

Eye Monitored Wheelchair System Using Raspberry Pi

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ABSTRACT: The purpose of eye movement based control electric wheelchair system is to eliminate the requirements of the assistance required for the disabled person. The implemented system will be allowing the disabled persons to control the wheelchair movement without the assistance from other persons. In this system control of wheelchair carried out based on Eye pupil movements. The camera is mounted in front of the user, to capture the image of any one of the Eye pupil (either left or right) and tracks the position of eye pupil with the use of Image processing techniques. According to the position of the eye, wheelchair motor will be directed to move left, right and forward. In addition to this, for the safety purpose ultrasonic sensor is mounted in front of wheelchair to detect the obstacles and automatically stop the wheelchair movement.

I.INTRODUCTION

Eye movement controlled wheelchair is to enable completely paralyzed patient as well as elderly to make their life more accessible [6]. Person who are unable to walk and are using wheelchair exert great amount of energy using physical strength to turn the wheels. Disabled would save energy and could use their hand and arm for other activities. Eye controlled wheelchair system is introduced using camera for capturing the image. Camera captured the image in real time based on face, eye and eye pupil detection with minimum delay of time and analyse the image as input to interface the motor driver IC, to perform the different operation such as left, right, forward and stop. Image processing open computer vision library is used for face and eye detection. Several Algorithms are used to find exact pupil location direction. Haar cascade like feature detection algorithm is used.

Currently different eye based method are used for controlling wheelchair such as EOG, ECG, EEG based, Eyeball sensing method [1][2]. Location of eye pupil decided depends on voltage variation. But different output voltage will be generates for different user, which gives wrong location of the eye pupil [4]. Voice activated power wheelchair system, which works properly when user speak the command clearly, according to it left, right, forward, back and stop. Other voices which come from surrounding user may affect the system. The head movement based system and chin control based system, bad movement gives problem [5]. Sip and Puff wheelchair system, not good for people with weak breathing. Infrared reflection based eye pupil detection system provide accurate detection of eye pupil centre location. But the infrared radiation affects the eye and people may loss the eye visibility.

Raspberry pi board is soul of the system, which control the complete system operation. Image processing based data signal sent to the raspberry pi, raspberry pi received the data and analyse it and send the control signal to motor driving circuit, based on the location of eye pupil. This will decide motor run either in clockwise or anticlockwise direction or stop. Two individual motors are fixed on each wheel. Ultrasonic sensor is mounted on the wheelchair for obstacle detection. If sensor gets any obstacle very close to the wheelchair, it indicates to the raspberry pi and it will sends the signal to motor driving circuit to stop the motor.

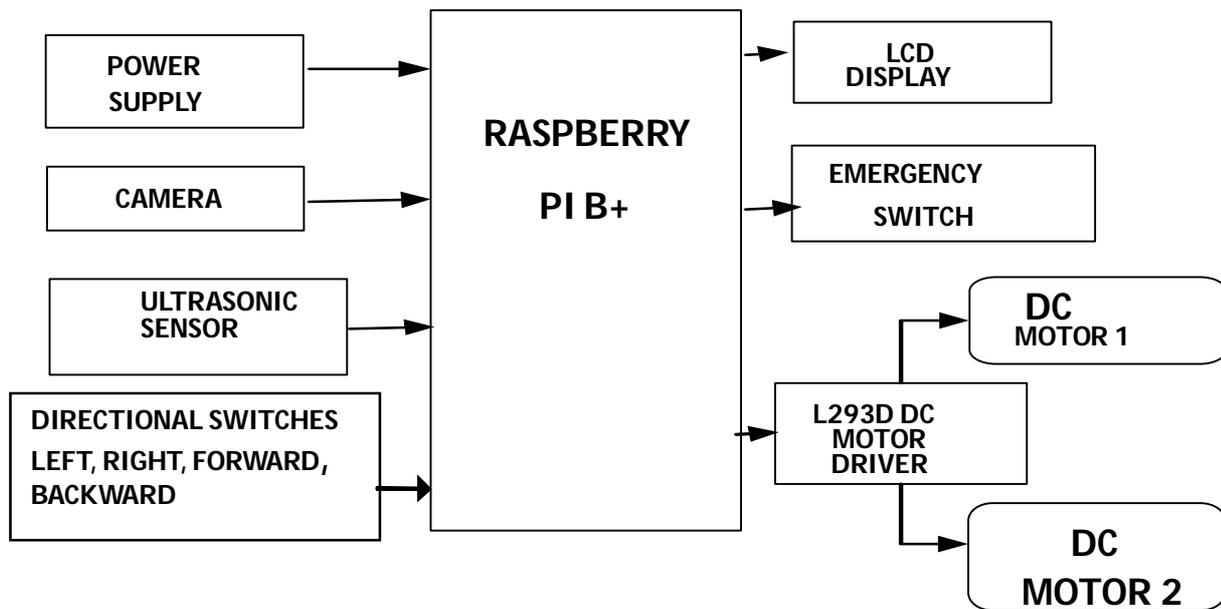


Fig. 1: System Architecture Diagram

Raspberry pi board is brain of the system. Raspberry pi board have its own operating system is known as raspbian which is Linux based operating system and compatible with raspberry pi board. A real time data receive and determine the digital data by raspberry pi B+ model board, which is very efficiently work with the multiple images. Raspberry pi sends the command to motor driver which is enabling the GPIO pin to raspberry pi. Web camera is used for capturing the image.

We can also use HD (high definition) camera but it increase the memory size, system can't able to read the image and it will increase the processing time. UV4L driver is needed for interfacing a camera with raspberry pi board. Ultrasonic sensor is used to detect obstacle in the path of wheelchair. Sensor is directly connected to the raspberry pi board. It receives the data and measuring the distance between wheelchair and obstacle. If any obstacle is detected very close to wheelchair, motors will stop to run the wheels. Ultrasonic sensor is a very affordable proximity / distance sensor that has been used mainly for object avoidance in various robotics projects.

Two 12 v DC motor is used in project to demonstrate running of wheelchair in forward, reverse, left and right direction. L293D motor driver is used to interface with raspberry pi which is TTL compatible. Two H bridges of L293D can be connected in parallel to increase its current capacity to 2 Amp. LCD is very helpful in providing user interface as well as for debugging purpose. Most common LCD controller is HITACHI 44780 which provides a simple interface between the controller and LCD. LCD is used as a monitor in most of the electronic project. Relay is an electromechanical device and basically consists of an electromagnet and a number of contact sets. Relay is used in this system to change the direction of motor very fast without using the finger.

II. SOFTWARE DESCRIPTION AND DESIGN

a) Open CV image library: Open CV is released under a BSD license and free for both academic and commercial use. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, iOS and Android. Open CV was designed for computational efficiency and with a strong focus on real time application.

b) Python language: Python is an interpreter, object oriented, high level programming language with dynamics semantics. Its high level built in data structures, combined with dynamic typing and dynamic binding; make it very attractive for rapid application development. Python's easy to learn syntax emphasizes readability and therefore reduce the cost of program maintenance. The fast edit – test –debug cycle makes this very effective. Moreover Matlab is used for coding but it is quite expensive and algorithms are proprietary, math work puts restriction on code portability.

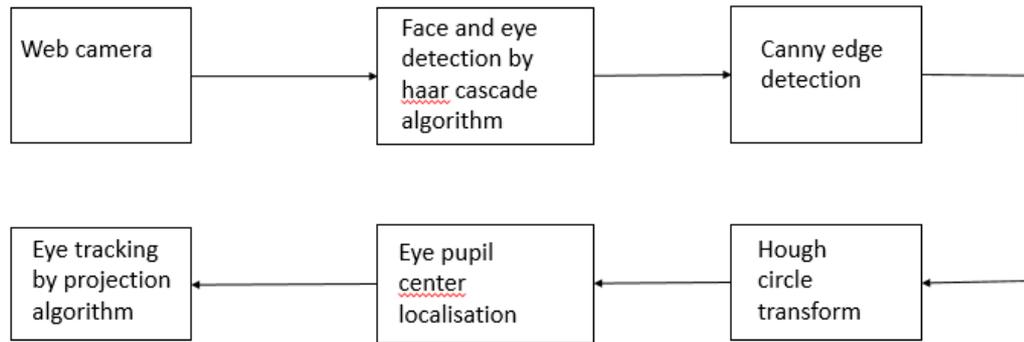


Fig. 2: Design block diagram

Algorithm used for detecting the eye pupil location by image processing. Several stages used to determine eye movement such as face and eye detection, colour to gray conversion, canny edge detection, Hough circle transform and eye tracking. Initially the system received the captured images by USB web camera. Our first aims to detect the user face accurately. If there are multiple faces, it will show the error. System indicates the face of user in a specific area of image. After that it will perform the several operation of image processing to track the eye movement. Figure shows the proposed methodology of implemented system.

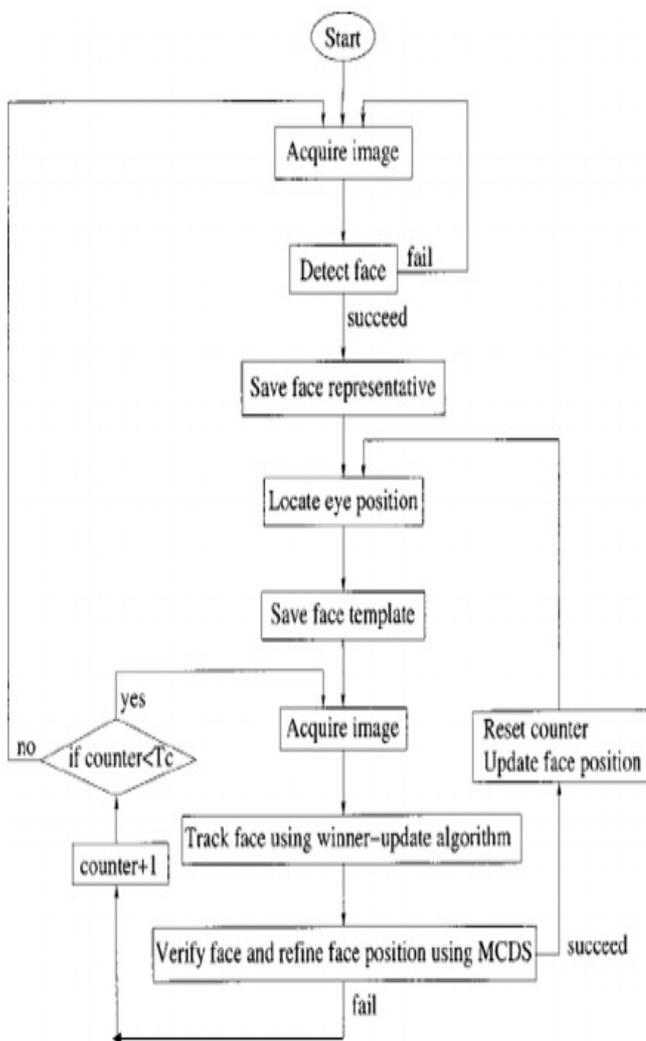


Fig.3:Flowchart for design method

III. METHODOLOGY

Camera will start to capture the images. For the face and eye detection Haar cascade algorithm is used. After detection of face, it will try to detect the eye inside the face and draw the rectangular box over the eye. To detect the eye pupil and define its centre points is ultimate goal of the system by several images processing technique. The system will crop the eye region of interest and it will draw the all possible circle on that particular area to detect the eyeball. Then we applied corner detection method to detect the corner. Average of these two points indicates the centre point. To measure the distance between the centre point and eye circle centre point using coordinates system. Minimum distance indicates the eye pupil in left and maximum value indicates the eye pupil presented in right. If there is no movement of eye it will indicates eye is in middle position. When eye move in left, left side motor will run and when eye move in right, right side motor will run. If eye will be in centre, both motors moved and wheelchair moving in forward direction. If any obstacle is detected, system will be stop and move either in left or right direction according to eye movement. If someone calls the user, user will stop the wheelchair by emergency switch. Eye blinking logic will be decide the start and stop operation. For edge detection canny edge detection is used. For circle detection Hough circle transform method is used. Image processing based on open CV library is installed in raspberry pi memory. Figure shows the flow chart of system.

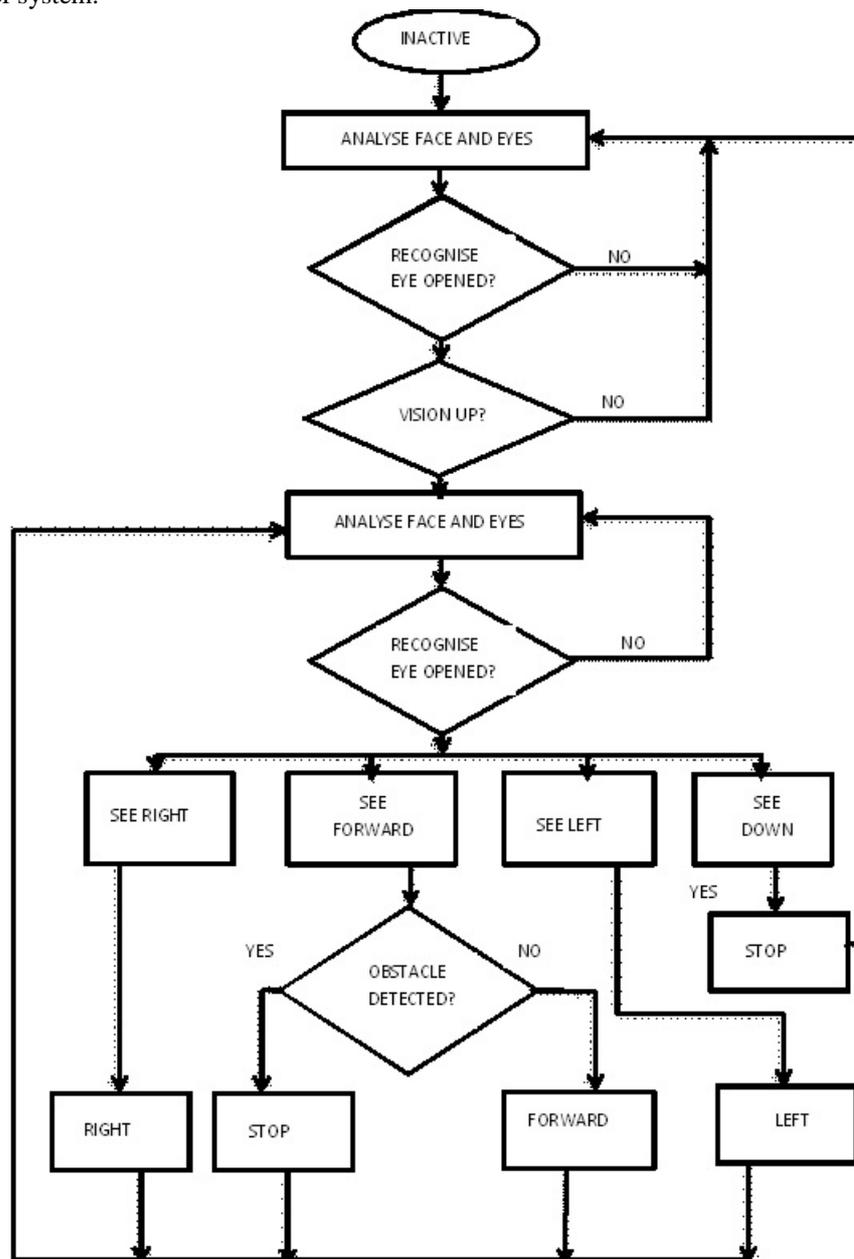


Fig.4: Flowchart of system

IV.ALGORITHM FOR THE WORKING OF WHEELCHAIR

- Step 1: keep the wheelchair in idle position.
 Step 2: Analyse the face and eyes.
 Step 3: If eyes is opened, see up for starting the wheelchair, Else, go to step 2
 Step 4: Again analyse the eyes.
 Step 5: There are 4 possibilities that an eye can look, if see right move the wheelchair to right.
 Step 6: If see forward, detect there is any obstacles
 Step 7: If there is any obstacles stop the wheelchair, else move forward
 Step 8: If see down, the wheelchair comes back to idle position, else go to step 2.

V.IMPLEMENTATION AND SYSTEM DESCRIPTION

The low power consumption credit card sized raspberry pi B+ board is used, which have inbuilt 40 pin GPIO, 4 USB ports, UART, PWM, HDMI port and Ethernet adapter port for internet connection via wireless or wired connection. Raspberry pi have a 512 MB RAM and capable of up to 32 GB external memory, controlled based on ARM architecture. Camera is directly connected with raspberry pi board and continuously captures the images, distance between eye and camera device is fixed. It may be 10 to 15 cm. Face and eye detected by Haar cascade algorithm and find out the exact pupil location. Then several algorithms used to measure the centre point from the average of both corners of the eye. This gives the correct information eye movements. The motor driving circuit is connected with raspberry, battery for power supply of motors, relay for controlling the motor driving IC. System continuously generates the directive signal to enable the GPIO pins and perform the required operation like left, right, forward and stop. Central switch is also connected with system for emergency purpose. Ultrasonic sensor is used for obstacle detection.

VI.SYSTEM INSTALLATION

To boot a train image in micro SD card win32 disk imager software used. Then putting a bootable memory device on raspberry pi board and admit the raspbian operating system directly without resetting [10].

VII.RESULTS

The wheelchair system received the resulted data of image processing and based on eye pupil centre location. It sends the command to motor driving circuit. Then wheelchair moves in required direction according to eye movement. Ultrasonic sensor is used in this system for obstacle detection. It measure the distance between wheelchair and obstacle. When obstacle is very close to wheelchair, motors will stop the wheelchair. Central switch is used for emergency purpose to stop the wheelchair.

VIII.CONCLUSION

Developed a wheelchair system which enables the disabled patient to move their wheelchair independently in their own direction. In the real time application, can use camera, emergency switch and ultrasonic sensor depends on their application. The wheelchair movement operation with some delay time. Dark light places affect the performance of wheelchair, difficult to track the eye pupil in dark light.

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