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Wheelchair Control using Eye Blinking

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Abstract: Locomotion is one of the basic needs of humans which people having limited abilities do not have. This renders them to rely on the use of wheelchair for moving from one place to another. For handicapped people human found a wheel chair which can be moved by using hands for those who don't have legs. But the people who don't have legs as well as hands cannot move their wheel chair self. They need some other person to move their wheel chair. But sometimes such person faces so many problems if they didn't get any person to move their wheel chair. The purpose of this project is to allow these people to move by automating the process of moving in any direction using just an Blink of an Eye. The process is very easy, as the disabled person who cannot move from place, has to just sit on wheelchair and blink his eye. As the camera detects the eye blink the wheelchair will start to move in desired direction. . Different types of Eye blink can be done to move in various direction.

Keywords: Raspberry Pi, Camera, Eye Aspect Ratio, Wheelchair

I. INTRODUCTION

The number of people who are paralyzed and therefore reliant on others due to loss of movement is increasing with the population. The development of the wheelchair for paralyzed people is very recent that began with the conventional manually powered wheelchairs and progressed to electrical wheelchairs. Conventional wheelchairs tend to focus only on manual use that assumes users will be able to use their hands which automatically exclude those who are unable to do so. Diseases or accidents that cause injury to the nervous system also occur frequently because people lose their ability to engage their voluntary muscles. Because voluntary muscles are the core actuator enabling people to engage their body, paralysis can be the root cause of a person not being able to move their limbs Most paralytic cases are permanent, however there are other forms such as periodic paralysis, caused by varying factors. The scientist Stephen W. Hawking was perhaps the most well-known case of major paralysis – Hawking was diagnosed with incurable Amyotrophic Lateral Sclerosis (ALS) in 1962, that resulted in him being bound to a wheelchair.

Patients suffering with close to or complete paralysis usually can control their eye movements which gave us the idea to develop an eye blink controlled electric wheelchair. The idea of an eye blink controlled wheelchair was inspired by a previous projects, that involved a glove sensor-based wheel chair which used the finger movements of the handicapped patient are used to command the wheel chair in a specific direction. As of today there are different eye movement-based methods used for controlling and commanding a wheelchair which includes EOG, ECG, EEG methods. Different output voltages will be generated for dissimilar users, which gives an incorrect position of the eye pupil. Voice activated wheelchair systems, which work properly when the user speaks the command clearly, but patients with weaknesses find this method difficult also other voices or noises which come from neighbouring users may affect the accuracy of the system. The head tilt movement-based systems and chin control based systems are also developed, this system has a low accuracy which is a big problem. Sip and Puff wheelchair systems are not good for patients with weak breathing. Infrared reflection based eye pupil detection system provide accurate detection of eye pupils position. But the long exposure to infrared radiation affects the eye and patients with weak eyes may loss their visibility. Raspberry pi board is the main processing component of the system, which controls the systems operation. Image processing based data signals are sent to the raspberry pi module , the raspberry pi receives the data and analyses it and then sends the control or command signal to motor driving circuit of the wheelchair, based on the location of pupil. This will decide motors movement in either the clockwise or anticlockwise direction or whether the wheelchair has to stop. Two individual motors are attached to each wheel. An Ultrasonic sensor is mounted under the wheelchair for obstacle detection and avoidance. If sensor gets any obstacle very close to the wheelchair, it indicates to the raspberry pi and it will send the signal to motor driving circuit to stop the motor.

II. PROBLEM DEFINITION

According to a new report prepared by the World Health Organization and the World Bank, 16 percent of the world's population is disabled and have self-locomotive inculpabilities. The blinking of eyes is an involuntary action and if we try controlling the start and stop motion of the wheelchair through blinking it will be difficult to achieve high accuracy. The motion of eyes is difficult to control at times and becomes it becomes tedious to give commands to the wheelchair. Driving a wheelchair is a monotonous task for severely handicapped patients and they have to deal with 2 problems at the same time , which creates an uncomfortable situation for them, i.e locomotion and localization.

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III.DESIGN OVERVIEW

This design is an intricate integration of hardware and software. The hardware has to first observe the surrounding environment and send needed data to the computer. Then the computer has to run software in order to analyse such data and make a decision as to where it is important and if so, where to direct the wheelchair.

A. Hardware

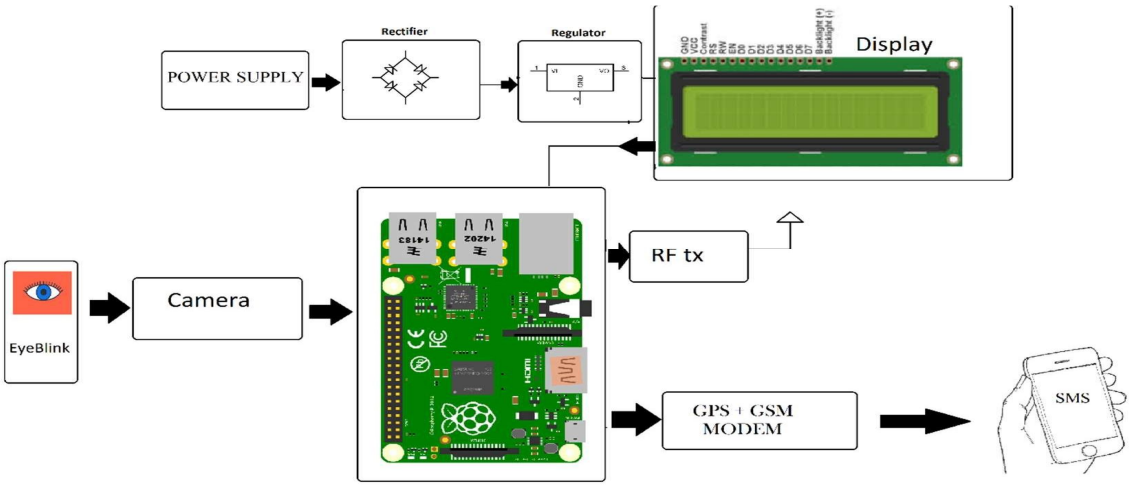
1) *Motors and Motor Driver:* This prototype chair is implemented with a small chair and we use motors set at 15rpm to move the chair. 12V rechargeable battery is used to run the motors. The command table of the motors are shown below

Input	Output
Blink both eyes once	Forward
Blink both eyes twice	Reverse
Blink Left eye only	Left
Blink Right eye only	Right
Close both eyes for 5 seconds	Stop

2) Eye Blink Sensor: *The wheelchair can be started, directed and stopped by eye blink movements. Eye blink sensor senses whether eye is open or closed. The eye blink sensor works by detecting the eye area and then monitoring the variations due to eyeblink.*

3) Obstacle Sensor: The obstacle sensor is placed at the bottom of the wheelchair. It is an ultrasonic sensor. It is used to bring the wheelchair to a stop in case there is an obstacle in front and the eye blink sensor fails. The obstacle sensor stops the wheelchair completely, turns and starts moving in the forward direction again.

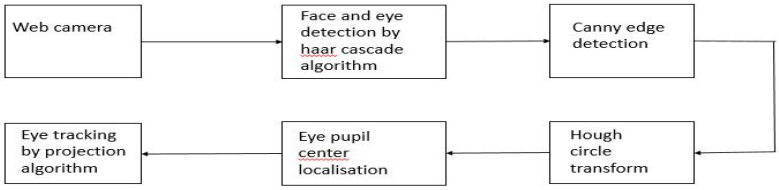
4) GSM Module and GPS: When the user has his closed for more than 15 seconds, it is considered as a state of emergency. The wheelchair is immediately stopped and uses the GSM Module and GPS to send an SMS to the registered mobile number with the exact location of the GPS.



B. Software

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

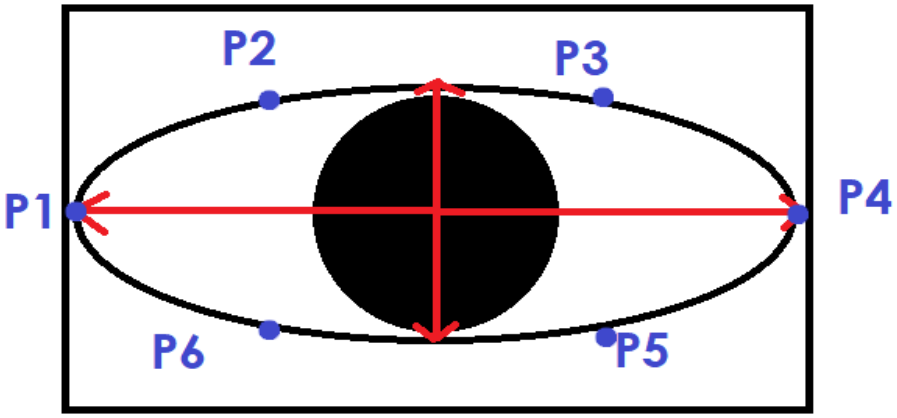
Python language: Python is an interpreter that is object oriented and has high level programming language level with dynamics semantics. Its complex built-in data structures combined with dynamic typing and dynamic binding; make it very attractive for rapid application development. Python's easy to learn syntax highlights 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.



Camera will start to capture the images. For the detection of face and the eye Haar cascade algorithm is used. After detection of the face, the algorithm will attempt to detect the eye inside the face and create a rectangular box over the eye. The detection of the eye pupil and to define its centre points is the ultimate goal of the system and is achieved by taking several images and using processing technique. The system will yield the eye region of interest and it will draw the possible circle on that specific area to detect the eye. Then we applied corner detection method to detect the corner. Average of these two points indicates the centre point..

Minimum distance indicates the eye pupil in left and maximum value indicates the eye pupil presented in right. If no movement of eye is detected it will indicate eye is in middle position and is counted as centre position. When the eye moves in left, the left side motor will run and when eye move in right, the 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 ahead , the system will command to stop the wheelchair and move either in the left or right direction according to the movement of the eye. If there is an emergency the wheelchair will contact the emergency number by using the emergency switch. The eye blinking sequence will be the deciding factor for 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.

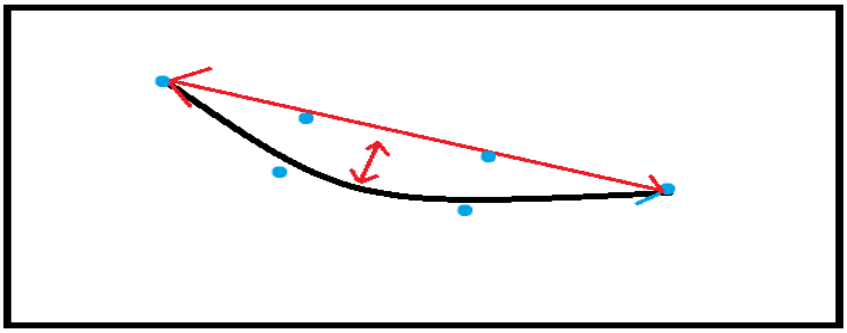
Determining if the “white” region of the eyes disappears for a period of time The eye aspect ratio is instead a much more elegant solution that involves a very simple calculation based on the ratio of distances between facial landmarks of the eyes. This method of eye blink detection is very fast, efficient, and easy to implement compared to other models. We can also apply facial landmark detection to localize certain important regions of the face, including features like eyes, eyebrows, nose, ears, and mouth.



There is a relation between the width and the height of the coordinates of the eye . Based on the work by Soukupová and Čech in their 2016 paper, Real-Time Eye Blink Detection using Facial Landmarks, we can then derive an equation that reflects this relation called the eye aspect ratio (EAR) from the given coordinates :

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Where the points are two dimensional landmark locations.
The numerator of this equation computes the distance between the vertical eye landmarks while the denominator computes the distance between horizontal eye landmarks, weighting the denominator appropriately since there is only one set of horizontal points but two sets of vertical points.



Using this simple equation, we can avoid image processing techniques and simply rely on the ratio of eye landmark distances to determine if a person is blinking.
On the top-left we have an eye that is fully open — the eye aspect ratio here would be large(r) and relatively constant over time. However, once the person blinks the eye aspect ratio decreases vividly, approaching zero.
Once the eye aspect ratios nears zero it is registered as a blink.

IV.ADVANTAGES AND DISADVANTAGES

A. Advantages

1) User friendly
2) Helpful for the paralysis stroke people who don't have much stamina in the hands
3) Reduces human activity
4) Reduces physical strain
5) Spontaneous output
6) Real time opoeration

B. Disadvantage

1) Expensive compared to traditional wheelchair

V. RESULT

The wheelchair that is controlled by the Eye Blink sensor is successfully designed. The design presented allows control of a wheelchair through a plethora of hardware and software components to create an effective system. While not a perfect system, the wheelchair now stands able to be solely controlled through eye blinking and thus helps persons with moderate/severe physical disabilities.

VI.CONCLUSION

This paper presents the model of a wheelchair that is controlled using eye blinking. Eye blink sensor is used to control the wheelchair. We have only made use of eye blink, various other activities of the face like sip and puff can be used to command the wheelchair. We could use other devices like Bluetooth and zigbee to communicate with various devices.

VII. ACKNOWLEDGMENT

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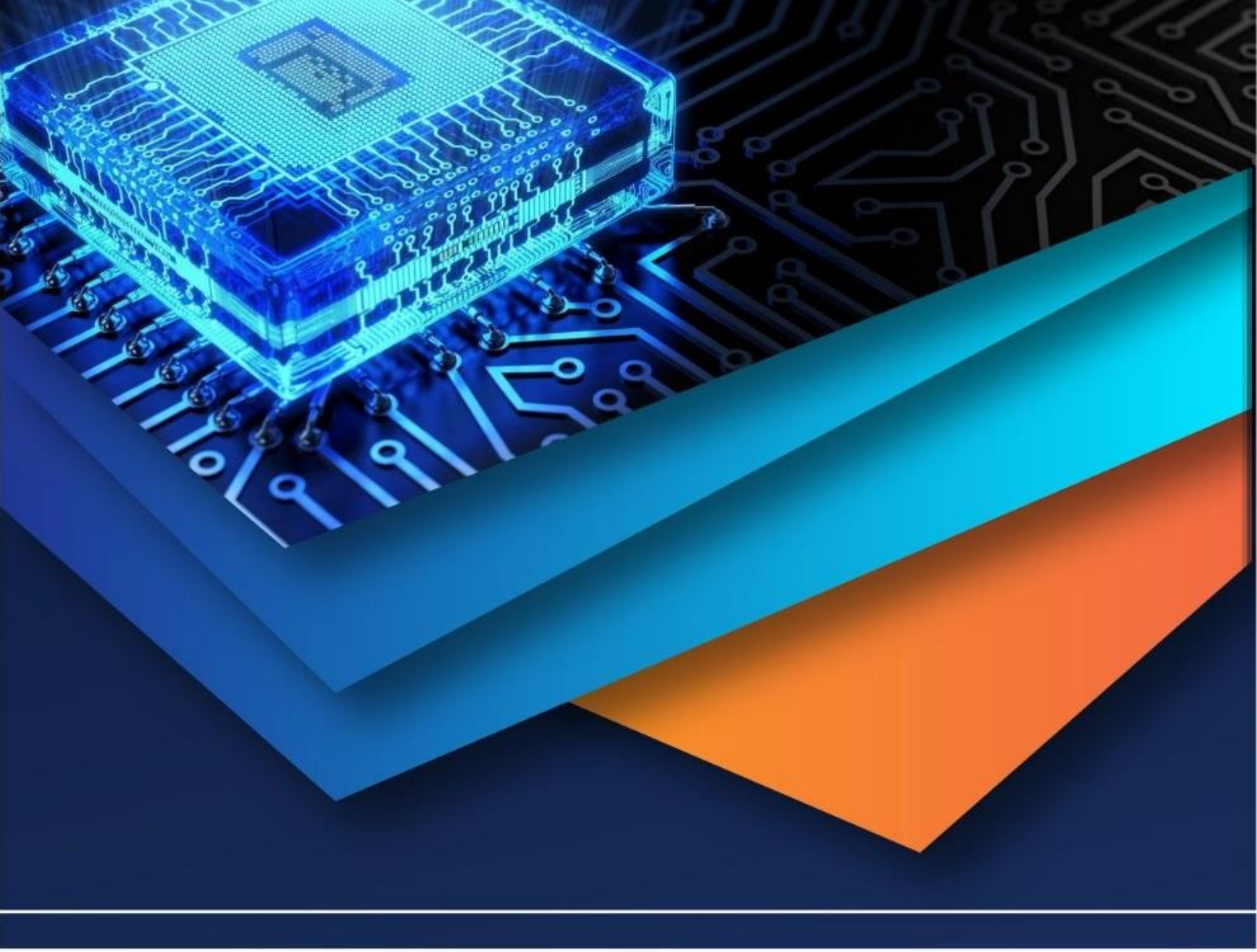

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