International Journal of Advance Engineering and Research Development (IJAERD)
Volume 1,Issue 5,May 2014, e-ISSN: 2348 - 4470 , print-ISSN:2348-6406

# WHEELCHAIR MOVEMENT USING EYEBALL DETECTION

Parth Pancholi[1], Jaimeet Patel[2], Saumil Ajmera[3]

[1]*Dept. of Electronics & Communication, G H Patel College of Engineering & Technology, Vallabh Vidyanagar, India, parth5151@yahoo.com*
[2]*Dept. of Electronics & Communication, G H Patel College of Engineering & Technology, Vallabh Vidyanagar, India, jvp3005@gmail.com*
[3]*Dept. of Electronics & Communication, G H Patel College of Engineering & Technology, Vallabh Vidyanagar, India, saumil92@yahoo.in*

**Abstract--**Designing a wheelchair is dealing with a thought of blending emotions with technology of unbeatable standards. The essence of scientific advancements is purely put through vigorous thought process considering and exploring all the availablepossibilities. Manually operated wheelchair; helping the physically challenged in their mundane life made their work dogmatic. Therefore, being an engineer, it is a task of elephantine proportions to put forth some of the technological developments which can render flexibility and robustness for the endemics. Hence, the idearose to make an "AUTOMATED WHEELCHAIR" which can be regulated by EYE-BALL movement. So an individual can control his/her wheelchair and can mitigate the dependency. Navigation and control serves as the major limitation of the overall performance, accuracy and robustness for this intelligent vehicle. This concept will address the problem and provide aunique navigation and control scheme for an automatic wheelchair utilizing the concepts of Image Processing and other guiding technologies.

**Keywords**--wheelchair, manually, automated, eyeball, navigation, image processing

## Introduction

In this paper, a method for eyeball localization is proposed for controlling wheelchair. To achieve higher level of accuracy and precision, an algorithm is furnishedwithvarious processing steps and develops an efficient system to reduce both the cost and the computational complexity.

Primary goal was to detect eyes reliablyin real-time and also to keep track on it, so a study of the physical properties of the pupil and eyes wasdone and also pixel values of the nearby locationswere analysed. Localization of eyeball is useformany applicationsand there are many algorithms developed which can easily provide the desired result. However all these algorithms can be executed on a controller with limited RAM speed andhence it became mandatory for us to develop an algorithmspecific for this application andit isdetailedin this paper.

Secondary goal was to make hardware assembly which can take command outputted from detected eyeball location. This in turn leads us to a fully automated wheelchair for the physically challenged people mounted with gear box, wiper motor and power supply. In the end, it was an integration of various modules and other add-on features assembled on the wheelchair which can make it more affordable and viable to the people. Conceptualization and implementation of this project was aimed keeping in mind the larger welfare of the human society.

## Existing Technique

In our systemwe have used Harr Cascade classifier developed by Intel. In this systemthe eyeball is detected with reference to the coordinates of the face and the eyeball can be located accurately by using geometrical technique and statistical analysis which prevents the unwanted detection of resembling features of the face to the eyeball.

## Problem Definition

Harr Cascade classifier had some drawbacks, i.e. it took more computational time in Raspberry Pi(an object similar to eye)which lead to vague results and during dark night time the threshold value had to be changed manually in order to obtain better results. It took around 0.69 s in windows and 2.16 s in Raspberry Pi. Also when we switched over to windows, it substantially impacted the overall price as the laptop was required to be mandatorily interfaced with our system.

## Proposed Scheme

Our approach highlighted the use of Hough Circle library of open CV to make the process of eyeball detection rapid, accurate and easier. As the execution time for obtaining coordinates of centre of eyeball detected was precisely 0.2s in Windows and 1.2s in Raspberry Pi which was comparatively less to the existing techniques used.IR LEDs were placed besides IR webcam in order to make the absorption of the incident rays of IR LEDs by the eyeball and reflection of the rest which in-turn helped us to detect the eyeball accurately.

Designing of the Wheelchair was an important task as it had to be full proof to make the overall system act without a glitch. For weight reduction mild steel was used to manufacture the wheelchair. For high torque generation 24 V wiper motor was used and to reduce speed andsmoothening the motion of wheelchair gearbox having ratio of 10:1 was used.

## Implementation of Proposed Scheme

a) Preparation of IR webcam

Normal webcam contained IR filter in front of lens which avoided thepsyshovisualeffect being captured. IR filter had to be removed from the webcam manually. IR LEDs were placed besides the webcam. IR rays had to be absorbed by the eyeball and rest of the IR rays were reflected back to webcam which made it easy to localize an eyeball.

b) Platform Selection:

A system had to be reliable and economical. Therefore use of an open source platform for coding was mandatory. Platform used for development of this system were Wheezy: An open source OS for Raspberry Pi controller, Open CV: an open source library for real time image processing and Python:a widely used general-purpose and high-level programming language for mathematical analysis.

c) Eye ball localization:

Step 1: Image Capture

IR webcam captured video of frame size 640×480 which had to be placed at a distance of about 5.5 cm from any of the eye. Obtained coloured frameswere converted into grayscale images. These imageswere resized by factor of0.25 to further reduce the computational time.

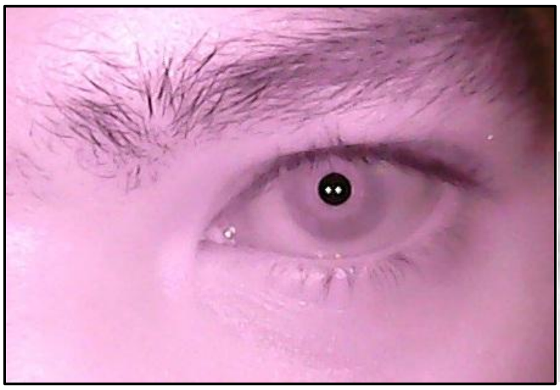


Fig. 1.1 Image Capture by IR webcam Fig. 1.2Conversion of Image to gray scale and scaling

Step 2: Application of Hough Circle

Hough Circle is a library of Open CV which wasutilized to detect circle and provided coordinates of centre and radius of circle detected. Resized image was applied to Hough Circle to obtain the coordinates of the centre of eyeball. An array of X and Y coordinates of centres of all frames was formed.Sorting this array and obtaining the median removed bogus values which were accidently generated by Hough Circle.

Fig. 2.1Detection of eyeball using hough circle and various other computations

Step 3: Formation of Rectangles

Previously obtained centre was used to form rectangles which contained whole eye image and was cropped to further reduce the size. Threshold of 30 was applied to the cropped image. Resultant image wasthen divided into three parts i.e. left, middle and right. Numbers of black pixel were counted in all three regionsand the maximum of three decided the logic to drive a wheelchair. If all the three regions had no black pixels, then the blink was assumed to be detected.

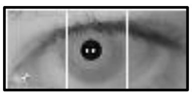
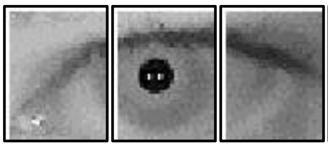


Figure 3.1 Formation of desired size rectangle around the eyes



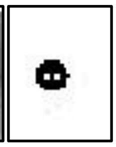


Figure 3.2 Formation of desired size rectangle around the eyesFigure 3.3Locating the maximum number of black pixels in middle region in the above figure 3.2

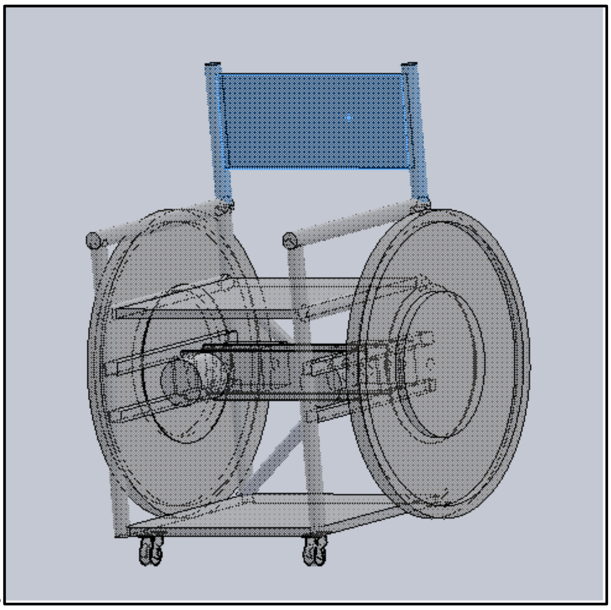
Step 4: Deciding the break points

To make a wheelchair automatic, user needed to have all the control to start and stop the system. For this we developed a logic based on blink detection. A flag variable was defined which decides ON/OFF control of motors. Once, four consecutive blink were detected the flag variable was inverted and the state of motor was changed from ON state to OFF state or vice-versa.

d) Wheelchair Designing

Once the logic was obtained from the controller, it had to be appropriately givento the motors through driver circuit. Drivercircuit converted 5V logic signal into 24 V to drive the wheelchair. A gear box of 10:1 was used to reduce the speed and to increase the torque. To reduce weight related issues we have used Li-Po battery which was of 12V but only of 300gm.

Driver circuit consist of components like transistors, diodes, relays and GPIO hub by which raspberry pi is directly connected with GPIO cable. There is H bridge connection between power supply and motor switching based on eyeball detection.



s

Figure 4.1 3-D Model of wheelchair design using MS material

Step1: Weight of individual components

Mass of body = 22kg

Mass of driving motor (2 pcs.) = 1.5kg

Mass of gear box (2 pcs) = 1.3 kg

Mass of Driving Wheel (2 pcs.) = 1.8kg

Mass of Free Wheel (2 pcs.) = 0.4 kg

Mass of Power Supply Battery (2 pcs.)= 0.8 kg

Miscellaneous Masses = 1.5kg

Mass of person =80kg (max)

Total Approximate Weight = 110 kg X 9.81m/s$^2$

=1079.1 N

Dimensions of wheelchair = height*length*breadth

= 60cm*50.28cm*57.23cm

Step 2: Torque Calculations

Force (F) = μ X N

(Where μ = Coefficient of friction between surface and rubber and N = Normal force)

F = 0.35 X 1071.14 N

T = F X r

= 0.35 X 1071.14 N X 0.33 m
= 123.71 Nm

T (Per Motor) = 61.3 N-m

Here, the input torque $T_a$ applied to the input gear GA and the output torque $T_b$ on the output gear GB were related by the ratio

$R = T_b/T_A$ $10=T_B/28.23$ $T_B$=282.3 N-m , Where R is the gear ratio of the gear train

As $T_b$is greater than $T_a$ which was in load condition and hence it can be easily driven

Step 3: Power Calculations

$P = \frac{2\pi NT}{60}$ (where N = rpm of the motor & T= Torque)

$= \frac{2X3.14X4X123.71}{60}$
= 50.66 W

Two 12V batteries having 5000mAh discharge rate were connected in series so the total battery rating would be given by,

Battery Rating= 24V*5Ah=120Wh

Total Discharge Time=Battery Rating/P

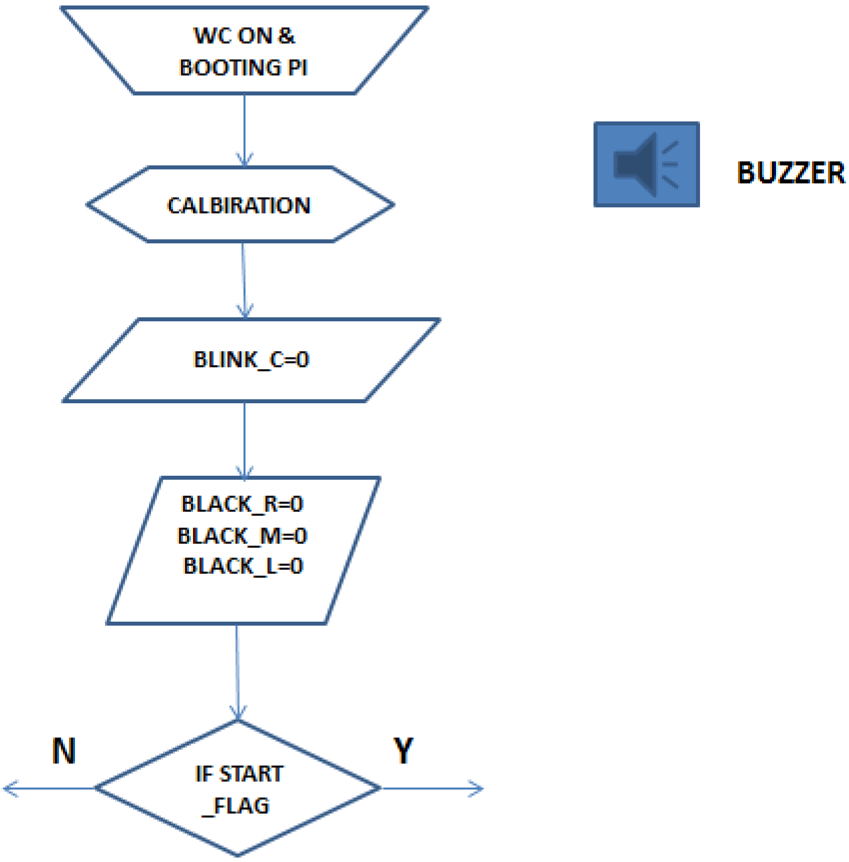
= 120/50.66 =2.36h

This wasthe discharging time of a Li Po battery for driving a Wheelchair

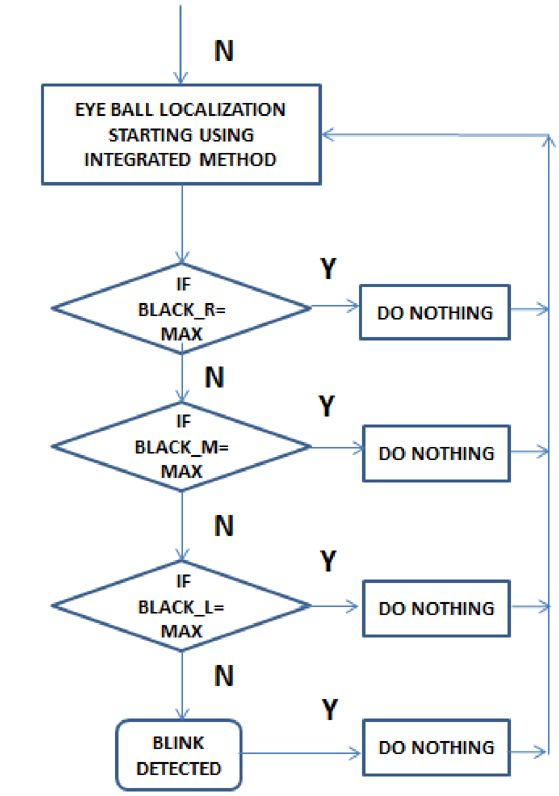
 

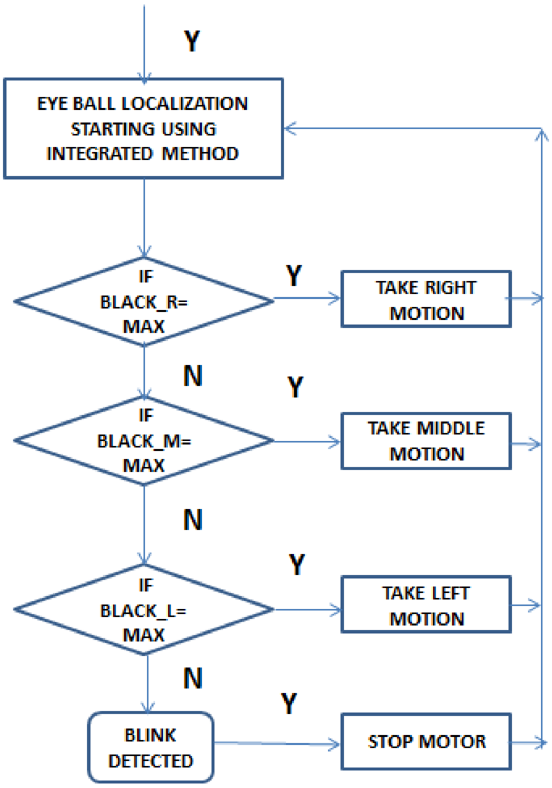
Two 24 V wiper motor were mounted on the shaft of the wheelchair. It provided high torque which was necessary for driving the wheelchair under the load condition of approximate weight of 100kg-120kg

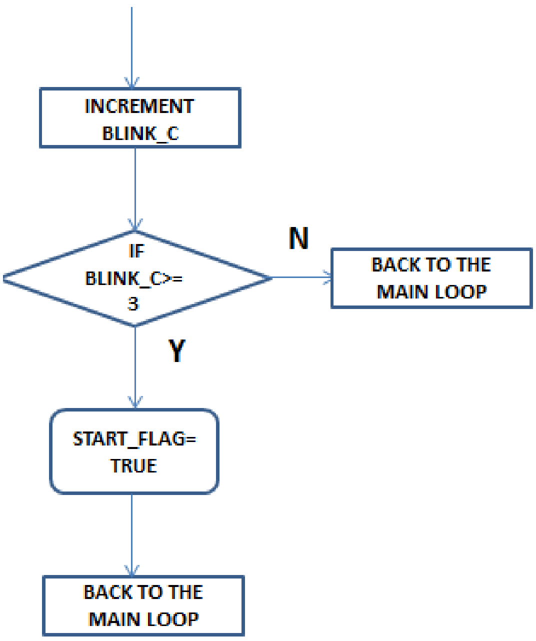
**Final System Flowchart**

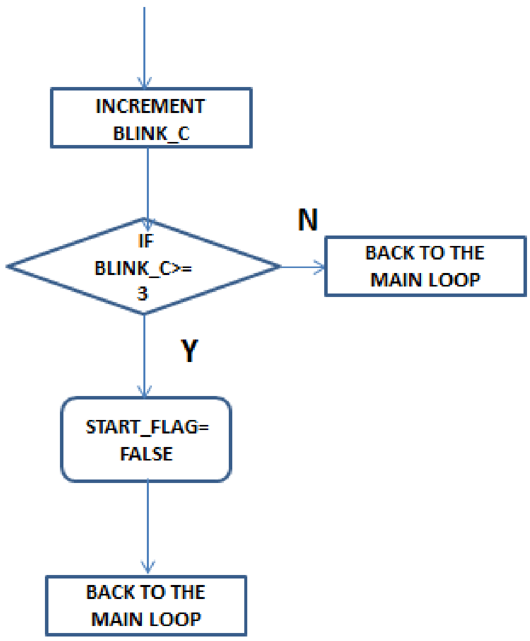



N
EYE BALL LOCALIZATION STARTING USING INTEGRATED METHOD
IF BLACK_R= MAX
Y
DO NOTHING
N
IF BLACK_M= MAX
Y
DO NOTHING
N
IF BLACK_L= MAX
Y
DO NOTHING
N
BLINK DETECTED
Y
DO NOTHING


Y
EYE BALL LOCALIZATION STARTING USING INTEGRATED METHOD
IF BLACK_R= MAX
Y
TAKE RIGHT MOTION
N
IF BLACK_M= MAX
Y
TAKE MIDDLE MOTION
N
IF BLACK_L= MAX
Y
TAKE LEFT MOTION
N
BLINK DETECTED
Y
STOP MOTOR


INCREMENT BLINK_C
IF BLINK_C>= 3
N
BACK TO THE MAIN LOOP
Y
START_FLAG= TRUE
BACK TO THE MAIN LOOP


INCREMENT BLINK_C
IF BLINK_C>= 3
N
BACK TO THE MAIN LOOP
Y
START_FLAG= FALSE
BACK TO THE MAIN LOOP

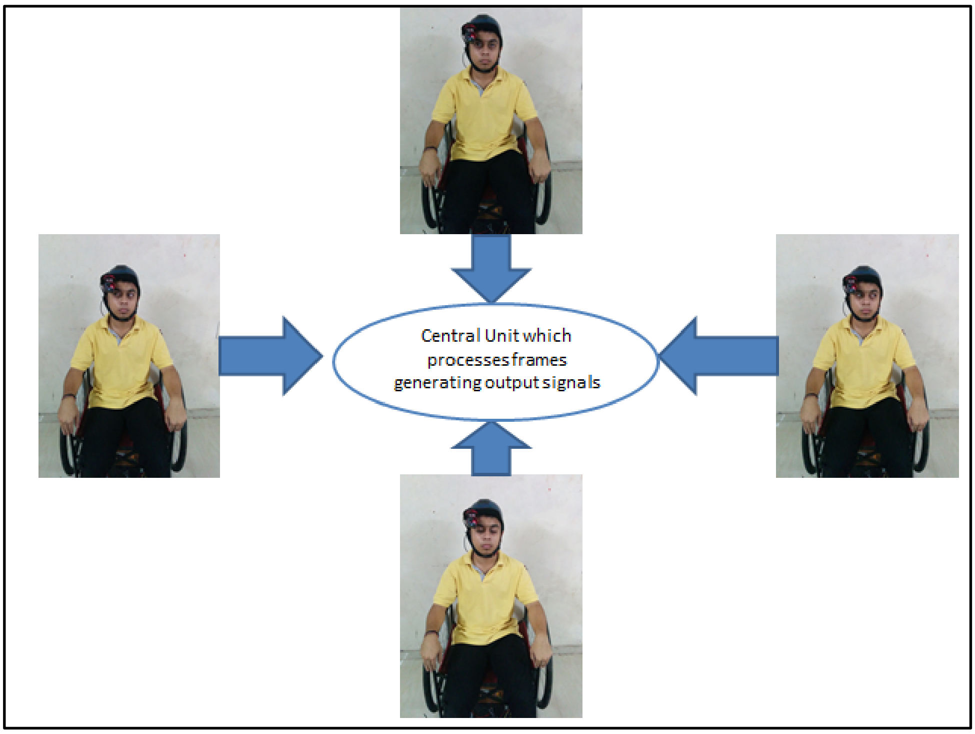



Figure . 5.1 Subject in command for controlling the wheelchair

## Suggested Add-on Features

Some of the features which can be added in order to make wheelchair easily operable arebuzzer or speaker command which can assist any operator to control wheelchair. Also a display device can be kept in front of the person in which a GUI is created A user manual canalso be provided for the knowledge regarding maintenance and guidance of various components at regular intervals.

## Conclusion

In this paper, a specific technique to design an automated wheelchair through eyeball detection for the physically challenged individualsis presented. The result obtained is suitable for driving the wheelchair smoothly for any physically impaired person of any age. Besides this IR LEDs can be turned OFF during day time to reduce power consumption and exposure of eye to IR rays which on constant exposure can cause damage to eye. Final system is fully robust and is provided with user manual for any maintenance related issue of any components.

## Acknowledgments

At the outset we would like to express our deep sense of gratitude to our respected guide Mr Rahul Goradia whose knowledge has guided us constantly throughout the whole project building period. We also pay our respects to our Professor Nilesh Desai who has inspired us to take up the challenge in the domain of Image Processing and embedded system design. We are also thankful to Professor Shankar Parmar who has helped us at every stage of Image Processingdomain. We are also kind to mechanical faculty and students who have helped us in undertaking the designing of wheelchair.

## References


1 "Navigation and Control of an Autonomous Vehicle" by IAN SCHWORER (Copyright 2005)

2 "Mobile Robot Positioning: Sensors and Techniques" Journal of Robotic Systems Vol. 14, Issue-4 (1997)

3 Antonio Haro Myron FlicknerIrfanEssa- Detecting and Tracking the Eyes using their Physiological Properties, Dynamics and Appearance –Appearance in proceedings of CVPR 2000 pp 163-168

4 M. Eriksson and N. Papanikotopoulos. Eye tracking for detection of driver fatigue. In *IEEE Conference on IntelligentTransportation Systems*, pages 314{319, 1997.

5Open CV &Python Tutorials-Alexander Mordiventsev & Abid K

6 Raspberry Pi and Open CV_arindyblog PDF

7 elinux (elinux.org) (instrucatables.com) (stackoverflow.com)

8 I. Essa. Computers seeing people. *AI Magazine*, 20(1):69–82, Summer 1999.