

# **An Efficient Wheelchair System for Tetraplegia Patients**

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**ABSTRACT:** The people suffering from Tetraplegia or crippling phenomenon require assistance to move from one place to another. They cannot move their limbs but they have a control over their eye movements. So this design is based on using the eye movements of the patient to help them give mobility to freely move around by themselves. This project is an attempt to make lives of the people suffering from this phenomenon simple and by simpler, it mean self-reliant, which will thereby reinstate their confidence and their happiness. The goal is to establish a wheelchair assembly different from the existing system. So in this system the person sitting in the wheelchair has a laptop wired to the wheelchair. On the laptop a MATLAB script is running which makes a decision depending on the images that are captured from the webcam which continuously takes screenshot of the pate its eyes. The Atmega328/P microcontroller then drives the motor based on the decision made by the matlab program which is serially transmitted to the IC. In addition to this an ultrasonic sensor is also added as a safety feature which will detect the obstacle in front of the wheelchair to avoid accidents. The system is cost-effective and thus can be used by patients spread over a large economy range.

**KEYWORDS:** Tetraplegia, Image processing toolbox, MATLAB, wheelchair

## **I. INTRODUCTION**

Tetraplegia is a condition that causes total or partial paralyses in all the four limbs, including in the whole body. It damages the spinal cord permanently due to which the person can not move. In tetraplegia the sensors and motor nerves are affected because of which a person suffering from tetraplegia loses body part or the whole body. The general causes of tetraplegia are as follows:

- Car crash, injury or fall
- Diseases like polio
- Multiple sclerosis

Patients who have no use of their limbs are extremely restricted in terms of mobility. There is a need of a system to help people with such disabilities. The aim of this work is to develop a new method for driving assistance for the disabled people.

Also, this project removes the necessity of the assistance required for the disabled people. This project is to help them give an independent accessible life. The development of the wheelchair for paralysed users is restricted the conventional manually powered wheelchairs and to electrical wheelchairs. Wheelchairs are a way of reincarnating the purpose of life in the lives of disabled people.

Conventional wheelchair uses tends to focus exclusively on manual use which use which assumes users still able to use their hands which excludes those unable to do so. Therefore, the people who have lost their mobility, end up getting

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bed ridden and without any mobility device. Diseases or accidents which damages the nervous system causes people to lose their ability to move their voluntary muscle. Because voluntary muscle is the main actuator enabling people to move their body, paralysis may cause a person not move their loco motor organs such as arm, leg and others. Existing system available are voice controlled or joystick operated wheelchair which cannot be used by these patients So there is a need of a wheelchair which is designed keeping in mind that the person using it cannot move their voluntary muscles.

## II. LITERATURE WORK

In the past decade, a lot of intelligent wheelchair control systems were developed using different methods and techniques. Human-computer interaction plays a big role to provide an interface using methods such as Bio-potential based Methods, voice-based method, Motion-based method and Image analysis method [1].

Bio-potential based method which utilizes potential from user's body actions acquired by using special instrument. Instrument such as Electrooculography (EOG), Electromyography (EMG) [11], and Electroencephalograph (EEG) [12], Search coil can be used for measuring bio-potential. The search coil output can be used as sources of computer input for handicap person. Limitations of this method are poor gaze direction accuracy compared to video tracker, relatively costly. Human-machine interface is the use of nonverbal information such as bio-potential signals [3]. A wearable EMG-based human computer interface [4] is proposed in which user expresses his intention as shoulder elevation gestures. A double threshold method was used to recognize the wheelchair control command using the time difference of muscle activation.

Voice Based method [13], which use user's voice as source input. Voice analysis is used to analyse user's voice and convert into digital data. This type of system is vulnerable against noise. Other voices which come from surrounding user may affect the system. Limitations of this method are it is less accurate on background noise, speaker variability, channel variability, speaking style, speed of speech, etc. Voice control is utilized in combination with the navigation assistance within the NavChair assistive wheelchair navigation system [6]. Voice control can also be implemented in a wheelchair without navigation assistance.

Another possible human-machine interaction, human motion recognition is also used. Motion based method [14]. utilizes other normal movement organs to operate computer input. Head, foot, and etc. can be used to control computer input. Limitation of this method is that it requires human effort to navigate like joystick, etc. Also, for a handicapped with any of the organs failed is not useful. Many different motion recognition approaches are based on hidden Markov models and artificial intelligence (Fuzzy logic and neural network). A Head motion recognition technique [5] is used as an algorithm of microcontroller system. A robotic wheelchair with three motion control modes [7] is proposed. Autonomous control mode, manual control mode and remote control mode are used. To facilitate the wheelchair in remote control mode, face recognition and hand gesture recognition were combined. Dynamic finger movement tracking and voice command based smart wheelchair [8] was developed in which word detection algorithm and normalization algorithm were used with MATLAB and flex sensors. To track the movement of fingers, flex sensors were used.

Search coil method [10] uses induced voltage with coil including in contact lenses attached to user's eyes. Limitation of this method is burden to user, here measuring time is limited to approximately 30 to 60 . They have limited Lifetime.

In this proposed system we have used image analysis method. The system is controlled by human eyes only. This system allows the user to look around freely while the wheelchair navigates automatically. Therefore, disabled person can control the system by themselves [2]. The gaze direction and eye blinking were used to provide the direction and timing command. The combination of a vision interpretation system and an electric wheelchair control system was used. To estimate the gaze location, pupil knowledge is used. The system detects eye movements using Viola-Jones algorithm and moves the wheelchair accordingly in the desired direction [1]. Image Analysis method, utilizes camera to analyze user's desire and convert into digital data. Several image processing methods are used to analyse user's desire. The user's desire itself can be done by Gaze based analyse user's desire from users gaze, Face based analyse user's desire from face expression, and the other,

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## III. EXISTING METHODOLOGY

### (A) EYE CONTROLLED WHEELCHAIR USING RASPBERRY PI

Raspberry pi board have its own operating system is known as raspbian which is Linux based operating system and compatible with raspberry pi board. Raspberry pi board controls 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 [14].

### (B) EYE CONTROLLED WHEELCHAIR USING LABVIEW

Lab VIEW is a graphical programming language that uses icons instead of lines of text to create application. LabVIEW make use of G Programming Language. It is a Flowchart-like dataflow programming model, using which, you can quickly tie together data acquisition, analysis, and logical operations and understand how data is being modified. From a technical standpoint, G is a graphical dataflow language in which nodes (operations or functions) operate on data as soon as it becomes available. The “flow” of data through the application graphically with wires connecting the output of one node to the input of another. The input image from the IR camera is opened in LabVIEW. The area of interest, that is, the pupil is snapped from the image and saved as a template. Template matching is done with the real time image of eye to determine the direction of glaze. The coordinates of the centre of the image is taken as the reference. The change in the position of pupil from this reference is used to determine the direction. Upper limit and lower limit coordinates are set for the right and left directions and whenever the pupil template comes within this limit corresponding left and right direction is determined [15].

## IV. PROPOSED METHODOLOGY

The Block diagram of proposed system is illustrated in fig.

It consist of the following components namely:

- i. **ATMEGA 328P IC**
- ii. **Ultrasonic sensor**
- iii. **Web camera**
- iv. **DC Motor and driver**
- v. **FTDI Converter**
- vi. **MATLAB software running on a laptop and Wheelchair Assembly**

The web camera captures the movement of the eyes and snapshots will be taken. Further the MATLAB software will perform Image processing.

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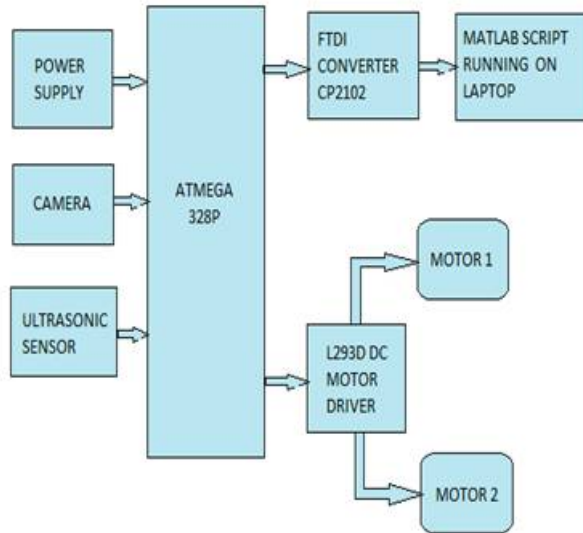


fig 1: Block diagram of proposed system

After that the MATLAB script makes the decision of whether the eye movement was in right or left direction. This data is then serially transmitted to the microcontroller Atmega328p which will guide the motors to move in a particular direction.

## A. DESCRIPTION OF EACH COMPONENT:

### 1. ATMEGA 328/P MICROCONTROLLER:

ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/P achieves throughputs close to 1MIPS per MHz. This empowers system designer to optimize the device for power consumption versus processing speed. The device is manufactured using Atmel's high density non-volatile memory technology. The On-chip ISP Flash allows the program memory to be reprogrammed In-System through an SPI serial interface, by a conventional nonvolatile

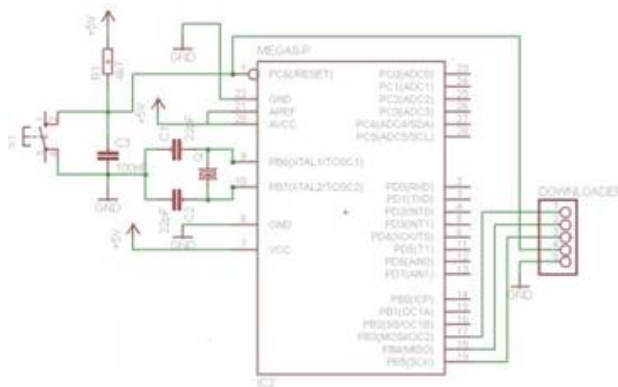


fig 2: ATMEGA IC

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memory programmer The Atmega328/P is programmed using Arduino software. Atmega328/P IC sends commands to motor driver.

So it is used to guide the motors in a particular direction i.e right left or straight.

### 2. ULTRASONIC SENSOR:

It is used to detect the obstacle in the path of the wheelchair. It is directly to the wheelchair. If a object is detected which is very close to the wheelchair, it is made to stop. So the use of ultrasonic. Sensor fits as a safety feature which can be used to avoid accidents. Ultrasonic sensors “are based on the measurement of the properties of acoustic waves with frequencies above the human audible range,” often at roughly 40 kHz .

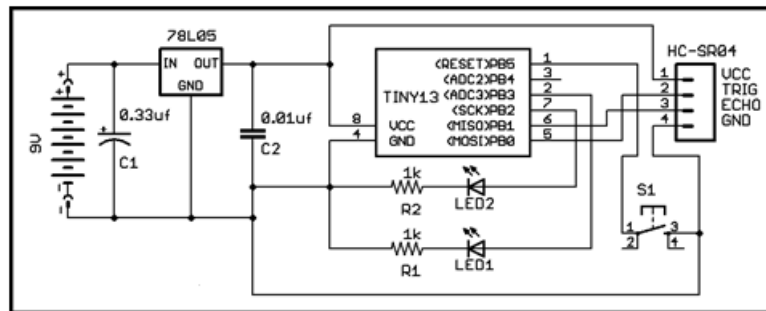


Fig 3: Ultrasonic sensor

They typically operate by generating a high-frequency pulse of sound, and then receiving and evaluating the properties of the echo pulse. It used to measure the distance of an object by using sound waves. It can measure the distance by sending the sound waves at a specific frequency and listen the sound waves to bounce back.

### 3. WEB CAMERA:

It is used for capturing the eye movements of the patient using the wheelchair. Depending on the camera signals, the matlab script running on the laptop takes continuous snapshots and processes the snapshot to detect the eye movements. The High performance webcam with ultra high definition 3 megapixel (2048 x 1536) video resolution and up to 12 megapixel (4096 x 3072) snap shot resolution. Supports HD ready 720p (1280 x 720) widescreen resolution for highest quality video broadcasting. In terms of still images, the camera is capable of 2592 x 1944 pixel static images, and also supports 1080p at 30fps, 720p at 60fps and 640x480p 60/90 video recording.

### 4. DC MOTOR:

DC Motors is used in this project to demonstrate running of wheelchair in forward, reverse, left and right direction. L293D motor driver is used to interface with Atmega IC.

### 5. MOTOR DRIVER(L293D):

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction.

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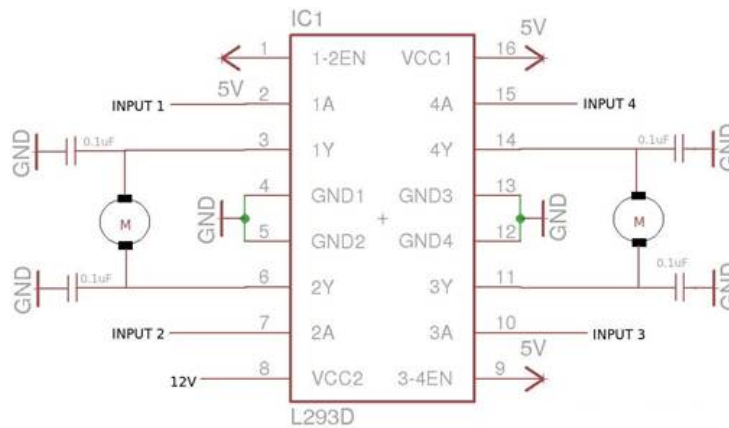


Fig 4:Motor driver IC

Voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction. In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently.

## 6. FTDI CONVERTER(CP2102):

The CP2102 is a highly-integrated USB-to-UART Bridge Controller providing a simple solution for updating RS-232 designs to USB using a minimum of components and PCB space. The CP2102 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm MLP-28 package.

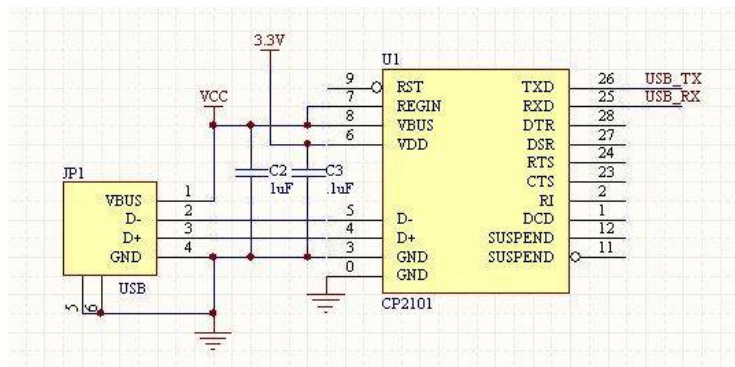


Fig 5:FTDI Converter

No other external USB components are required. The EEPROM is programmed on-board via the USB allowing the programming step to be easily integrated into the product manufacturing and testing process.

## 7. POWER SUPPLY:

The power from the laptop is used to drive the Atmega microcontroller. The DC motors used in this project is given external 12 V power supply.

## B. CIRCUITRY:

Some of the system requirements of the project are listed below:

- i. Motor driver circuit is used for the movement of the wheels
- ii. The wheelchair must be continuously wired to a laptop where Matlab script is running.

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## C. IMAGE PROCESSING:

Image Processing Toolbox provides the set of reference-standard algorithms and workflow apps for image processing, analysis, visualization, and algorithm development. In this image acquisition, image pre-processing, image segmentation, Image representation and Image description, Image recognition and Image interpretation will perform.

### A. Image acquisition:

Initially, webcam object and digital image is create. This will be captured by web camera. This is the process known as image acquisition.

### B. Image pre-processing:

This process is to improve signal to noise ratio and image features by modifying the colors and intensities of the image. Image enhancement technique is used in this process. It involves enhancing the contrast, initializing the positions and creating object detector for face and eye pair. Then get snapshots of the images.

### C. Image segmentation:

It determines the region boundaries in an image. This divides input image into parts or objects. Then extract biggest face from the image and then searched the eye pair from the biggest face and if it is available then extract the half eye pair form the image.

### D. Image representation and image description:

Image representation converts the input image into suitable form for computer processing. Image description is to extract features that result in some quantitative information. After the image has been segmented into object and background region , describe them in characteristic features for computer processing during pattern recognition.

### E. Image recognition and Image interpretation:

This is to assign meaning to an ensemble of recognized objects. Based on the information provided by its descriptor the label is assigned to an object.

## V. SOFTWARE DESCRIPTION

### .A) MATLAB software:

MATLAB is a high level computing language and interactive environment for algorithm development, data visualization, data analysis and numerical computation. Using MATLAB, you can solve technical computing problems faster computing problems faster than with traditional programming languages such as C, C++ and FORTRAN.

MATLAB has excellent graphic capabilities and its own powerful programming language .One of the reasons that MATLAB has become such an important tool is through the use of sets of Matlab programs designed to support a particular task. These sets of program s are called toolboxes and a particular toolbox of interest to us is the image processing toolbox. Image processing Toolbox provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization and algorithm development.

#### B) Flowchart

The flowchart of this paper is illustrated in figure. Several operations used to determine eye movement are as follows:

#### A. Create a webcam object and Get the snapshots of the image

Initially, create a webcam object. For the face and eye detection cascade object detector is used. This detector uses viola-jones algorithm to detect people's faces, nose, eyes, mouth or upper body. Then the system receive the snapshots of the image captured by web camera.

#### B. Conversion to grayscale image

Convert the captured image into grayscale image. It convert all the pixel values into grey level.

#### C. Flip the image horizontally

Flip the grayscaled image horizontally and also the elements in each row and column. It means it returns the same arrays as that of original ,but with the order of elements reversed.

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### D. Create a Boundary box

Created boundary box using detector. Boundary box co-ordinates of rectangular border that fully encloses a digital image. If face exist then it goes to further process but if not then it starts from the initial process.

### E. Find the biggest face and extract the location of eye pair

If there are multiple faces it will find the biggest face from surrounding region. Extract the face from the image. Then find the locations of the eye pair using object detector. Displays the full image and draw all the regions that contains face. Display the face image and check if eye pair is available. Then find the biggest eye pair.

### F. Resize the eye pair width in half and perform Hough transform

Resize the eye pair width in half and extract the half eye pair from the face image. Adjust the contrast and perform Hough transform. It is a feature extraction technique used in image analysis and digital image process. Then find the distance from left edge to centre point and from right edge to centre point.

### G. Detect a particular direction

Detects a particular direction e.g. left, right, forward. 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.

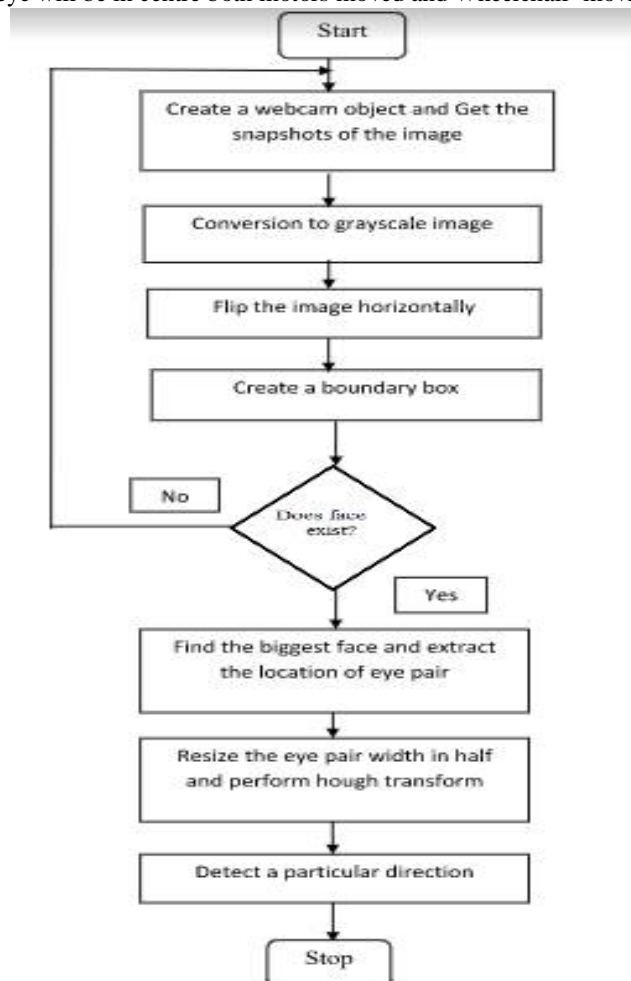


Fig 6 . Flowchart of the Proposed system



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## VI.RESULTS

This system gives satisfactory results. The speed of the wheelchair can be controlled and it is capable of introducing less jerk. The wheelchair system successfully detects all the eye movements. The image capture, eye movement detection and the algorithm for validating movement attempts perform very reliably as this results suggest. The project still needs few modifications so as to achieve optimised results.

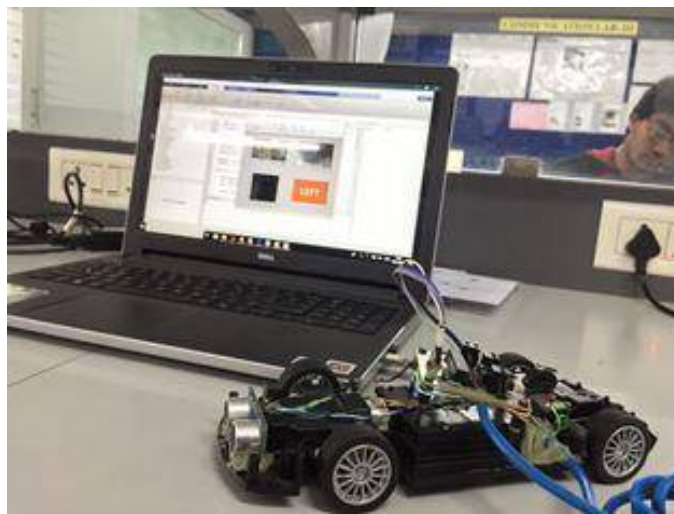


Fig 7 . Result of the Proposed system

## VII.CONCLUSIONS

This system is an attempt to make the lives of the people suffering from Tetraplegia or any other disability which causes loss of limbs simple and by simple it mean self-reliant.

In this image processing is used with the help of MATLAB to take snapshots of the patient's eyes. The decision to move the wheelchair in right or left direction is done by the MATLAB script running on the laptop which is wired to the wheelchair

Depending on the eye movements, the data is send to the microcontroller which moves the wheelchair in a particular direction. The aim of this project is to make a small contribution towards the development or betterment of the society.

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