e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:06/June-2022 Impact Factor- 6.752 www.irjmets.com

SMART WHEELCHAIR

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ABSTRACT

People who are unable to walk and are using wheel chairs exert great amounts of energy using physical strength to turn and steer the wheels. With eyesight being their guide, the disabled would save energy and could use their hands and arms for other activities. There are no products on the market, but there are other applications such as virtual reality using eye tracking to control the vision of the game. Eye tracking is not heavily used in mainstream products but are beginning to pick up as input to electronics become more and more natural. The purpose of this project is to develop a wheelchair that will be controlled by the eyes of the person seated in the wheelchair. This will allow people without full use of their limbs the freedom to move about and provide a level of autonomy.

I. INTRODUCTION

In this proposed system project will consist of three main parts. The first part is the head mounted camera and laptop system that will track the camera wearer's eyes. The camera will take an image of the eyes that will be sent to the laptop where the images will be processed using the open-source image processing software OpenCV. Once the image has been processed it moves onto the second part, our microprocessor. The microprocessor will take a USB output from the laptop and convert the signal into signals that will be sent to the wheelchair wheels for movement. Also, the pressure and object detection sensors will be connected to our microprocessor to provide necessary feedback for proper operation of the wheelchair system.

The final part of the project is the motor drivers to interface with the wheelchair itself. There will be two motor drivers for each motor on the wheelchair both left and right. Each motor driver will consist of an h-bridge that will power the motor depending on the output of the microprocessor. The motor drivers will control both speed and direction to enable the wheelchair to move forward, reverse, left, or right.

II. METHODOLOGY

A head mount camera detects the eye movement and wheelchair is moved accordingly. The head mount camera is connected to the laptop where a continuously running python script processes the image and gives command to the microcontroller to control the wheels of a Wheelchair. This system came as a boon for such people. But the constraint was that you had to carry your laptop every time along with the Wheelchair System. That was bulky and costly to remove the bulkiness and costliness of the Eye Movement based Electronic Wheelchair System, which uses MATLAB, we came up with ideas of using Raspberry Pi to control the whole Wheelchair System. Since Raspberry Pi has its own OS and it is easily portable, people switched to using Raspberry Pi based Wheelchair System. Although in the existing Raspberry Pi based Wheelchair System, latency (delay in response) is the biggest issue. Hence, we have come up with a system that uses efficient algorithms for image processing using OpenCV and reduces the latency as much as possible. OpenCV processes the eye and by applying the two algorithms (Centroid and Threshold), movement of wheelchair is initiated. Python is used for programming the Raspberry Pi. Shell Script is used to continuously run the same procedure when power is supplied to Raspberry Pi through power backups i.e., through power banks

Iris Detection

For simplicity, we have attached a web camera onto the handle part of the Wheelchair that is used to detect the eye motion. Then we have designed an algorithm to track the iris part of the eye using centroid calculation method and implemented the same in the Open CV. Once the iris is tracked, then the threshold is set.

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Threshold

A very basic principle is used for the movement detection. The feature point of both the eyes is considered as the reference. The difference between the pixel values of eye positions is calculated by comparing current snapshot and the previous one. The minimum movement of the eye for a valid attempt is considered as threshold. By evaluating the difference, and if the difference is above the threshold in any direction left or right, the corresponding flag is set. If the difference is less than the threshold value, then there is no need of movement. failure in detection occurs due to non-linearity. At such instances a bias can, be given to the eye, which was detected in the previous snapshot.

Image Processing is done on every frame of image. From every image, eye is detected using the traditional Viola-Jones Algorithm. But to track the iris we have come up with an idea of using Centroid Algorithm. There are various methods already used for tracking eye movement. But these methods often fail to accurately estimate the eye centers in difficult scenarios, e.g., low resolution, low contrast, or occlusions. Our method is invariant to changes in scale, pose, contrast and variations in illumination.

Centroid Algorithm

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This method also reduces the latency (response time of the raspberry pi) to a very large extent. What it does is that it crops out the only the eye part from the image. We convert it into grey scale image and then into binary image. In binary image, black represents zero and white represents one. So, we start traversing through the image along x-axis and y-axis and wherever we find zeros (black region), we make a set of those values and average them all to find the Centroid point. The same has been replicated by the diagram given below

Threshold Algorithm

First find the length of the image captured. Along the length make two divisions using mathematical approach as shown the figure given below. The right division is the right threshold and the left division is the left threshold. If the Centroid position is between these two divisions, then the movement should be in straight direction. If the Centroid position is greater than right threshold, then initiate right movement. If the Centroid position is lesser than left threshold, then initiate left movement.

III. MODELING AND ANALYSIS

Hardware components used

1. PI Camera – as an input source for capturing eye ball
2. Raspberry PI 3 model B – as a processing unit
3. IR Sensor – it is used to detect obstacles in front of wheelchair
4. 2-channel relay – it is used to control the rotations of wheels like moving front, left, right
5. DC Motors – there are attached with wheels

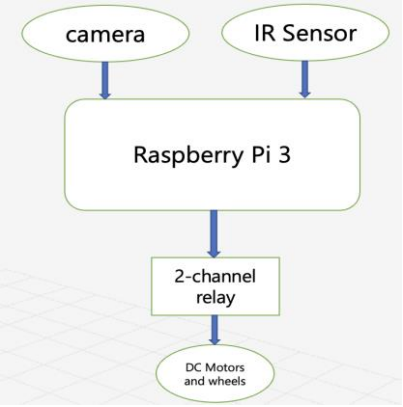

Figure 1: Block Diagram

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Working

Initially when the device is turned on the camera continuously capture the video of face and sends it to the Raspberry PI. The Raspberry PI detects the eyes from the face using dlib face predictor. Now the captured eye image is converted into grey scale image. Now thresholding algorithm is applied which detects whether the eye balls are in right, left, top.

According to the position of the eye balls Raspberry PI sends digital signal to 2-channel relay module. If a person sees up the wheelchair moves front. If the person sees right the wheelchair moves right similarly if person see left the wheel chair moves left. If the person sees down or straight the wheelchair stops.

Whenever there is an obstacle ahead of wheelchair which that person can't see the IR Sensor detects the obstacle and stops the wheelchair. It is a safety feature.

IV. RESULTS AND DISCUSSION

The circuits when implemented separately works as per the desired output however during integrating all, output fluctuates and shows different response every time. This could be a problem of loose connections of the wires or internal wiring of the bread board used. This project lists down the results realized from the practical work and examines whether ideas / solution approaches recommended in research are met by the practical implementation.

From the series of experiments, we have conducted the following results were obtained:

- A paralyzed person can easily control his wheel chair using his/her eyes
- It can detect any kind of obstacle such as a wall or stairs etc. and stops the wheel chair from moving further front
- This wheel chair does not have an option of moving back, but it can turn 180 degrees either right or left

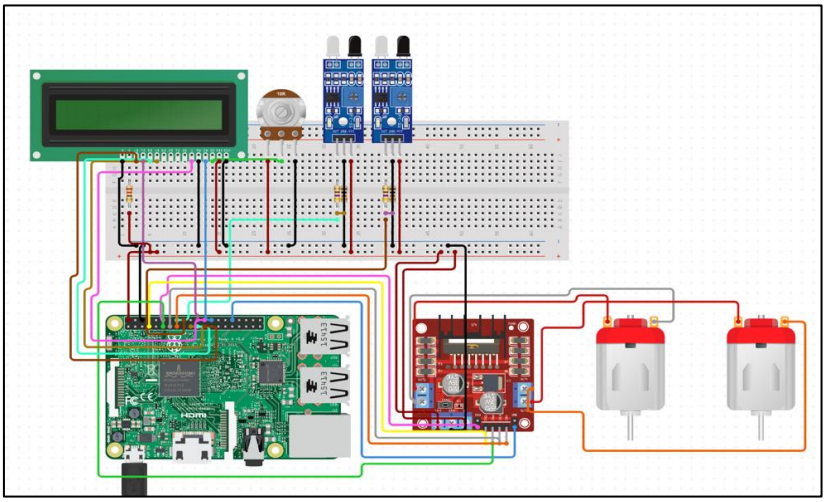

Figure 2: Circuit diagram

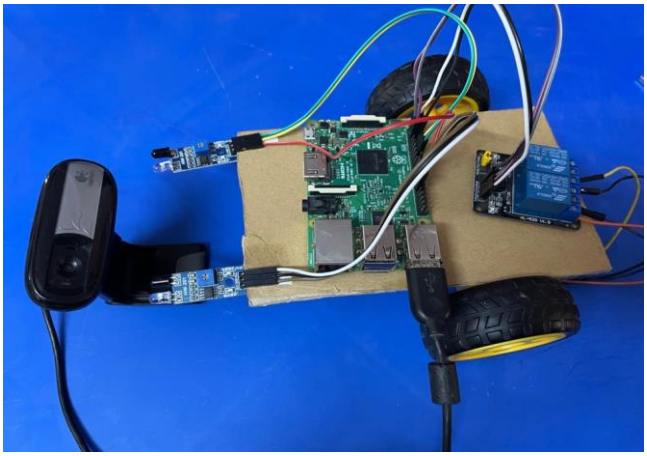

Figure 3: Final Result

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Advantages

1. It is very accurate and fast
2. It is completely automatic
3. Reduces the usage of manpower
4. It consumes very low power
5. It is a portable device

Disadvantages

1. Hardware complexity.
2. Sudden speed control is not present

V. CONCLUSION

The project SMART WHEELCHAIR has been successfully designed and tested. It has been developed by integrating features of all hardware components used. Presence of every module has been reasoned out and placed carefully thus contributing to best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the project has been successfully implemented. Finally, we conclude that Embedded system is an emerging field and there is a huge scope for research and development.

ACKNOWLEDGEMENTS

We are grateful to our guides Assistant Prof. Mr. R. NARENDAR and Prof. B. GIRI RAJU for their continuous support and guidance. Through their guidance, we were able to successfully complete our project. Sincere thanks go to Dr P. SATISH KUMAR, Head of the department of Electronic and Communication Engineering at ACE Engineering College, for his support and time. We are very grateful to my family and friends for their constant support and encouragement during the project period

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