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# Eye Movement Based Wheelchair Control System for Physically Challenged Persons

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***Abstract*— *The proposed Eyes base Electronic Wheel Chair is controlled by human eyes only. This concept can be used for people with loco-motor disabilities. The proposed system involves three stages: image detection, image processing and sending of processed signals to the controller. The eye movement is detected using a camera. The images of the eye will be sent to the laptop where the images will be processed and the corresponding output signals are then send to the microcontroller and then motor driving circuit which controls the motor.***

**Keywords-** camera; RF module; image processing unit; controller; motor driver

## I. INTRODUCTION

A wheelchair is nothing but a chair that helps disabled people to move from one place to another. The device comes in variations allowing either manual propulsion by the seated occupant turning the rear wheels by hand, or electric propulsion by motors. There are often handles behind the seat to allow it to be pushed by another person. Wheelchairs are used by people for whom walking is difficult or impossible due to illness, injury, or disability. People who have difficulty sitting and walking often make use of a wheel bench. A basic manual wheelchair incorporates a seat, foot rests and four wheels: two caster wheels at the front and two large wheels at the back.

Sometimes, moving freely is difficult for a person with a physical disability although electric wheelchair is available in the market for them, but some disabled people cannot drive an electric wheelchair manually even with a joystick. They lack the physical ability to control the movement.

To enable a disabled person to drive a wheelchair safely and easily, researchers have proposed several electric wheelchair systems, such as:

Voice Based wheelchairs use user's voice as source input. Voice analysis is used to analyze user's voice and to convert it into digital data. The weakness of this system is vulnerable against noise. Other voices which come from surrounding user may affect the system.

- Motion based method, utilizes other normal movement organs to operate computer input. Head, foot, etc can be used to control computer input.
- Image Analysis method, utilizes camera to analyze user's desire and convert it into digital data. Several image processing methods are used to analyze user's desire. The user's desire itself can be fulfilled by Gaze based analyzer to detect user's desire from users gaze, Face based analyzer detects user's desire from face expression etc.

One of the important process of the proposed system is detecting and tracking the eye movements. This concept will be an eye movement based controlled wheelchair system. A camera will track the movement of eye and control a wheelchair to go forward, stop, left or right. The most challenging aspects will lie in finding a good way to differentiate iris and pupil locations, determining the eye‘s movement, and controlling the wheelchair‘s wheels in proper movement.

## II. LITERATURE SURVEY

There were many previous works carried out on electric wheelchairs. And some of them helped us to get ideas for this concept.

There are devices like keyboard, mouse and other input devices that have been used to interact with digital instruments. Handicap people cannot operate these computer devices. In this prototype, the computer input device by human eyes is for handicap person and for wearable computing. The computer input devices existing can be divided into different categories:

Bio-potential based method: Bio-potential based method is a method which utilizes potential from user's body actions acquired by using special instrument. Instruments such as Electrooculography, Electromyography, and Electroencephalograph (EEG) search coil can be used for measuring bio-potential. The search coil output can be used as sources of computer input for handicap person. EOG method[3] uses voltage differences between fore and aft surface of eyes.

Advantages: Potential Difference can be calculated easily in both light and dark.

Drawback: Poor gaze direction accuracy compared to video tracker, is relatively costly.

Voice based method: It uses user's voice as source input. Voice analysis is used to analyze user's voice and convert it into digital data. The weakness of this system is vulnerable against noise. Other voices which come from surrounding user may affect the system.

Drawback: Less accurate.

## III. SYSTEM MODEL

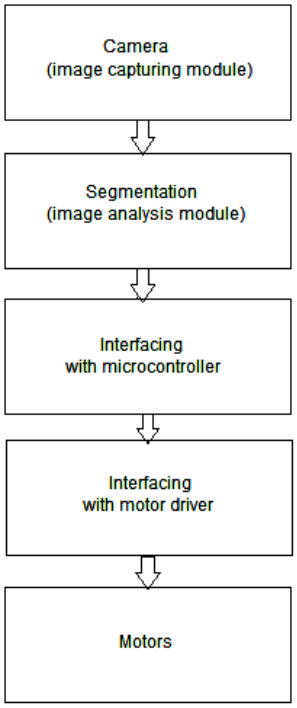


Figure 1 System Model

### A. *Image Capturing Module*

The eye capturing module consists of a camera that captures the image of eye ball. It captures a sequence of iris position, since iris is small in size and dark in color, it is difficult to acquire good image. Before applying this signal to the Image analysis module, it should be converted to gray signal from RGB. For taking a perfect iris pattern, we must have enough resolution camera.

### B. *Segmentation - Image Analysis Module*

Segmentation is a process of dividing a digital image into a multiple regions and extracting meaningful regions known as Region of Interest (ROI). The main objective of segmentation is to remove non useful information, namely the pupil segment and the part outside the iris. Daugman proposed an integral-differential operator to find both the pupil and the iris contour. Daugman's method is claimed to be the most efficient one.

The algorithm will perform the iris recognition in two steps:
STEP 1: Finding pupil at the center.
STEP 2: Finding the direction of eye.

STEP 1: Finding pupil at the center.

First step is to calculate the Gaussian blur function. In image processing, a Gaussian blur (also known as Gaussian smoothing) is the result of blurring an image by a Gaussian function. Basically a Gaussian blur is a low pass filter. Which reduces the image's high frequency components. Mathematically, applying a Gaussian blur to an image is the same as coiling the image with a Gaussian function.
The equation of a Gaussian function in one dimension:

$$G(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$$

and in two dimension:

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

where x is the distance from the origin in the horizontal axis, y is the distance from the origin in the vertical axis, and σ is the standard deviation of the Gaussian distribution.

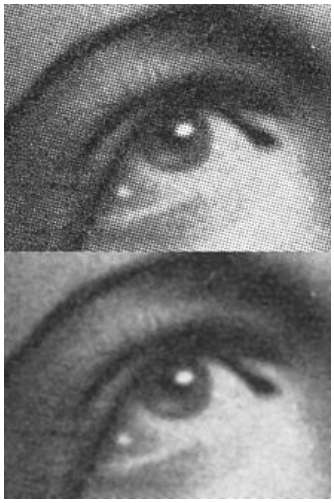

Figure 2 Gaussian blur can be used in order to obtain a smooth grayscale digital image.

STEP 2: Finding the direction of eye.

In this step, the image is given to MATLAB for processing and an output image with the coordinates of iris and pupil. The size of the output image will be 320*240.The output image will be divided into nine cells.

| | | |
|---|---|---|
| (1,1) | (1,2) Top | (1,3) |
| (2,1) Left | (2,2) Straight | (2,3) Right |
| (3,1) | (3,2) Bottom | (3,3) |

**Cell**(1, 2): pupil position as Top.
Condition: if ((x > 120 and x < 188) && y <105))
**Cell** (2, 1): pupil position as Right.
Condition: if ((y > 105 and y < 130) && x <120))
**Cell** (2, 2): pupil position as Straight.
Condition: if ((x > 120 and x < 188) && (y > 105 and y <130))
**Cell** (2, 3): pupil position as Left.
Condition: if (x > 188 && (y > 105 and y < 130))
**Cell** (3, 2): pupil position as Bottom.
Condition: if ((x > 120 and x < 188) && y >105))

### *C. RF Transmitter*

A wireless radio frequency (RF) transmitter and receiver can be easily made using HT12D Decoder,HT12E Encoder and ASK RF module.

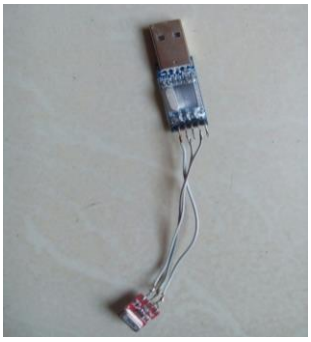

Figure 3 RF Transmitter

### *D. RF Reciever*

An RF receiver module receives the modulated RF signal, and demodulates it.

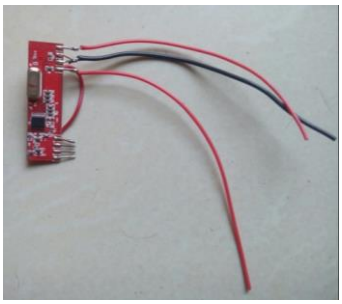

Figure 4 RF Receiver

### *E. Microcontroller*

The microcontroller will take a USB output from the laptop and will apply it to the control output signal to motor driver that will interface with wheelchair for movement.

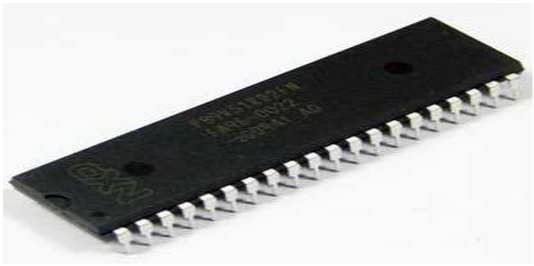

Figure 5 Microcontroller

## IV. CONCLUSION

This paper has presented how using a wheelchair system operated by eye movements, disabled person can move from one place to the desired without any problem. It consists of eye tracking webcam, microcontroller, motor, chair image processing unit and associated circuits. The motion of the eyeball is tracked by using a webcam in the system. The movement is obtained due to the image processing with the

help of python software. To make the life of paralytic people independent such a hardware along with the software is a great tool.

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