COMMUNICATION AID FOR PARALYZED

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ABSTRACT

Paralysis is defined as the complete loss of muscle function in any part of our body. The most important problem for patients suffered from paralysis is the lack of communication with other. A patient who is unable to communicate orally may experience elevated despair and thwarters, when his needs are not met due to failure of the care giver to grasp his needs. In the medical field, the problem of effective communication is heightened mainly in the Intensive Care Units, where patients are critically ill and tend to have barriers in communication such as muscular weaknesses that either result in preventing speech or making communication difficult or impossible. In our current scenario there exists many ways to communicate with paralyzed patients such as Chart based encoding and Brain computer Interface. But these are very complex and tiring and thus difficult for them to communicate. So we chose eye tracking system where we thought of developing a picture communication board that could illuminate the needs of the paralyzed patients through their eye gaze. Hence main aim of our project is to design real time system that can assist the paralyzed to specify the needs through their eye gaze. The image processing techniques is used to detect the eye gaze. By gazing at any one four frequent needs displayed on the communication board, the user can illuminate the needs notify the caretakers simultaneously by means of a buzzer and hence convey the needs effectively.

Keyword: - *ERICA, Face Detection, Hough Transform, Gaze Tracking.*

1. INTRODUCTION

The ability to move freely is highly valued by all people and this is impossible in case of a paralyzed patient. Nowadays, different communication aids are commercially available for disabled people. It generally requires considerable skill to operate. Moreover, some disabled people find it difficult to use these communication aids manually, even with a joystick, because they lack the physical ability to control the movement. To enable a disabled person to communicate effectively and easily so that they can enjoy a higher quality of life, we have proposed a communication aid that has all the needs displayed on it. So by gazing at these needs, one can communicate effectively to the caretaker. The four basic needs and high-performance face recognition are employed in this system. This system consists of a web camera which is mounted right in front of the user to capture pictures of the user‘s face and alert is given by the buzzer. Although a number of techniques have been implemented for eye gaze detection, there is no application that has been developed to actually put the gaze detection to practical use. The principal contribution of this paper is the conceptualization of a system which will go a long way in helping the paralyzed to achieve some level of independence.

1.1 Human Eye

The eye is the most important sense organ that we humans are endowed with. It helps us in visualizing objects. We see objects only when light coming from them enters into our eyes. The human eye is roughly a spherical ball consists of the following parts such as sclera, cornea, iris, pupil, lens and retina.

- Sclera: It is a protective tough white layer acts as the outer covering of the eye.
- Cornea: The front transparent part of the sclera through which light enters into the eye.
- Iris: A ring like structure and a dark muscular tissue behind the cornea.
- Pupil: It is the small opening in the iris which controls the amount of light that enters the eye.
- Lens: It is the transparent structure behind the pupil which changes its shape to focus light on the retina by the action of ciliary muscles.
- Retina: It converts image formed by the lens into electrical impulses and then transmits these impulses to brain through optic nerves.

Fig -1: Structure of human eye

2. PROBLEM STATEMENT

To develop an eye-gaze controlled communication board for paralyzed patient who could move only their eyes so that they could communicate effectively to their care takers.

3. LITERATURE SURVEY OF EXISTING SYSTEM

In our current scenario, there exists many communication aids for paralyzed. Some of these are Chart-based techniques and Eye gaze Response Interface Computer Aid (ERICA).

In chart based technique, patient and family create a chart of the most often patient request. The caretaker point out each need and asks the person whether he requires it or not. This method makes both the patient and caretaker tired and is not user friendly. Also we can use laser pointers that can be utilized by paralyzed individual in combination with a letter board or words, phrases, or letters on a piece of poster board.

Fig-2: Chart Based Technique

ERICA is a device that tracks eye movement to enable hands-free computer operation. This system translates the eye movement into cursor movement, moving the computer's cursor to exactly where the user is looking. Eye tracking is done using infrared illumination which is harmful for eyes and the user has to type his need using eye movement to specify the same. This makes the method time consuming.

Fig-3: ERICA

So, the above limitations of the existing systems motivated us to develop a user friendly, cost effective and non tiring communication aid for paralyzed patients.

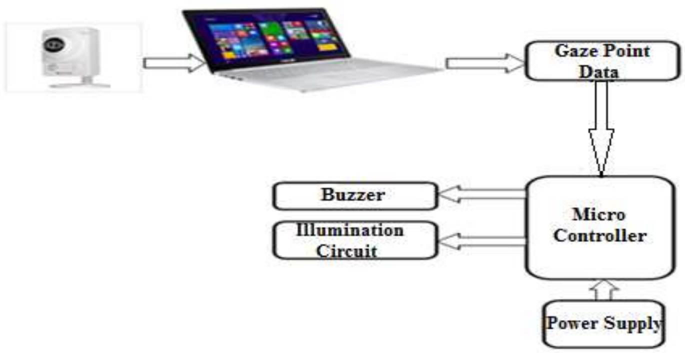
4. PROPOSED SYSTEM

4.1 Methodology

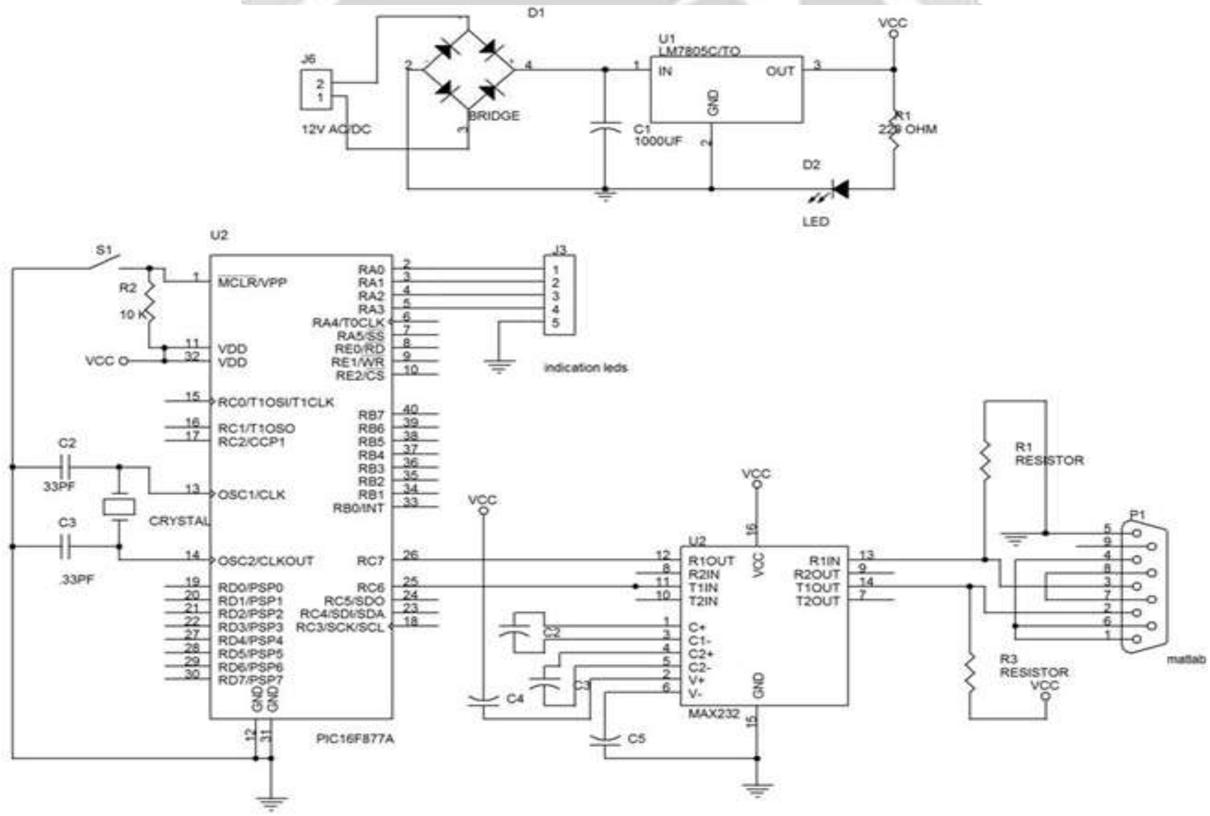
The proposed communication aid ensures communication with the patient as follows:

- On a communication board the images of various requirements of a paralyzed patient are displayed.
- The patient must be able to focus and fix his/her gaze up, down, straight, left and right. By gazing at the needs displayed on the communication board, he can illuminate it and convey the needs to caretakers.
- The web camera placed near the patient captures the user's video images and eye gaze is tracked by image processing.
- The detected gaze point is then transmitted to the communication board using serial communication.
- The display unit will receive the transmitted data and is send to the microcontroller unit.
- The microcontroller will fetch the received data and then check for display section to be illuminated and activates the buzzer.
- The patient's wish or need, represented by the image is illuminated and is noticed by the care taker.

4.2 Block Diagram



4.3 Circuit Diagram



4.5 Circuit Diagram Explanation

4.5.1 Power Supply Section

This section consists of an ordinary power supply, bridge rectifier and a voltage regulating device. The 12Volt DC voltage is given to a bridge rectifier which rectifies it and the capacitor filters it and is then given to a fixed three terminal positive voltage regulator IC LM7805 to produce a steady 5Volt DC output voltage.

4.5.2 Interfacing Section

4.5.2.1 MAX232

MAX232 is a dual driver/receiver which is used to connect the PIC microcontroller to the PC/Laptop. It is used to exchange the RS232 logic to TTL logic levels through the serial communication of microcontroller with the personal computers. The PC works with RS232 logic levels with the voltage of -25V to +25V. Here the Receivers R1 and R2 of MAX232 IC is used to convert the RS232 logic levels from PC into 5V TTL Logic level and is then given to the receiver pin of the PIC microcontroller.

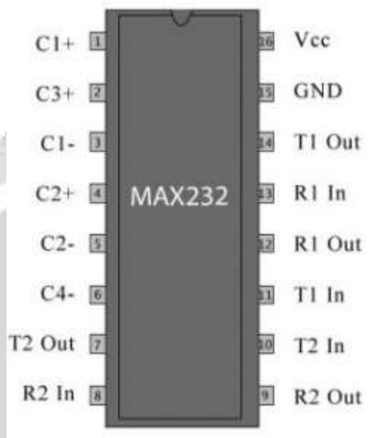


Fig-4: MAX232 Pin out

4.5.2.2 PIC16F877A

- RISC architecture.
- Operating frequency 0-20 MHZ.
- Power supply voltage 2.0-5.5V.
- In circuit serial programming option.
- A/D converter.
- 256 bytes EEPROM memory.
- 368 bytes RAM memory.
- 3 independent timers/counters.
- Enhanced USART module.

The PIC microcontroller 16f877A with the USART port enables the serial communication. The PIC operates with TTL logic levels with the voltage of 0-5V. The PIC compares the received gaze point data from MAX232 with the already programmed gaze point data and produces the corresponding output.

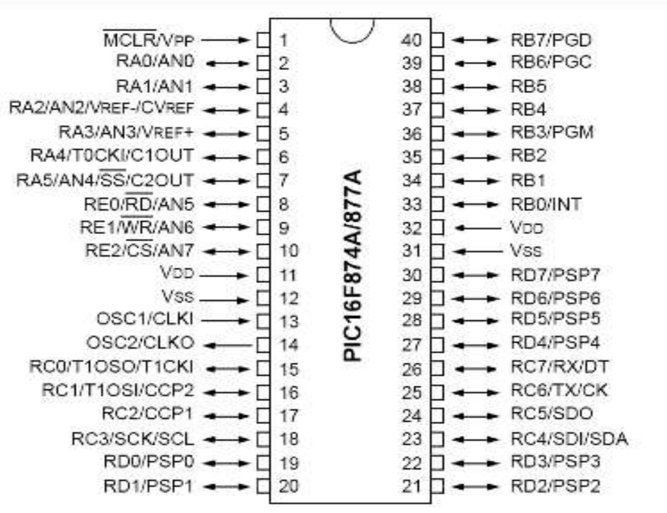


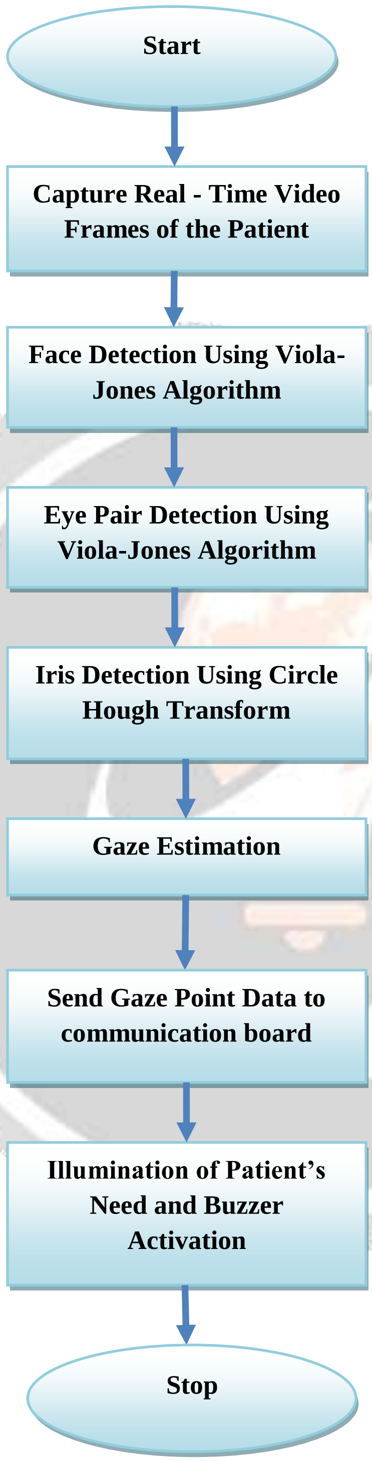
Fig-5: PIC16F877A Pin out

4.5.3 Output Section

The output section consists of indication LED's through which the corresponding needs of the paralyzed patient is illuminated.

4.6 Communication Board Model

4.7 Flowchart



4.8 Algorithms Implemented

4.8.1 Viola Jones Algorithm

Viola Jones Algorithm is used to detect eye and face from an image. Viola Jones face detection algorithm is based on the Haar-like features which are as follows,

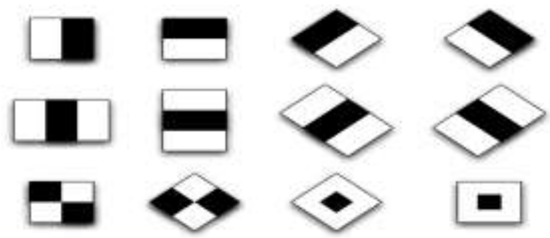


Fig-6: Haar-like Features

The three concepts involved in this algorithm are:

- Integral image formation
- Adaboost Learning Algorithm
- Cascading

4.8.1.1 Integral image formation

An integral image is formed to reduce the computation time while evaluating Haar-like features. During evaluation we take a particular Haar feature and scan it over the entire window (image is divided into 24x24 window as in case of Viola Jones Algorithm) each time with new size. For each time we calculate the Haar features by taking the summation of the pixels which lie within the white rectangles and are subtracted from the summation of pixels in the grey rectangles.This can consume more time, so we go for integral image. An Integral image at any point can be formed as the summation of pixels above and to the left of that point. [3]

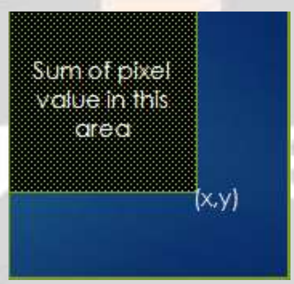


Fig-7: Integral Image Formation

4.8.1.2 Adaboost Learning Algorithm

AdaBoost or “Adaptive Boosting” is a machine learning meta-algorithm which is used to extract suitable Haar feature. In order to boost the performance of the classifier, a collection of the weak classifiers are combined to form a strong classifier. [3] The first two features selected by AdaBoost for the tasks of face detection are as follows: First Feature: The region of the eyes is often darker than the region of the nose and cheeks. Second Feature: The eyes are darker than the bridge of the nose.

4.8.1.3 Cascading

We can construct an efficient classifier by cascading the different classifiers. Thus formed classifier can reject many of the negative sub windows while detecting almost all positive instances. In each classifier the input image is compared with the Haar features since each classifier are assigned a set of Haar features. If it is matched then it goes to next classifier which compares the next set of features and if it is not matched then they are rejected. [4]

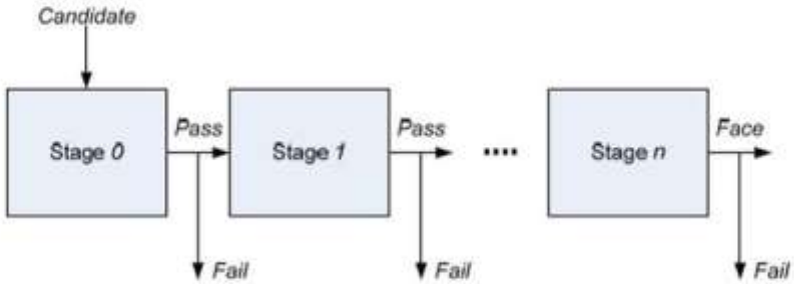


Fig-8: Cascading

4.8.2 Circular Hough Transform

For the detection of features of a particular shape like lines or circles in digitalized images, we use Hough Transform. The main principle of Hough transform is represented by the projection of the N-dimensional image space to a parameter space with a dimension M. To find the radius and the center coordinates of the iris, and consequently in gaze direction detection, we use Circular Hough Transform. Here we map our image points into Hough space. [1]

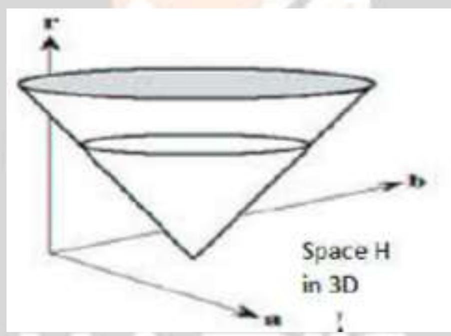


Fig-9: Hough Space

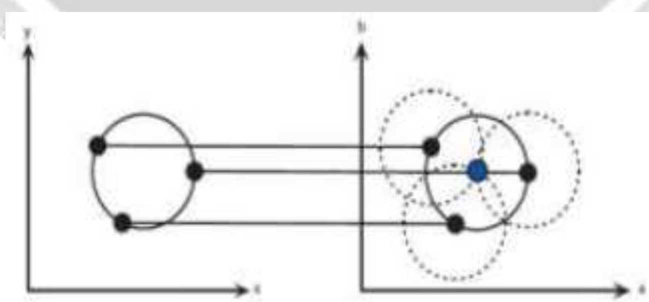


Fig-10: Mapping from X-Y space to the Accumulator space

The characteristic equation of a circle of radius R and center (a, b) is $(x\text{-}a)^2 + (y\text{-}b)^2 = r^2$. Parametric form of the equation of the circle is $x=a + R \cos(\theta)$ and $y=b + R \sin(\theta)$. The role of Hough transform is to search for the triplet of parameters (a, b, R) which determine the points (x_i, y_i). So first we detect the edges of an image and generate a binary image. For every 'edge' pixel, generate a circle in the accumulator space. Then we calculate every point on the circle in the accumulator space and store it in accumulator cells. The cells with greater number of votes are the centers. [2]

Fig-11: Iris Detection

4.9 Gaze Tracking

The eye gaze is tracked by examining the position of iris center from the bounding box of the detected eye. Let X_L and Y_L be the width and height of the bounding box of the detected eye as shown in figure and let P_X and P_Y be the center of the iris detected by Circle Hough Transform.

Eye gaze is determined by the following steps:

a. If $0.5Y_L<P_Y<0.65Y_L$ and $0.65X_L<P_X<0.8X_L$, then eye gaze is straight.
b. If $0.5Y_L<P_Y<0.65Y_L$ and $P_X>0.8X_L$, then eye gaze is towards left.
c. If $0.5Y_L<P_Y<0.65Y_L$ and $P_X <0.65X_L$, then eye gaze is towards right.
d. If $0.65X_L<P_X<0.8X_L$ and $P_Y<0.5Y_L$, then eye gaze is towards top.
e. If $0.65X_L<P_X<0.8X_L$ and $P_Y>0.65Y_L$, then eye gaze is towards top.

Note: When patient gaze towards his right, the captured image looks left and vice versa.

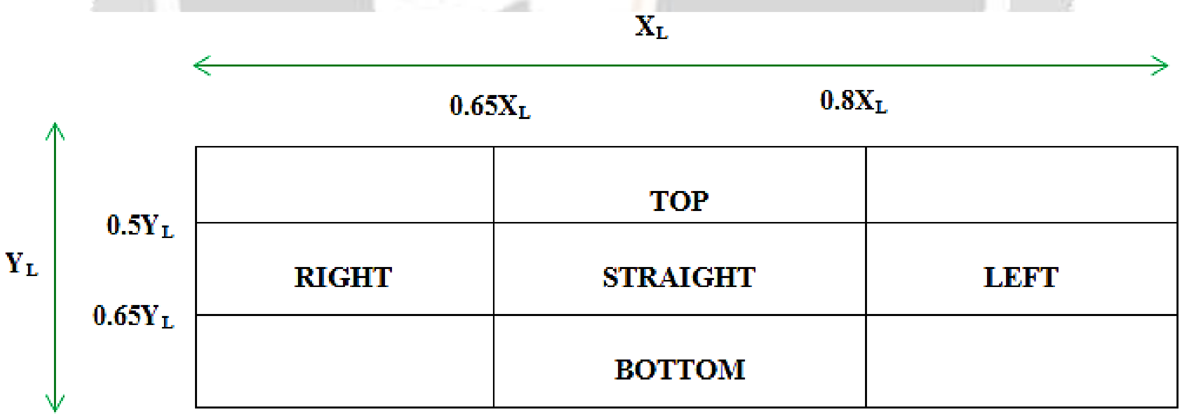


Fig-12: Gaze Tracking Illumination

5. RESULTS AND SIMULATIONS

The proposed communication board displays the four frequent needs of the paralyzed patient at its top (in need of doctor), bottom (meet family), right (change patient's position) and left (in pain).

(A) When the patient wants to change his position, he gazes towards the corresponding image which is at the right section of the communication board (with respect to patient). His/her gaze is tracked by image processing and then the data '1' is sent via serial communication to the hardware section. When the data '1' is received five times, the LED corresponding to it at the communication board is illuminated and the buzzer is activated which helps the caretaker to realize his need and fulfil him.

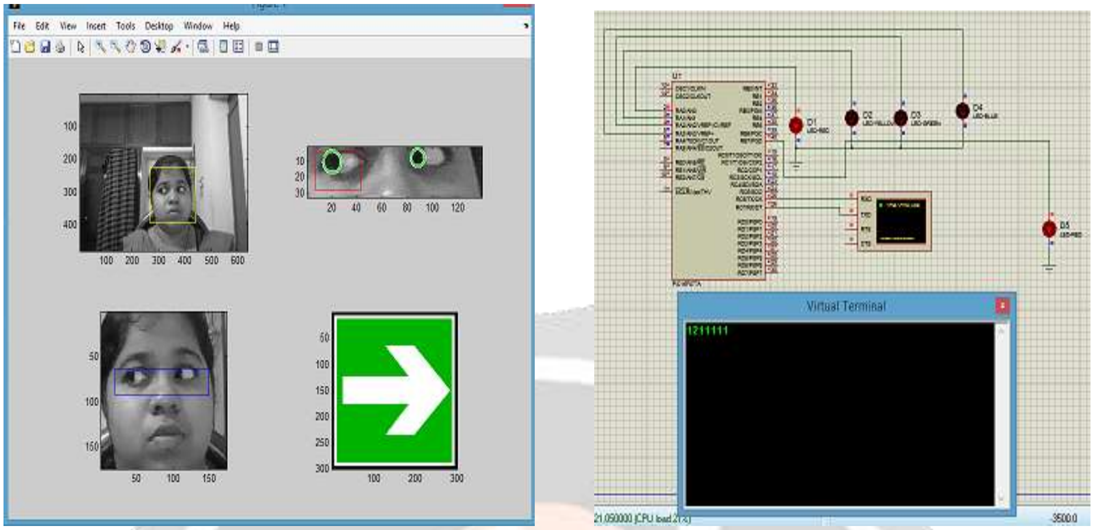


Fig-13: Matlab and Proteus Simulation of (A)

In MATLAB simulations, when patient gaze towards his right, the captured image looks left and the arrows shown indicate the gaze direction of the patient. In Proteus simulations, buzzer is represented by the LED at RB7 and the indication LEDs are connected to RA0, RA1, RA2, RA3 of PIC 16F877A.

(B) When the patient wants to meet his family, he gazes towards the corresponding image which is at the bottom section of the communication board. His/her gaze is tracked by image processing and then the data '2' is sent via serial communication to the hardware section. When the data '2' is received five times, the LED corresponding to it at the communication board is illuminated and the buzzer is activated which helps the caretaker to realize his need and fulfil him.

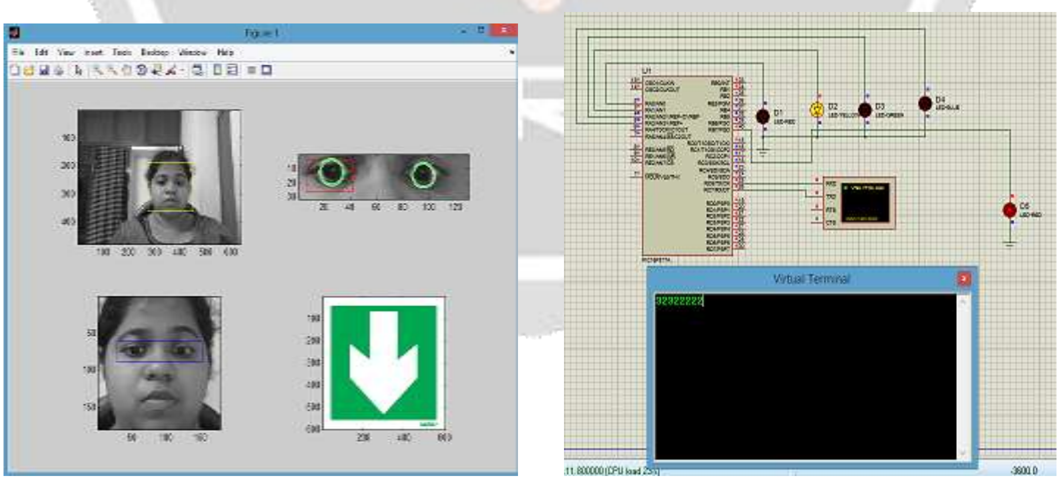


Fig-14: Matlab and Proteus Simulation of (B)

(C) When the patient is in pain, he gazes towards the image of 'pain' at the left section of the communication board (with respect to patient). His/her gaze is tracked by image processing and then the data '3' is sent via serial communication to the hardware section. When the data '3' is received five times, the LED corresponding to it at the communication board is illuminated and the buzzer is activated which helps the caretaker to realize his pain and take care of him.

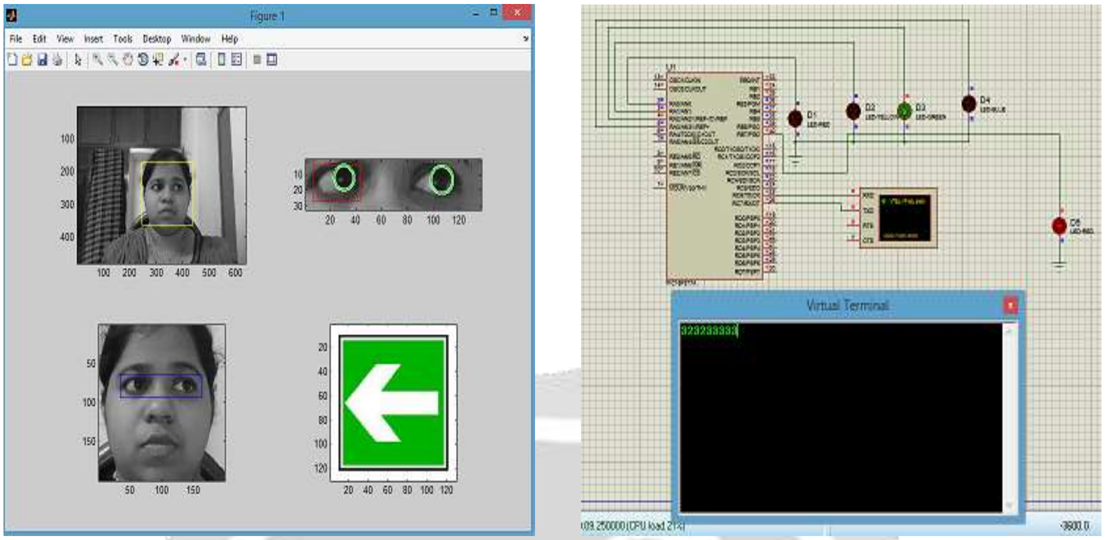


Fig-15: Matlab and Proteus Simulation of (C)

In MATLAB simulations, when patient gaze towards his left, the captured image looks right and the arrows shown indicate the gaze direction of the patient.

(D) When the patient is in need of doctor, he gazes towards the image of ‘doctor’ at the top section of the communication board. His/her gaze is tracked by image processing and then the data ‘4’ is sent via serial communication to the hardware section. When the data ‘4’ is received five times, the LED corresponding to it at the communication board is illuminated and the buzzer is activated which helps the caretaker to realize his need and fulfil him.

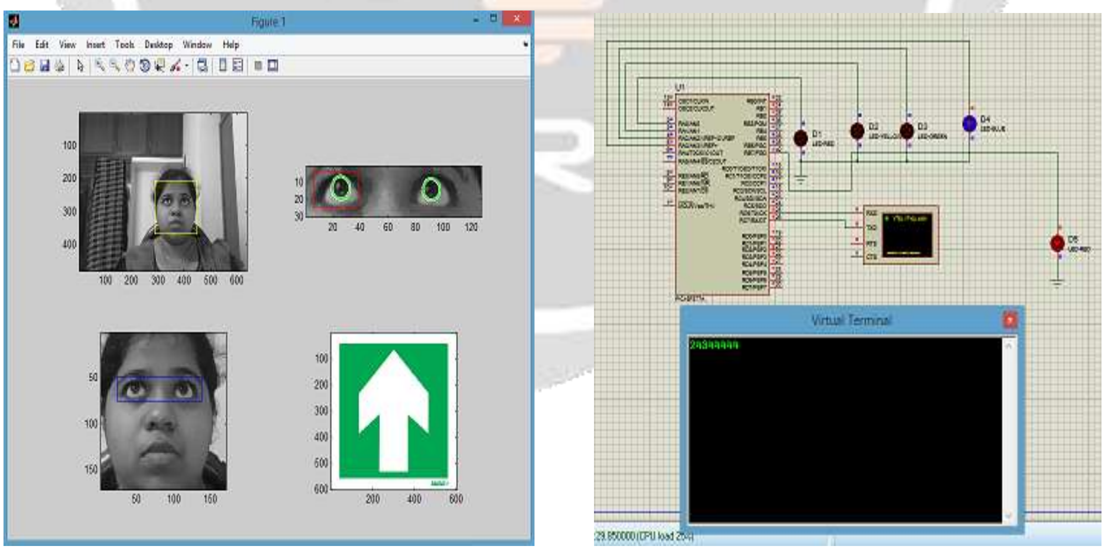


Fig-16: Matlab and Proteus Simulation of (D)

(E) When the patient is not in any need, he gazes towards the centre section of the communication board. His/her gaze is tracked by image processing and no data is sent via serial communication to the hardware section.

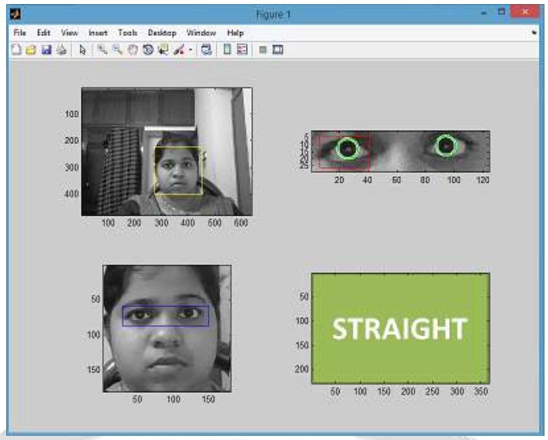


Fig-17: Matlab and Proteus Simulation of (E)

6. CONCLUSIONS

None of us can imagine our lives without communication and movement. They both give people the opportunity to learn and share knowledge with each other, to work and accumulate experience, to share their moods and emotions, to inform others about events, and to express their own opinions. Without gestures, facial expressions, and speech, people would cease to understand each other, and communication would be very difficult. This can be a consequence of paralysis. The communication of the paralyzed patients is the challenging area in the medical field. Various technologies are coming up in this field but all of these are not user-friendly or cost effective. So we developed a system that tries to rectify the drawbacks of the existing methods in a user friendly way.

From the recent studies it is evident that the new intelligent systems using face recognition models will bring great comfort and ease to our life. Haar - like feature approach is the most used method for face recognition projects (especially for video detection of faces and eyes) in recent years, because it is able to work in real time systems with great performance. Hence the proposed model based will definitely show better performance and prove beneficial to the society.

7. REFERENCES

[1]. Prateek Verma, Maheedhar Dubey, Somak Basu, Praveen Verma," Hough Transform Method for Iris Recognition-A Biometric Approach", International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 6, June 2012.

[2]. Hideki Kashima, Hitoshi Hong, Kunihito Kato, Kazuhiko Yamamoto, "An Iris Detection Method Using the Hough Transform and Its Evaluation for Facial and Eye Movement.", ACCV2002: The 5th Asian Conference on Computer Vision, 23--25 January 2002, Melbourne, Australia.

[3].Uma Sambrekar and Dipali Ramdasi," Human Computer Interaction For Disabled Using Eye Motion Tracking.",2015 International Conference on Information Processing (ICIP) Vishwakarma Institute of Technology. Dec 16-19, 2015

[4]. Ijaz Khan, Hadi Abdullah and Mohd Shamian Bin Zainal, "Efficient Eyes and Mouth Detection Algorithm Using Combination Of Viola Jones And Skin Color Pixel Detection", International Journal of Engineering and Applied Sciences, June 2013, Vol. 3, No. 4.