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EYE CONTROLLED WHEELCHAIR BASED ON ARDUINO CIRCUIT

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Abstract— **Statistics suggests that there are around 40 cases per million of quadriplegia every year. Great people like Stephen Hawking have been suffering from this phenomenon. Our project attempts to make lives of the people suffering from this phenomenon simple by helping them move around on their own and not being a burden on others. The idea is to create an Eye Controlled System which enables the movement of the patient's wheelchair depending on the movements of eyeball. A person suffering from quadriplegia can move his eyes and partially tilt his head, thus giving is an opportunity for detecting these movements. There are various kinds of interfaces developed for powered wheelchair and also there are various new techniques invented but these are costly and not affordable to the poor and needy people. In this paper, we have proposed the simpler and cost effective method of developing wheelchair. We have created a system wherein a person sitting on this automated Wheel Chair with a camera mounted on it, is able to move in a direction just by looking in that direction by making eye movements. The captured camera signals are then send to PC and controlled MATLAB, which will then be send to the Arduino circuit over the Serial Interface which in turn will control motors and allow the wheelchair to move in a particular direction. The system is affordable and hence can be used by patients spread over a large economy range.**

Keywords- **Automatic wheelchair, Iris Movement Detection, Servo Motor, Daugman's algorithm, Arduino.**

I. INTRODUCTION

Powered wheelchairs having high navigational flexibility are one of the most important devices for the physically disabled and mentally handicapped people. For normal people, driving wheelchair is difficult and it is more difficult for handicapped people. Automated wheelchair is a mobility-aided device for people with moderate/severe disabilities or also for elderly. There are various interfaces developed for dealing with patients suffering from different disabilities; such as joystick control, head control and voice control. Not all people are able to navigate using the above mentioned interfaces. Foe such people, the eye controlled interface is the way out. This interface is not only for people who are unable to use other interfaces but this can be used by old people as well. This wheelchair will help them carry out their tasks more comfortably.

II. PROBLEM STATEMENT

A clinical survey indicates that 9-10% of severely disabled patients having difficulties find it impossible in using powered wheelchair in spite of having some training in handling and operating the wheelchair. This indicates that they are lacked of motor skill and strength and difficult to operate a sophisticated wheelchair functions. Our system aims at user friendly product which requires no rigorous training.

III. LITERATURE REVIEW

A. Software:

Current input devices such as joystick, keyboard, mouse and other devices which are used for interaction with the automated devices require various hand movements. These input devices cannot be used by people suffering from physical disabilities. The existing devices and their disadvantages for handicap person are as categorized:

(1) Bio-potential based method which utilizes potential from user's body actions acquired by using special instrument. Instrument such as Electrooculography (EOG), Electromyography (EMG) [1], and Electroencephalograph (EEG) [2], Search coil can be used for measuring bio-potential. The search coil output can be used as sources of computer input for handicap person.

Limitations of this method are poor gaze direction accuracy compared to video tracker, relatively costly.

(2) Voice Based method [3], which use user's voice as source input. Voice analysis is used to analyze user's voice and convert into digital data. This type of system is vulnerable

against noise. Other voices which come from surrounding user may affect the system.

Limitations of this method are it is less accurate on background noise, speaker variability , channel variability , speaking style , speed of speech , etc

(3) Motion based method [4] , utilizes other normal movement organs to operate computer input. Head, foot, and etc. can be used to control computer input.

Limitation of this method is that it requires human effort to navigate like joystick, etc. Also for a handicapped with any of the organs failed is not useful.

(4) Search coil method [5] uses induced voltage with coil including in contact lenses attached to user‘s eyes.

Limitation of this method is burden to user, here measuring time is limited to approximately 30 to 60 .They have limited Lifetime.

(5) Image Analysis method, utilizes camera to analyze user's desire and convert into digital data. Several image processing methods are used to analyze user's desire. The user's desire itself can be done by Gaze based analyze user's desire from users gaze, Face based analyze user's desire from face expression, and the others.

This method is costly.

B. Hardware:

(1) USB cable: In computing, a USB cable is a serial communication physical interface through which information transfers in or out one bit at a time

(2) Arduino: Arduino is a simple microcontroller board and open source development environment that allows you to make computers that drive both functional and creative projects alike.

(3) L298D allows DC motor to drive on either direction.

IV. PROPOSED METHODOLOGY

A. System Overview:

Consists of three main parts:

(1) Camera mounted on the wheelchair and laptop for tracking the movement of the users eye.

(2) The Arduino board will take the camera signal detected by Matlab code from the laptop and convert the digital output to electric signals that will be sent to the wheelchair wheels for movement.

(3) A signal triggered Wheel Chair.

B. General Architecture and Description:

Movement of eyeball is tracked for locating the motion of eye. According to the tracked location of the of the eye, the direction of the possible motion is found. Based on this direction determined, the command is transferred to the motor control device via Arduino. The eye motion tracking hardware is as shown in the figure 1:

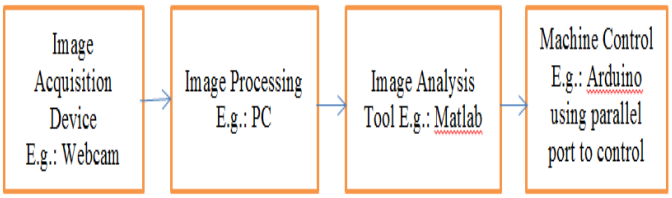

Fig 1: Basic Block Diagram

Image Acquisition Device: It consists of a web camera with suitable interface for connecting it to PC.

Processor: It consists of personal computer or a dedicated image processing unit.

Image Analysis: Certain tools are used to analyze the content in the image captured and derive conclusions e.g. Matlab 7.0

Machine Control: After making the conclusion, mechanical action is to be taken e.g. using parallel port of a PC to control the vehicle movement.

Arduino Board: Arduino board is used to pass the matlab signal to the motor driving circuit.

Motor Driver Circuit: Depending upon signal received from microcontroller it will send particular signal to DC motor in order to avoid drive wheelchair forward, backward, left and right.

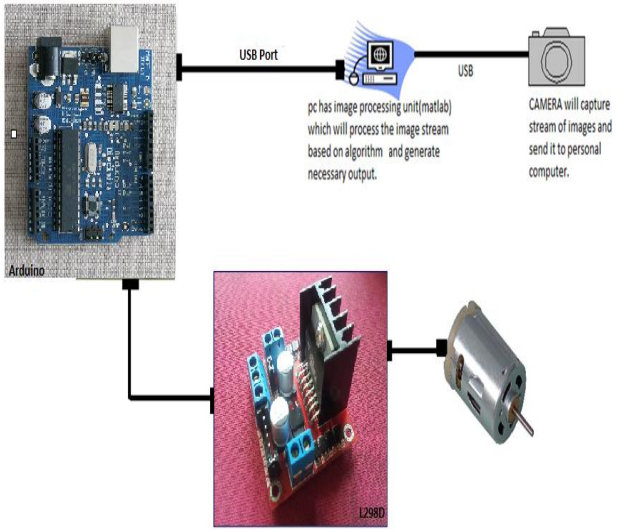

Fig 2: System Description Diagram

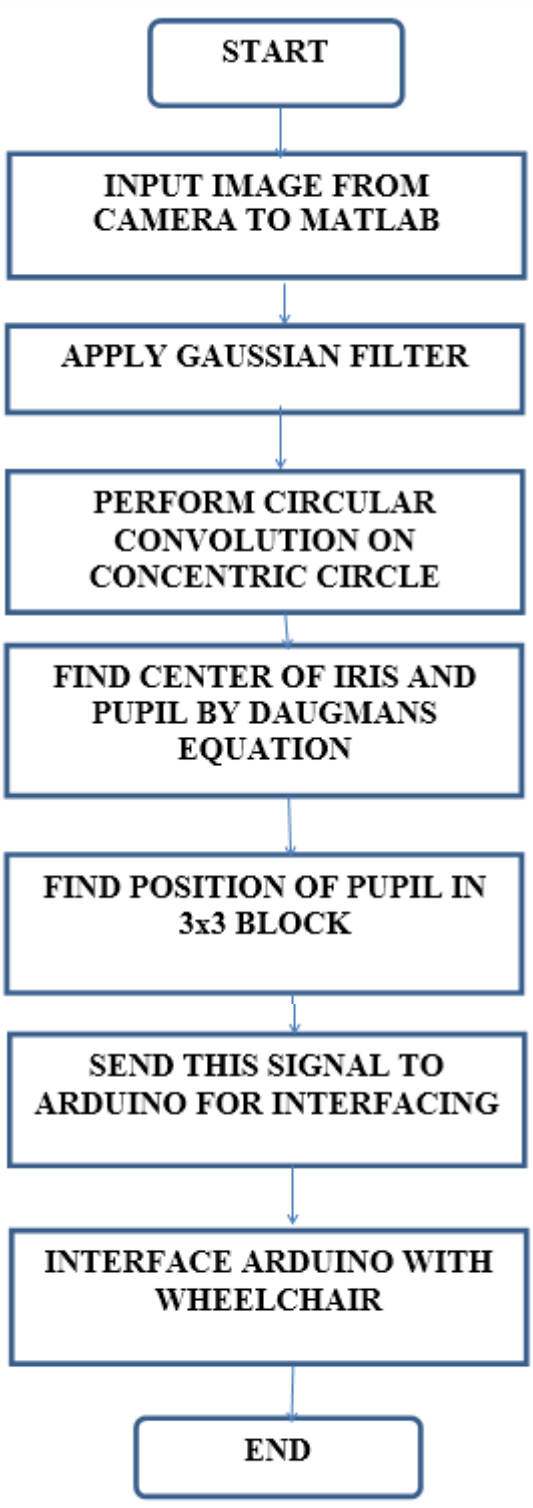

Fig 3: Flow graph of the system

C. Algorithm/ Method:

1. Input the image from camera into Matlab.

2. Apply Gaussian blur function. This creates two concentric circles. Values from this distribution are used to build a convolution matrix.

3. This convolution matrix is applied to original image. This results in the center pixel having highest weight and neighboring tool having smaller values.

4. Center of the pupil is located by Daugmans' formula

$$_{(r,0,y0)} = \partial/\partial r \left(\int_0^{2\pi} I(r * \cos\theta + x0,\ r * \sin\theta + y0) \right.$$

Where r is the radial distance from center and θ is the phase angle.

5. Matlab frame is divided into 3x3 matrix wherein the frame size is 320*240. Since the breadth of the rectangle is responsible for dividing the rectangle into three rows, 240 should be divided into three parts. But in order to reduce errors the Center or Second row is given a little smaller width. Similarly the length of the rectangle is responsible for dividing the rectangle into three columns 320 should be divided into three parts. To reduce errors the center or second part is made of smaller width.

Depending upon the location of pupil in these blocks action is performed.

- **Block (1, 2)**

The output coordinates of the iris satisfying below condition will detect the pupil position as **Top**.

Condition: if ((x > 120 and x < 188) && y < 105))

- **Block (2, 1)**

The output coordinates of the iris satisfying below condition will detect the pupil position as **Right**.

Condition: if ((y > 105 and y < 130) && x < 120))

- **Block (2, 2)**

The output coordinates of the iris satisfying below condition will detect the pupil position as **Straight**.

Condition: if ((x > 120 and x < 188) && (y > 105 and y < 130))

- **Block (2, 3)**

The output coordinates of the iris satisfying below condition will detect the pupil position as **Left**.

Condition: if (x > 188 && (y > 105 and y < 130))

- **Block (3, 2)**

The output coordinates of the iris satisfying below condition will detect the pupil position as **Bottom**.

Condition: if ((x > 120 and x < 188) && y > 105))

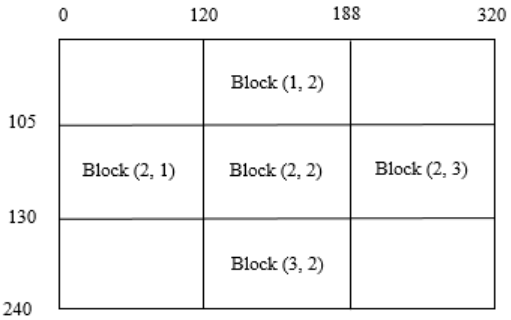

Fig 4: Image Processing Diagram

V. EXPERIMENTAL RESULT

(1) The UI of the system is designed in such a way that it is easier for the people to use. Also it has the facility for adjusting the threshold according to the eye size for capturing the pupil movement.

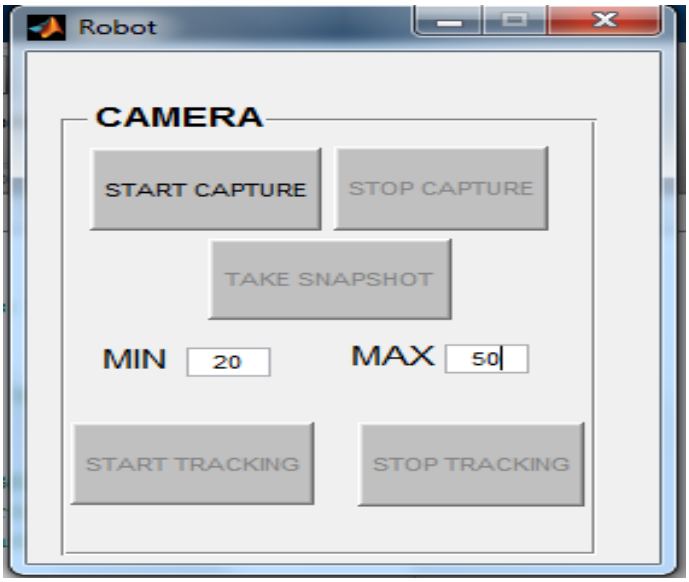

Fig 5: Snapshot for UI

(2) The input and its corresponding images shown below are produced after using Daughman's algorithm on input image for processing in MATLAB. The position of iris and pupil will be detected. And the position of the image is detected and the decision for the given below input image will be produced as LEFT or RIGHT respectively.

Fig 6: Snapshot of user looking leftward

Fig 7: Snapshot of user looking rightward

(3) The input and its corresponding images shown below are produced after using Daughman's algorithm on input image for processing in MATLAB. The position of iris and pupil will be detected. And the position of the image is detected and the decision for the given below input image will be produced as CENTER and UPWARD in fig 8 and 9 respectively.

Fig 8: Snapshot of center position

Fig 9: Snapshot for user looking up

VI. CONCLUSION

In this system we present an innovation in ordinary wheelchair by adding motor type mechanism and making easier and simple wheelchair to handle by using eye motion tracking for physically disabled and paralyzed. The aim of this system is to contribute to the society in our small way by setting out an idea for a system which could actually better the lives of millions of people across the globe.

The future scope of this system would be to develop a mobile app to manage the wheelchair control. Also introducing home automation in the system would be an added feature of the wheelchair where a disabled person can turn on/off home appliances without getting up from his position.

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