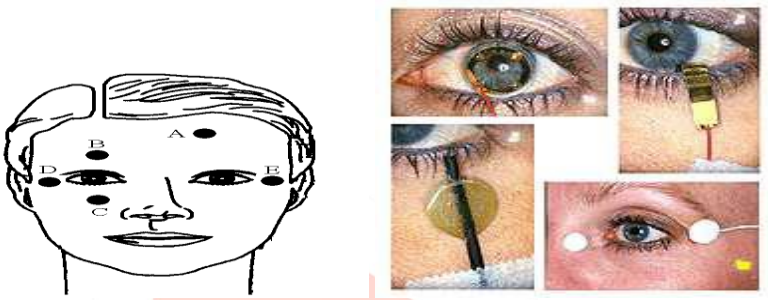

Fig.1 *Electrodes placement and different electrodes[2]*

This system may be used for increasing communication and/or control. The analog signal form 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. The EOG signal changes approximately 20 microvolts for each degree of eye movement. The signal are sampled 10 times per second. [2]

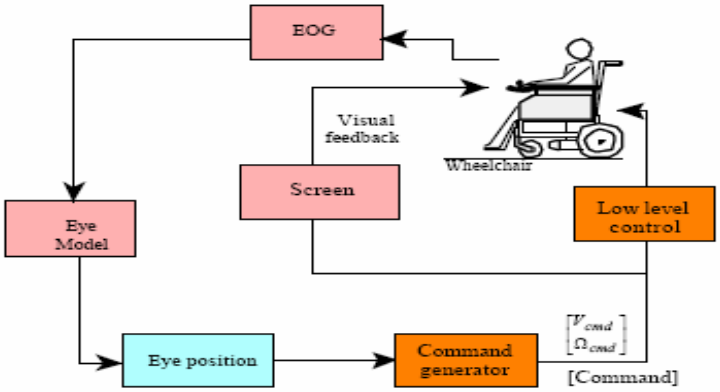

Fig.2 EOG based wheelchair system[2]

The EOG signal is recorded using Ag-AgCl electrodes by means of an acquisition system are sent to an onboard PC in which they are processed to calculate the gaze direction. Then, in accordance with the guidance control strategy and the ocular movement detected , the corresponding control command is activated. The communication between the PC and the motor drivers of the right and left wheels.The low level control of the electronic system for controlling the DC traction motor is implemented with a PID(programmed into Neuron Chip)and its mission is to ensure that the linear speed of the right and left-hand wheels is approximately that indicated on the electronic control cards. [2]

[II]EYEBALL SENSING method for wheelchair control

The basic principle of this direction sensing is the color of the eyes. There are two main colour pigments in the human eyes. i.e., black and white. The colors show different wavelengths in the spectrum. White being the farthest colour in emits the lowest wavelength. So the wavelength of white light is chosen as the standard parameter. White light can be measured by infrared

sensors. The wavelength of the white portion if the eye varies from 600nm to 640 nm. The infrared light ray measures and reflects the wavelength emitted by the white portion and based on that the eyeball sensor is constructed. [4]

The Infrared sensors are placed on either side of the eyes fixed in goggles. The whole circuitry is fitted inside a table-top instrument which is connected to the spectacles through a long flexible cable which performs the analysis, processing and amplification of the signals derived from the sensor's eye-ball movements. Both eyes are lit up by the energy from the Infrared Light-Emitting Diode (IRLED) sections. The silicon phototransistors and the IR sources are mounted in front of the eyes so that the obstruction of the field of view is minimized and the capability to accurately monitor the position of the eye is maintained The Eye ball position is detected with reference to the Iris. Harmless 950nm wave length IR Transmitter and IR detectors are used to sense the position of the Eye ball. The Tx , Rx sensors are positioned in such a way to sense the position of Iris Up/Down ,left/right. [4]

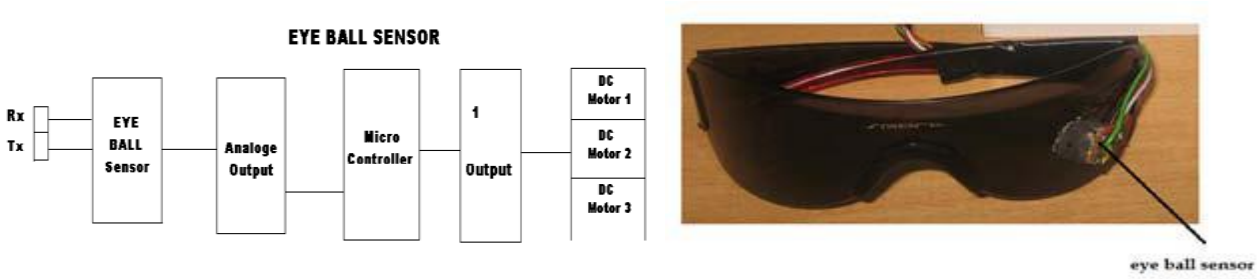

Figure 3: connectivity with wheel chair and eye ball sensor on goggles.[4]

The eyeball sensor is fitted on to the patient and the wavelength of white portion is recorded. Then when the patient wants to move right side, his left eye shows no variation in wavelength but in the left eye the black portion is sensed by the sensor which leads to decrease in the wavelength which automatically indicates to the wheel chair the direction it has to in. the same mechanism happens in the right eye too. [4]

[III] Camera based wheelchair control

The block diagram shown in Fig. 4 shows the block diagram of the Eye Controlled Wheelchair. The eye movement is tracked using a camera mounted on to the headgear. The headgear construction greatly simplifies the optics by using a microlens video camera for dark-pupil tracking. The headgear is equipped with proper illumination. This headgear is interfaced to the laptop/desktop via USB interface through which real time video of the eye is sent. The laptop/desktop hosts image processing software which processes the video feed from the camera and determines the position of the pupil. The laptop/desktop then sends signals corresponding to the pupil position to the micro-controller circuitry which drives the motor through motor driving circuit. [7]

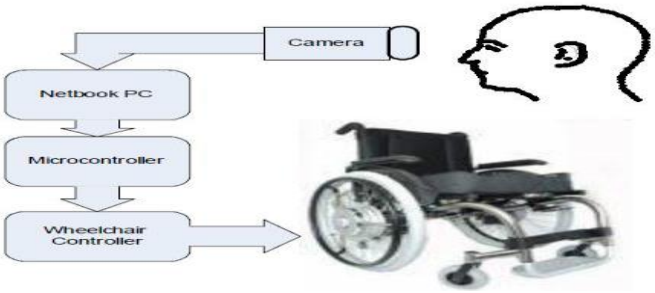

Fig. 4.Block Diagram for camera based wheelchair. [7]

Opto-Isolatoris an electronic device designed to transfer Electric signal by utilizing optical light waves to provide coupling with electric isolation between the input and output. The main purpose of the opto-isolator is to prevent high voltage or rapidly changing current from damaging the serial port of the laptop/desktop. [7]

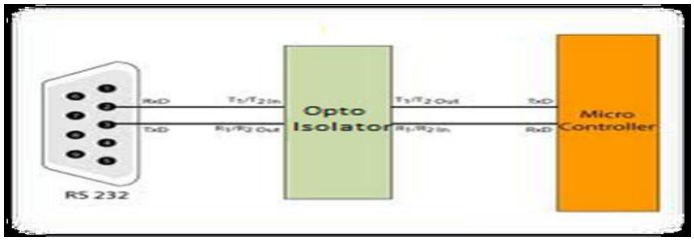

Fig.5optpisoator conection [7]

The signal received from the serial port is the processed by the micro-controller and corresponding control signals are sent to the wheelchair controller. This program embedded into the micro-controller will move the motor in either clockwise or anti-clockwise direction. [7]

Eyeball Extraction

The image captured from the camera is fed to processor. Since the image consists of only the eye, as shown in Fig 1, basic thresholding method is sufficient for the extraction the eyeball. For that purpose, first the RGB image is converted into a gray scale image. Then with proper threshold value, the eyeball is extracted. Along with the eyeball, even the eyelashes get extracted. They are filtered on the basis of area of the extracted region. The eyeball region has the occupies maximum area in the image and thus the eyeball region is extracted by filtering the regions of eyelashes on the basis of area difference. Then the centroid of the eyeball is found out to track the eyeball. We used MATAB and its image processing toolbox for processing the image. We first converted the image into gray scale image and used threshold value of 0.79 to convert it into binary image. [9]

Algorithm

The coherence algorithm works for detecting the motion of eye. This algorithm operates on the frames extracted from the video of the eye. From the frame, the algorithm extracts the pixels which lie on the vertical edges of the rectangular area selected by the user. These pixels are then processed to determine the RGB values. When the user is looking straight in font, the pixels on both the vertical lines are black. This is interpreted as the "center" direction of the user's eye. When user looks towards left, the pixels on the left vertical are black, but the pixels on the right vertical line are white. This can be seen in the Fig. 1 shown below. The closed eye condition is also recognized by the software. This condition is then used to determine the blinking of the eye. The natural blinks of eye are distinguished from the unnatural blinks. The user has to blink his eye for a second if he wants to start moving or stop moving the wheelchair. [6]

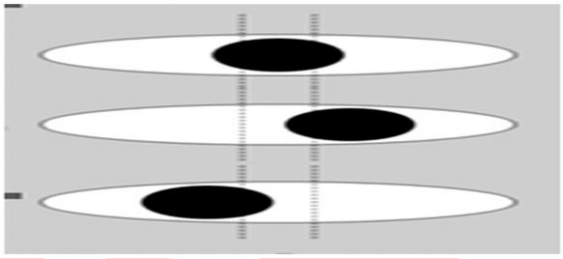

Fig.6 The Two Scan Lines for Detecting the Motion of Eye [6]

Conclusion-

An eye movement wheelchair is any motorized platform with a chair designed to assist a user with a physical disability, where an artificial control system augments or replaces user control. Its purpose is to reduce or eliminate the user's task of driving a motorized wheelchair. Usually, a smart wheelchair is controlled by a computer, has a suite of sensors , etc.The table shows the comparison of the all Related method work.

NO:	Method	Author&Year	conclusion
1	Analysis of Different Level of EOG Signal from Eye Movement for Wheelchair Control	Nurul Muthmainnah Mohd Noor, Salmiah Ahmad,Department of Mechatronics, Kuliyyah of Engineering, IIUM, Gombak, Malaysia	Eye movement can be a very significant communication tool among tetraplegia (quadriplegia) for wheelchair control. The fact is that different tetraplegic may have different eye movement strengths to be used for commanding the wheelchair to move.
2	Eye Controlled Wheel Chair Using EOG	Alex Dev, Horizon C Chacko and Roshan Varghese, (ICCCE 2012), 12 & 13 April, 2012	Eye movements require minimum effort and allow direct selection techniques and this increases the response time and the rate of information flow. the acquired EOG signal was very low amplitude. the above signal was very noisy such that it was not able to feed into the microcontroller.
3	Automation of wheelchair using ultrasonic and body kinematics	Preethika Britto, Indumathi. J,Sudesh Sivarasu, Lazar Mathew, CSIO Chandigarh, INDIA, 19-20 March 2010	The eyeball sensor was tested with various samples against normal and hemiplegic patients. The following results were obtained, they were found to be almost stable and reliable a person using a wheelchair and eyeball technique should not be limited by the device intended to assist them if the environment have accessible features.

4	Iris Movement Tracking by Morphological Operations for Direction Control	Yash Pathak, Samir Akhare, Vishal Lambe Yeshwantrao Chavan College of Engineering, Nagpur September - 2012	Our contention is that eye-movement tracking represents an important, objective technique that can afford useful advantages for the in-depth analysis of interface usability. The user has to only look left or right to move the robotic vehicle towards the desired direction. The diagonal motion is achieved when user looks left or right for only small duration of time .
5	Eye Controlled Wheelchair	Sandesh Pai, Sagar Ayare, Romil Kapadia, October-2012	This system consists of a camera, micro-controller and wheelchair controller. This hardware along with the software can prove to be an effective system to make the life of the paraplegic patients independent.The critical part of the system is image processing at real time which can be addressed by using better high end image processing software.

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[4] Automation of wheelchair using ultrasonic and body kinematics ,Preethika Britto,Indumathi.J,Sudesh Sivarasu,Lazar Mathew, CSIO Chandigarh, INDIA, 19-20 March 2010

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[7] Eye Controlled Wheelchair,Sandesh Pai, Sagar Ayare, Romil Kapadia, October-2012

[8] Iris Movement Tracking by Morphological Operations for Direction Control ,Yash Pathak, Samir Akhare, Vishal Lambe. September – 2012.

[9] Eyeball and Blink Controlled Robot with Fuzzy Logic Based Obstacle Avoidance System for Disabled K.S.Sabarish, A.M.Suman, (ICEEE'2012) June 16-17, 2012, Bangkok.