IoT Based an Eye-Ware to Assist in Ocular Communication

Vishal Verma¹, Deepali Gupta²*, Sheifali Gupta³, Harsha Chauhan⁴
Chitkara University Institute of Engineering and Technology, Chitkara University, Punjab, India

Verma.vishal@chitkara.edu.in, deepali.gupta@chitkara.edu.in, sheifali.gupta@chitkara.edu.in, harsha.chauhan@chitkara.edu.in

Abstract. This paper is completely focused on the difficulties faced by the paralyzed patients and the today technology help these patients to relief them. Currently the physical therapy, occupational therapy, respiratory therapy and the speech therapy are used to treat the patient who is suffers from paralysis. There is need of the device with this the paralyzed person convey his feelings like pain, hunger and loo. In this paper author purposed an electronic googles that can help the paralyzed person to convey his feelings using the eye blink pattern. The infrared sensor (IR) pair are used to detect the eye blinking pattern. When the IR rays strike to pupil it, large intensity of IR rays is reflected back. When the eye lashes are closed the less amount of IR radiation is reflected back. Two pair of infrared sensors are installed on the both glasses of the google. The blink pattern is pre-programmed in the microcontroller. ESP8266 microcontroller is used to process the all data coming from IR sensor. When the blink pattern is detected the message is sent to the care taker through internet connection.

1. Introduction

In the era of medical science, the electronic sensors and computer are the essential part of life that makes human life more easy and healthy. In broader term the health is free from illness/disease, injury, pain and lack of physical fitness. The human health is very important parameter. There are some factors like genetic disorder, infections and life style which influence human health.

The technology like electronic sensor and computer plays very important role to maintains our body fit and healthy. There are many applications are made for physical disabled person using electronic sensor and computer vision. The sensors play very important roles for physically disabled persons like paralyzed, deaf, blind etc. The computer vision based smart mouse for paralyzed person is a great example of the electronic sensor and computer vision. The patient can operate the personal laptop using their movement of head. The Accelerometer is used to detect the head movement and the eye blinking is used to select the icons [1]. The Eye tracking can have used to establish a communication connection between the computer and human. The eye tracking can have used to rapidly track the images very quickly [2]. So there are many applications developed based upon the eye tracking and eye blinking pattern for the physically disabled and paralyzed persons. The infrared (IR) reflectance oculography is used to detect the driver’s drowsiness during the driving period [3]. There are many road crashes happen due to driver drowsiness. An electroencephalography (EEG) based video eye tracking system used to interface the brain with computer [4]. The EEG is a sensor that are used to read the human emotions and brain signal of a human. In this paper author purposed a smart helping system for the physically disabled and paralyzed person. The infrared based Smart
goggles detects the eye blinking patterns and send alert message to the guardian and care taker of the patient.

The rest of the paper is arranged as follows: Section 2 encloses the methodology of the proposed solution. The result outcomes of the proposed solution are discussed in Section 3. Section 4 concludes the paper.

2. Related Work

The author observes that the paralysis can affect the human body with numerous ways. The paralysis can make someone unable to move, the human body nervous system is completely damaged and the some of the movable body parts stuck at one place. When the human body part stops their working the patient lost bladder control and cause bladder infection. When the human body part stuck due to paralysis attack it cause ulcer, blood clots in their veins and depression also. Wang Juan et.al [5] The invention discloses a recovery health-care type paralysis nursing device. The recovery health-care type paralysis nursing device comprises a bed frame, a first bed plate, a second bed plate, a third bed plate, an excrement and urea collecting mechanism, a cleaning mechanism, a first overturning driving mechanism, a second overturning driving mechanism and a controller. Wang Linping Wu et.al [6] The invention provides a medical auxiliary nursing machine. The machine comprises a main chair and an external hanging part. The main chair comprises a seat support, a back support, a leg support, a first driving device and a transversely-moving device. The back support can be rotatable arranged on the back side of the seat support. The leg support can be rotatable arranged on the front side of the seat support. Tan Xiyu et.al [7] proposed a Wearable buttocks washing glasses electric care bed, electric nursing bed of the front bed, the rear bed, smart toilets, control means, means to wear off trousers, the hip perforated sheets composition; 4/10 bed occupied area before, after accounting for the bed 6 / 10 area, smart toilet located behind the front end of the bed.

The present invention relates to an electric bed care technical field, particularly relates to a method based on the hips of the wearer of the glasses washed electric care bed. Sun Yushan et.al [8] had presented an invention relates to a medical instrument, generally relates to a paralyzed patient limb rehabilitation training apparatus. It can have pivoted bracing piece and the swinging boom of setting on the bracing piece between the base under and at last base to set up, the swinging boom is provided with and supports the emergency support of patient around bracing piece rotary motion, emergency support is including the left soles and the right branch frame. Tian Wentong et.al [9] had proposed a smart bed for paralyzed person. The smart bed contains a vertical and longitudinal moving mechanism. The movement angle is adjust using the electronic system that is installed on it. He Chunyan et.al [10] had proposed a cleaning system for the paralyzed person. This solution is related to medical field; it is basically an automatic foot washing device for paralyzed person. Shang-Lin Wu et.al [11] had proposed a system that used the electrooculography signal to control the computer interface. The system is capable to recognized the eye movement of the person in all the eight directions. Lawrence Y.Deng et.al [12] had proposed a system that are used to detect the motion of an eye using electrooculography signal. The system is capable to recognize the eye movement in four directions. The system has 90 % accurate to recognize the eye movement. Armando Barreto et.al [13] had proposed a system that is used for the disabled peoples to make their lives advanced with computer vision. Electromyography is used to detect the brain signal, these brain signal converted into 2d signal. These 2d signal are used to move the mouse cursor in the two direction. Ville Rantanen et.al [14] had developed a wearable device that are used as a gaze tracker. The system hardware is installed on the head of physically disabled person. These devices used for the physically disabled persons. Eduardo Ianez et.al [15] had proposed a system that used the brain signal to control the movement of a robotic arm. The electro-encephalography sensor is used to reads the brain signal. The proposed system tested on the six different persons. According to person the robotic arm follows different path.

3. Design Structure
The proposed system is divided into two parts one is transmitter unit and second is receiver unit. The basic block diagram of transmitter and receiving unit is given below.

Transmitter Unit:

![Figure 1 Block Diagram of Transmitter Unit](image1)

Receiver Unit:

![Figure 2 Block Diagram of Transmitter Unit](image2)

Algorithm:

Step 1: Initialize all the sensor pin to their respective pins.
Step 2: Set baud rate of ESP8266 at 115200.
Step 3: The status of left IR sensor and right IR sensor pin is observing continuously.
Step 4: The blinking pattern of IR sensor with condition are given as:

| S.No. | Condition                                         | Alert message to Guardian                      |
|-------|---------------------------------------------------|------------------------------------------------|
| 1     | If left eye is open and right eye is closed       | Patient wants food                             |
| 2     | If left eye is closed and Right eye is open       | Patient want to go wash room                   |
| 3     | If left eye is closed and right eye is blink      | Patient have pain in some body part            |
| 4     | If right eye is closed and left eye is blink      | Patient wants water                            |

Step 5: If any of the blinking pattern is observe at microcontroller pin then signal is send to Receiver unit.
Step 6: The receiver unit sent email/message alert to the guardian and care taker.
4. Hardware Design
Node MCU (ESP8266) Microcontroller: The Node MCU (ESP8266) microcontroller is the open source platform to build a IOT products with a few lines of code. The input voltage range of ESP8266 is 0V to 3.3V and maximum delivering current is 250 ma. The ESP8266 microcontroller have 32Kb ram and 200Kb flash memory. An inbuilt Wi-Fi module is attached with it; data can be easily share to the internet cloud. The C language and Lua programming language are used to programme a Node MCU microcontroller. The Node MCU have thirty input and output pins that are used to interface external peripheral to it. The pin diagram of Node MCU is shown in Figure 3.

![Figure 3 Pin Diagram of Node MCU (ESP8266)](image3)

Infrared (IR) TCRT5000 Sensor: The micro infrared sensor is used to detect the eye blinking pattern of the patient. The two infrared sensor pair are used for both left and right glass of goggles. The micro infrared sensor as shown in the figure 4 is the combination of both transmitter and receiver. The maximum detecting range of infrared sensor is 15mm. The maximum collector output current is 100 mA. The output of infra-red TCRT5000 is phototransistor type. When the IR rays reflect from any surface these reflected portion detect by receiver and according to detection the receiver produced its output.

![Figure 4 Diagram of Infra-Red (TCRT 5000) Sensor](image4)

Power Supply: The normal power bank is used as the power supply for the hole circuits. The maximum battery capacity of the power bank is 10000 mAh. The maximum output voltage and current delivered by the power source is 5 Volt and 2 Ampere. The power source has lithium polymer (Li-Poly) battery with double USB ports. The figure 5 show the diagram of power supply.

![Figure 5 Diagram of Power supply](image5)
Analog to Digital Converter (ADC MCP3008): The Node MCU have only single channel ADC so that only single IR sensor is interfaced with the Node MCU. If we connect more than one analog sensor more than two Node MCU will be required. The MCP3008 ADC is the 10-bit resolution and eight interfacing channel. The ADC have 16 input and output pin for the interfacing of analog sensor. The maximum data sampling rate achieved by MCP3008 ADC is 200 Ksps. The figure 6 shows the pin diagram of ADC. The interfacing technology of MCP3008 is based upon SPI.

![Diagram of ADC (MCP3008)](image)

5. Software Design
Algorithm for Interfacing of Smart Goggles Using Embedded C:

Step 1: Initialize the port for connection of ESP8266.
Step 2: Initialize the Input and output pin for interfacing the IR sensor.
Step 3: Initialize the variable to store the left and right IR sensor data. The variable L is used to store left IR sensor data and variable R is used to store right IR sensor data.

| S.No. | Condition                                      | Right IR Sensor Value | Left IR Sensor Value |
|-------|-----------------------------------------------|-----------------------|----------------------|
| 1     | When Both eye are closed                      | L=50                  | R=50                 |
| 2     | When Both eye are open                        | L=150                 | R=150                |
| 3     | When left eye is open and Right eye is closed | L=150                 | R=50                 |
| 4     | When left is open and Right is closed         | L=50                  | R=150                |

Step 4: Received the data from IR sensor output pin.
Step 5: The continuously compare the received data to pre-programed conditions:

For example:

| S.No. | Condition                                      | Alert message to Guardian |
|-------|-----------------------------------------------|---------------------------|
| 1     | If left eye is open and right eye is closed   | Patient wants food        |
| 2     | If left eye is closed and Right eye is open   | Patient want to go wash room |
| 3     | If left eye is closed and right eye is blink  | Patient have pain in some body part |
| 4     | If right eye is closed and left eye is blink  | Patient wants water       |

Step 6: If the any of the condition matched the alert message id send to the guardian.

Arduino IDE: Arduino IDE is used to programme the ESP8266 microcontroller unit. The code is flash into the microcontroller using this Arduino IDE.

![Arduino IDE](image)
Ubidot Cloud: Ubidots internet cloud: - Ubidots is the internet cloud platforms for professionals and beginners. It is establishing in 2012 and provide end to end internet of things services to the users. Ubidots establish this IOT platform with partnership with NETUX Pvt. Lmt. Ubidots IOT cloud platform is efficiently used for automation, surveillance and for health-care applications. Approximately all microcontrollers with wifi module are easily interfaced with Ubidots and we can easily transfer any sensor data or control any device with this IOT cloud platform [16].

![Ubidot Internet Cloud](image)

**Figure 8 Ubidot Internet Cloud**

6. Working

The figure 10 shows the receiving unit of the proposed system. The receiving unit contains a Node MCU, speaker and a buzzer for The figure 11 shows the working diagram of the proposed solution. As shown in the figure the two IR sensors are installed on the glasses of the goggles. The both left and right IR sensor are interfaced with the Node MCU ESP8266 microcontroller. The basic working of IR sensor is completely based upon the Infra-red radiations that are reflected by pupils of our eyes. The microcontroller is programmed in such a way that if the blinking eye pattern is observed at the input pin of the microcontroller the alert message is send to the guardian and care taker of the patient. The Node MCU ESP8266 microcontroller have inbuilt Wi-Fi module. When the blink wye pattern matched with the condition the Wi-Fi module send alert message to the receiver module. The vocal cords of the paralyzed person are damaged due to effect of the paralysis on our nervous system. So that the paralyzed person can see all the things an All the respective instructions are written over the roof, near the patients bed, front wall of the room so that the patient can easily follow these instructions. As we know the paralyzed person can understand and feel all the things but can’t express to others. The solution can fulfil the all basic requirements of the paralyzed patient. Instructions are as follows:

| S.No. | Condition | Alert message to Guardian |
|-------|-----------|--------------------------|
| 1     | If left eye is open and right eye is closed | Patient wants food        |
| 2     | If left eye is closed and Right eye is open | Patient want to go wash room |
| 3     | If left eye is closed and right eye is blink | Patient have pain in some body part |
| 4     | If right eye is closed and left eye is blink | Patient wants water       |

The step wise working of flow diagram as describe as first of all we initialize the input and output pins if the system. The system is basically divided into the two units as transmitting unit and the receiving unit. The transmitting unit have IR sensor as input device, because the IR sensor continuously monitor the status of the paralyzed patient. The receiving unit have speaker and the display unit as the output device because when the anything is happened with the patient the speaker and the display at the receiving unit and the speaker give alert message to the care taker.
Figure 9 Shows Flow Diagram of the System

Figure 10 Shows The Receiver Unit of The Proposed System
This proposed system will be better from previously/available system on the basis of following parameter:

- **Cost effective:** The Node MCU (ESP8266) microcontroller is used to interface IR sensor. The IR sensor data send to cloud using Wi-Fi module. The average cost of goggles and IR sensor is 150INR-300INR. While ESP-8266 module cost is 250INR, it has inbuilt Wi-Fi module. The proposed system is very cost effective.

- **Efficiency:** Our proposed system contains System-On-Chip (SOC) with integrated TCP/IP protocol to communicate with cloud platform, which is an internet connection based network. While other existing solution uses Zigbee module that are totally based upon mesh network. In internet based network maximum data transfer rate is 11mbps - 54mbps whereas in mesh network maximum data transfer speed is 250kbps. In term of data transfer our system is more efficient.

- **Reliability:** TCP/IP protocol make our proposed system more reliable than traditional approaches. The IR sensor data continuously transfer to the ubidot internet cloud and the receiver module continuously fetch the IR sensor data. If the patient wants something like water and food, the system sends alert message to the guardian.

- **Scalability:** Our system is easily scalable as compared to other solutions. The proposed system is very cost effective with high efficiency. It is easily affordable solution. Rich person as well as poor person easily afford that system. So it is easily scalable.

7. **Conclusion**
The authors have proposed an electronic system that are very useful for paralyzed persons and physically handicapped patients. It sends an alert message to the guardian and care taker when the patient has pain in any body parts, go to wash room and need some food or water. Our solution is more cost-effective, reliable, efficient and scalable. The proposed system can be implemented in hospitals and for the personal home purpose.

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