

# Review Paper on Wheelchair Control Using Eye Movement

Priyanka Kokaje<sup>1</sup>, Nitesh Rane<sup>2</sup>, Prathamesh Shelar<sup>3</sup>, Omkar Tarave<sup>4</sup>, Prof. Vinayak Chavan<sup>5</sup>

Department of Electronics And Telecommunication

Finolex Academy Of Management And Technology, Maharashtra, India

**Abstract-** This paper describes about tracking of eye and detection of system to control the wheel chair. This is used for the handicapped person. The paper describes about various techniques and algorithms that can be used by a person for controlling wheelchair using eye movement.

[1]The video is taken and from that video snapshots will be taken of every 25th frame and then the information is extract which will be useful in detecting motion of the eye of the person or user. Later this processed in open source software. The output obtained from software is further given to motors which drive the wheel of wheelchair. The idea behind this is to make a physically challenged people independent.

**Keywords-** Image processing ,Viola-Jones algorithm, Eye detection, Coherence algorithm , Circular Hough Transform , Daughman algorithm.

## I. INTRODUCTION

The number of people in the world are paralyzed due to which they lose their self mobility so with the developing world this people are facing lot of challenges.The advancement of manual powered wheelchair with electrical wheel chair are seen worldwide. Manual powered wheelchairs tend to use external helping hand for pushing and people who are unable to do this suffer from various problems they need to be dependent on another person for this purpose. The persons who are unable to move their voluntary muscle suffer from various diseases and it also affects their nervous system. Voluntary muscle plays important role in enabling people to move their body. The paralysis effects the human body as it restrict the person from moving their locomotor organ such as leg, arm and others. Paralysis may be local or global or follow specific patterns [1]Sclerosis (ALS) in 1962, there after using a wheelchair to move .Many of those suffering from paralysis can control their eye movement which inspired us to develop an eye-controlled wheelchair which will be harmless and make the patient independent.

## II. LITERATURE SURVEY

There are many people who are not able to move wheelchair on their own and according to survey many

suffer from disease like quadriplegia .Many people previously worked on this so by taking analysis for previous works. Studying various surveys and analyzing the information from the reviews the wheelchair can be controlled with eye movement. The computer input devices such as keyboard, mouse, and the other input devices have been used to interact with digital instruments.The handicap persons cannot handle these devices. In this paper, a commands are given by detecting the motion of human eyes so computer input is human eyes it is only is proposed for handicap person. This can be divided into five categories-

### A.Bio-potential based control[15]

In this method by recognizing the bio-potential signals the interface recognizes the person gestures like forehead movement, closing the jaw using special instrument. Instrument such as Electrooculography(EOG)[11] Electromyography (EMG), and Electroencephalograph (EEG)[12], Search coil can be used for measuring bio-potential.EOG [13] method take into consideration voltage differences between the image before and after.

### B. Voice based control

In this technique person voice is use as input source which use user's voice as source input. Wheelchair control is obtained using voice commands. Voice analysis is used to analyze user's voice and convert it into digital data. The disadvantage of this system is it is vulnerable against noise. Other voices coming from surrounding atmosphere have effect on this technique.

### C. Motion based control

In this technique user's various moving organs are used to control the computer input. Moving organs include hand, head, foot etc.

### D. Image Analysis method

In this technique user utilize camera to capture image of the desired object and after which it is converted 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 [16] analyze user's desire from users gaze, Various algorithms are present to carry out image processing.

#### E. Search coil method [8]

This technique uses induced voltage with coil including in contact lenses attached to user's eyes.

Studying and analyzing various aspects of each method image based method is taken into consideration for full-filling the objective of wheelchair control.

Many people have worked on this problem with help of algorithms like [10] Coherence Algorithm, Daughman's Algorithm and Viola-Jones Algorithm Various algorithms gives results but accuracy of result depends on type of algorithm used.

### III. ALGORITHM'S

#### A. Coherence Algorithm-

The motion of eye of the person is detected using coherence algorithm. The snapshot of the motion of human eye is taken which is like video from which frames are extracted. The operation is further carried out by considering these frames. The algorithm later extracts the pixel which lie on the vertical edge of rectangular area which is selected by user from the frame. These extracted pixels from the frame are further processed for determining the RGB values. When user is looking towards left direction pixel on left vertical line is observe to be black and that on right vertical line is white. When the user is looking at straight direction the pixels on both lines are black pixels .

When user is looking towards right pixel on right vertical line is black and on left vertical line is white. The above interpretation is justified by observing fig.III.A shown below.

The case when the person eye is closed is also considered by software.This condition then can be used to determine the blinking of the eye. The blinking of eye of user which takes place naturally by user is different from the unnatural or intended blinking of eye. The user has to blink his eye for a second if he desire to stop or start the moving of wheelchair.

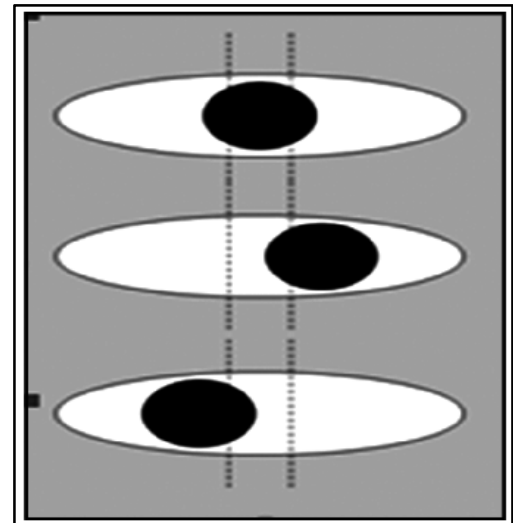


Fig III.A Coherence algorithm

#### B. Doughman's Algorithm

This algorithm uses for iris recognition.The operator assumes both pupil and iris with circular form. two pre-process operations are done which contributes to the improvement of result.

##### Histogram Equalization :-

This operation improves the improves the contrast between each eye's regions, which helps the segmentation task.

##### Binarization ;-

Image binarization which gives the separability between iris region and remaining region.

Daughman's algorithm is based on the applying the differ

ential operator to find the iris and pupil region. The image is then scanned for circles which contain maximum gradient change, which indicates the edges. The threshold value is determined to be 200 for the gray scale image. The bright spot value usually higher than 245 will be canceled. Basically system is essentially work for localize inner and outer boundaries of the iris in image of an eye. Further the upper and lower eyelids detection has to be done. This methodology selects to search regions to detect upper and lower iris. . After edge detection process edge image of an eye is generated. As the iris region is segmented from captured image the next stage is to transform the iris region which fixed the dimension in order to allow comparison. After this it compares the previously stored templates values for the

images with the current image and depending upon the threshold value iris is recognized.

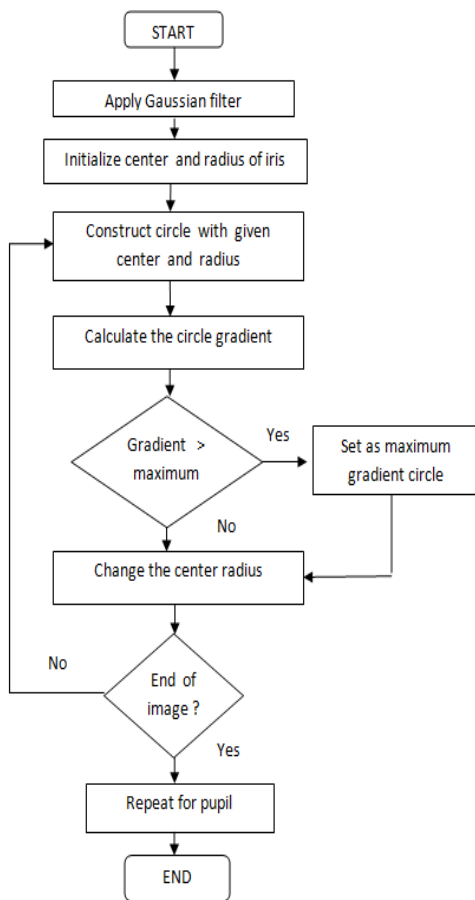


Fig III.B Flowchart of Doughman’s algorithm

C. Circular Hough Transform

The circular Hough transform is basic technique used in digital image processing used for basic application that is detecting circular objects in digital image. The basic purpose of this technique is to find circle in a perfect image inputs. For this circle candidates are produced by voting in hub parameter space and then selecting a local maxima from the accumulator matrix.

From the definition of circle in 2-D space is given by equation

$$(x-a)^2+(y-b)^2=r^2$$

where, (a ,b) is a centre of circle and r is radius of circle. If we have fixed 2-D point (x ,y) then according to above equation we find respective parameters. So here parameter space would be 3-D that is (a ,b, r).All the parameters that satisfy (x, y) would lie on surface of inverted right angled cone whose apex is at (x,y,0).In 3-D space the

circle parameter can be determined by many conic surfaces that are defined by points on 2-D circle. Basically this process carried out in two steps to be carried out-

- 1) Fixing the radius
- 2) Find the optimal centre of circles in 2-D parameter space.

Accumulator matrix and voting-

The accumulator matrix is matrix used to find the intersection point in a parameter space. The element of accumulator matrix gives us no. of circles in a parameter space. That number of circles is called as voting number. After that voting process we are able to find local maxima in accumulator matrix and depending upon positions of local maxima are corresponding to circles centre in original space.

Algorithm

1. For each A [a,b,r]=0
2. The filtering process on given image is carried out using Gaussian blurring to convert the image in gray scale for particular filtering operation which is used in this algorithm. Also we used a Canny Operator which gives edges on the image
3. Now vote all possible circles in accumulator
- 4.Finally local maxima voted circles from accumulator A gives circle Hough space .
5. Maximum voted circle of accumulator gives us desired circle from the image.

So this is all about overall concept of Circular Hough Transform technique whose basic job to detect circles in given digital image but apart from this it has some limitations which are as follows-

1. A parameter space for circular Hough transform is 3-D so required lots of storage in computation.
- 2 .Circular Hough transform is not robust to noise.

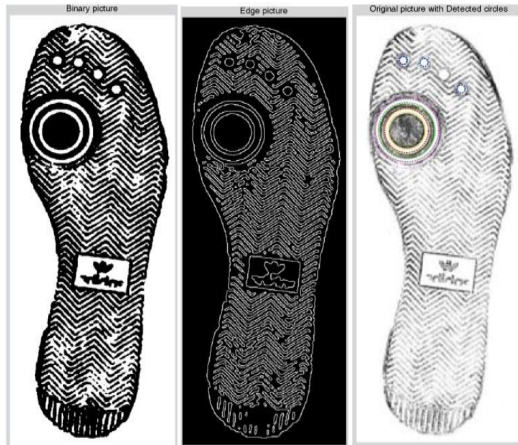


Fig III.C. Circular Hough Transform

D.Viola-Jones algorithm

The Viola- Jones algorithm deals with detection of faces in an image. The researcher’s have made advancement in detecting faces. It is easy for humans to detect faces but computer uses only binary language so its difficult for them so instructions and commands are necessary. To make the task more easy to perform, Viola-Jones requires full view frontal upright faces. The basic starts with using camera in which the person eye image is captured. The person should look forward towards camera in order to capture image but if camera is tilted on either side then output may not be as desired and thus wrong interpretation can be done by software as detection of eyes is oftenly followed by recognition. Viola Jones algorithm, deals with face detection so it can also easily detect the eyes of the user. This algorithm is based on haar like features [10]. They are called haar features because of their similarity with Haar wavelets. Haar like features exhibit rectangular structure as shown below. These features are mainly used for feature detection. The sum of the pixels from the white portion is subtracted from the ones present in the grey portion. Figure (5.2a) & (5.2b) [3] shows the two rectangle feature which is the sum of the difference between the two regions. It is the adjusted on basis of person left eye. Algorithms being used for the tracking and detection process such as Viola-Jones and template matching. Algorithms works according to following procedure .

Viola Jones algorithm uses 24\*24 window as the base window to start evaluating the features in any given image. If all such features are considered it will result into 160,000+ features in this window. Later integral image allows for calculation of sum of pixels inside any given rectangle using only four values of the rectangle, this eases the job of calculation. There are total 160,000+ features used for face detection but our aim is to deal with eye detection so out of all this features only few features will be needed for this adaboost

filter comes in action. Adaboost filter deals with selecting suitable and best features among all these 160,000+ features. Weighted combination of these features is used to interpret whether window contain face or not. Selected features selected by these filter are considered to be suitable if they can perform better than random guessing. These features are also called weak classifiers. Adaboost construct strong classifiers as linear combination of weak classifiers. The algorithm deals with scanning may times through the same image each time with new size. All non faces all discarded quickly and algorithm concentrate on probable face regions. Classifier is used to compute best results but instead of using single classifier cascade classifier is used. Single classifier need more computation cost as compared to cascade. So cascade classifier is used which is composed of stages where each stage has certain number of features. This results into obtaining accurate result that is whether given sub window has definite face or not. This algorithm tend to give user accurate results.

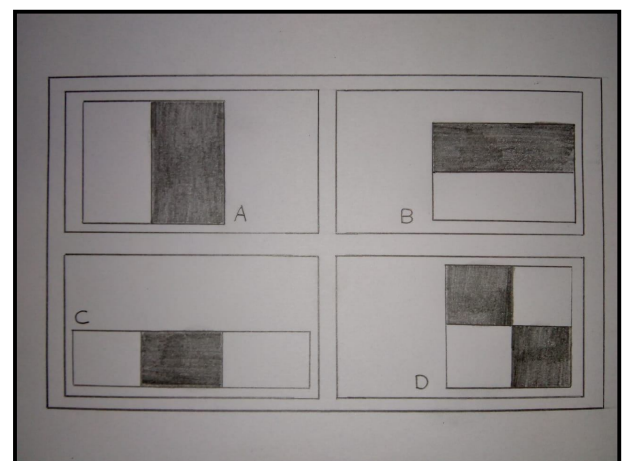


Fig III.D.1 Rectangle features

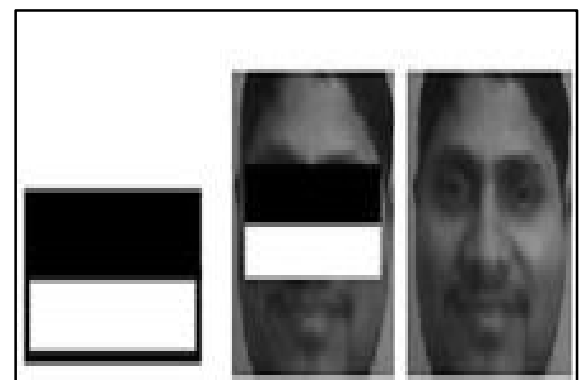


Fig III.D.2 Haar Feature

**IV. PROPOSED METHODOLOGY**

**A. System overview**

Consists of three main parts:

(1) Webcam mounted in front of person sitting on wheelchair will capture the movements of eye.

(2) A decision based on the processing done by the open source software application is communicated and received by the ATMega1284P. The receiving commands or signals when received by controller the port pin becomes high on which the motors have been connected for desired motion of the Wheel Chair.

(3) A Wheel chair on which assembly will be mounted.

**V. GENERAL ARCHITECTURE**

The block diagram of overall system is shown in fig.1.

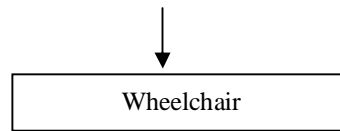
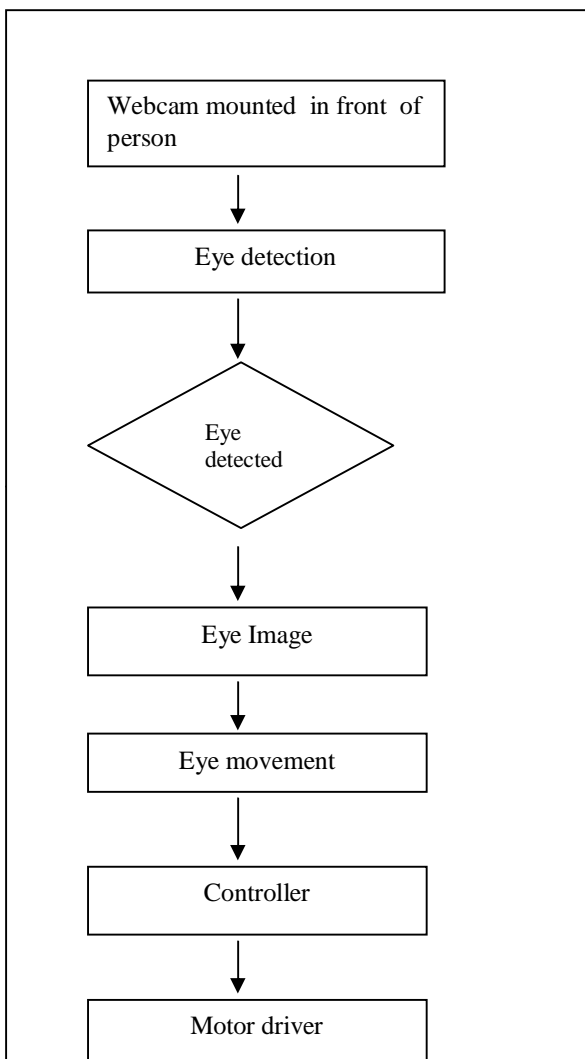


Fig-1 Flowchart of architecture

**VI. DESCRIPTION**

**A. Eye Movement detection**

The image undergoes processing before the eye is detected. The image obtained is first converted into grayscale image and then contrasted so that darker parts become darker and brighter part becomes brighter which improves the eye detecting capability of the Viola Jones algorithm. The resolution of this grayscale image is 720x1280. The Viola Jones algorithm is applied to detect both the eyes. The image is cropped according to requirement.

**B. Motor control based on eye position**

O	SR.N	EYE PUPIL POSITION	WHEEL CHAIR POSITION
1		Top right	Right
2		Bottom left	Left
3		Centre	Centre
4		Blink	Stop

Table 1-Eye and wheelchair positions

Controller will drive motor based on above table-1.

a)Valid Left: The decision to turn left will be considered as valid if the eye turns left and stays there for a cycle. This action will be detected by controller as a request to turn left. After that, the patient will turn right to again look forward. This signal should be considered as void.

b)Valid Right: The decision to turn right will be considered as valid if the eye turns right and stays there for a cycle. This action will detect as the user want to turn at right and thus will result right turn request. The patient will turn left if he desires to move wheelchair in forward direction. Thus, this signal should be considered as void.

c) Valid Straight: The person when is looking at right and now intend to look towards forward condition then person will look at left from its current position and vice versa then the command detected will be straight forward. This will give command as to go straight.

d) Given the application of the system safety mechanism is incorporated, wherein based on the blink detection the wheel chair halts. If the user wants to halt the wheel chair in case of an emergency, he can blink thrice, causing the wheel chair to halt.

## VII. CONCLUSION

This paper presents the system that works on the detection of pupil using webcam which is continuously staring at patient's eye. Image processing is done with open source software like scilab, octave and the images are obtained. This system is set up for paralyzed or handicapped people. The combination of the hardware and software makes the life of paralyzed people self dependant.

## REFERENCES

- [1] Shruti Kulkarni, Prashali Sharma, Nilay Chowdhury, Tanay Chowdhury, "Smart Mutatable Advanced Technology Wheelchair", IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) e-ISSN: 2278-1676, p-ISSN: 2320-3331, Volume 10, Issue 6 Ver. II (Nov – Dec. 2015).
- [2] P.komal.vaishnavi, M.pavitra, "Face Recognition using VIOLA-JONES Algorithm", IJSRT Journal
- [3] Dabhade, Sarala A., and Mrunal S. Bewoor. "Real Time Face Detection and Recognition using Haar-Based Cascade Classifier and Principal Component Analysis." International Journal of Computer Science and Management Research 1.1 (2012).
- [4] D. Cagigas and J. Abascal. 2004. Hierarchical path search with partial materialization of costs for a smart wheelchair. Journal of Intelligent and Robotic Systems. 39(4): 409-431.
- [5] M. Challagundla, K. Yogeshwar Reddy and N. Harsha Vardhan. 2014. Automatic motion control of powered wheel chair by the movements of eye blink. 2014 IEEE International Conference on Advanced Communications, Control and Computing Technologies, Ramanathapuram, 2014, pp. 1003- 1007.
- [6] M. A. Zia, U. Ansari, M. Jamil, O. Gillani and Y. Ayaz. Face and eye detection in images using skin color segmentation and circular hough transform. 2014 International Conference on Robotics and Emerging Allied Technologies in engineering (iCREATE), Islamabad. pp. 211-213.
- [7] W. W. M. Khairousfaizal, A.J Nor'aini. 2009. Eyes detection in facial images using circular hough transform. Signal Processing & Its Applications 2009. CSPA 2009. 5th International Colloquium on. pp. 238-242.
- [8] Gunda Gautam, Gunda Sumanth, Karthikeyan K C, Shyam Sundar, D.Venkataraman, "Eye Movement Based Electronic Wheel Chair For Physically Challenged Persons", International Journal Of Scientific & Technology Research Volume 3, Issue 2, February 2014
- [9] Michael F. Land "Eye movements and the control of actions in everyday life" 5. S. Tameemsultana and N. Kali Saranya, "Implementation of Head and Finger Movement Based Automatic Wheel Chair", Bonfring International Journal of Power Systems and Integrated Circuits, vol. 1, Special Issue, pp 48-51, December 2011
- [10] Poonam S. Gajwani, Sharda A. Chhabria, "EYE MOTION TRACKING FOR WHEELCHAIR CONTROL". International Journal of Information Technology and Knowledge Management July-December 2010, Volume 2, No. 2, pp. 185-187
- [11] K. T. V. Grattan, A. W. Palmer, and S. R. Sorrell, "Communication by Eye Closure-A Microcomputer-Based System for the Disabled", IEEE Transactions on Biomedical Engineering, Vol. BME-33, No. 10, October 1986.
- [12] Q.X. Nguyen and S. Jo, "Electric wheelchair control using head pose free eye-gaze tracker", Electronics Letters, Vol. 48 No. 13, 21st June 2012
- [13] Q.X. Nguyen and S. Jo, "Electric wheelchair control using head pose free eye-gaze tracker", Electronics Letters, Vol. 48 No. 13, 21st June 2012
- [14] Djoko Purwanto, Ronny Mardiyanto, Kohei Arai, "Electric wheelchair control with gaze direction and eye blinking", Artif Life Robotics, 14:397-400, May 18, 2009.
- [15] S. Mitra, T. Acharya: —Gesture Recognition: A Survey, IEEE Transactions on Systems, Man, and Cybernetics, Part C: Applications and Reviews, Vol. 37, No. 3, May 2007, pp. 311 – 324.
- [16] L.R. Rabiner: —A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition, Proceedings of the IEEE, Vol. 77, No. 2, Feb. 1989, pp. 257 – 286.
- [17] Viola Jones Algorithm- [http://en.wikipedia.org/wiki/Viola%E2%80%93Jones\\_object\\_detection\\_framework](http://en.wikipedia.org/wiki/Viola%E2%80%93Jones_object_detection_framework)
- [18] Motor Controller circuitry from ECE 4760 web page for lab

<http://people.ece.cornell.edu/land/courses/ece4760/labs/f2013/lab4.html>

[19] Cascade Object Detector –  
<http://www.mathworks.com/help/vision/ref/vision.cascadeobjectdetector-class.html>