Final Presentation on Project on

SMART WHEELCHAIR FOR PARALYZED

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OVERVIEW

- ❖Introduction
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- ❖Eye Tracking Algorithm
- ❖Home Automation System
- ❖Simulation of Wheelchair
- ❖Eye Tracking
- ❖Working Model
- ❖Working of Wheelchair
- ❖Estimation of Components
- ❖Limitations
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INTRODUCTION

❖Paralyzed stroke patients are unable to normally communicate with their environment.

❖Part of their body that is under their control is their eyeballs.

❖Basic day to day operations are switching on basic devices like fan, bulb etc.

❖Smart Wheel Chair is the solution that we are proposing for these problems.

OBJECTIVES

- ❖To control the electric wheel chair by tracking eye movements.
- ❖To design and implement an electric wheelchair.
- ❖To track eye movement and control basic devices like bulb, fan etc.

LITERATURE REVIEW

[1] **Diksha Raj, Anish Kalra, Sreejith Krishna N, Suhriday Roy, Dr. Shreenath K N**, “Wagon - The Smart Wheelchair”, *International Journal of Emarging Technologies and Innovative Research* , vol.8, 2021

❖It comprises a wheelchair that works on hand gestures, voice command inputs, app inputs(Keypad), and head movements input for locomotion of the differently abled persons

❖Project can be upgraded in terms of speed and the lag can be overcome by replacing them with more advanced tools and sensors.

LITERATURE REVIEW

[2] **Tan Kian Hou, Yagasena and Chelladurai**, “Arduino based voice controlled wheelchair”, *First International Conference on Emerging Electrical Energy, Electronics and Computing Technologies*, vol. 1432, 2019

- ❖Smart motorized voice controlled wheelchair.
- ❖Voice command controls the movements of the wheelchair.
- ❖Microcontroller used is Arduino Uno.

LITERATURE REVIEW

[3] **Ahmad F. Klaib, Nawaf . Alsrehin, Wasen Y. Melhem, Haneen Bashtawi, Aws A. Magableh**, “Eye Tracking Algorithms, Techniques, Tools, and Applications with an Emphasis on Machine Learning and Internet of Things Technologies”, *Expert Systems with Applications*, vol. 166, 2020.

❖Machine learning and the Internet of Things are essential factors in the development of eye tracking applications.

❖This eye tracking techniques have more accurate detection results compared with traditional event-detection methods.

LITERATURE REVIEW

[4] **M.H.A. Sibai, S.A. Manap**, “A Study on Smart Wheelchair Systems”, *International Journal of Engineering Technology and Sciences*, vol. 4, 2015

❖Presented different smart technologies for wheelchairs.

❖The human - machine interface and the navigation methods and devices, were the two key areas of concentration.

SCHEMATIC DIAGRAM

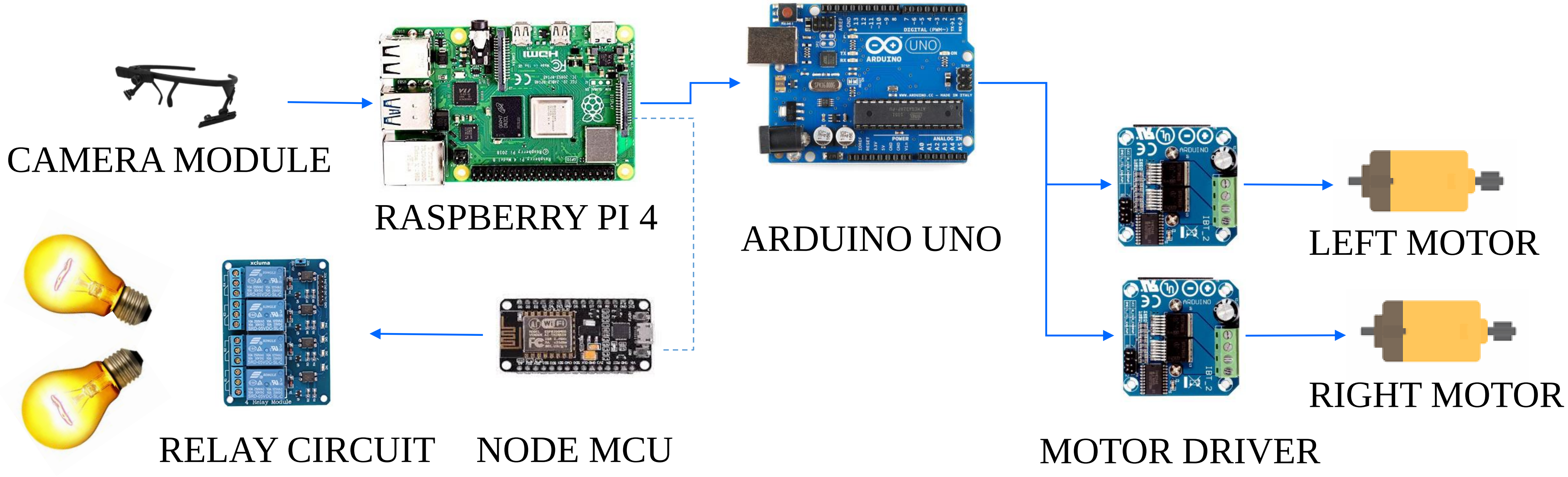


Fig 1. Block Diagram of Smart Wheelchair

SMART WHEELCHAIR

The whole project is divided into 3 parts:

❖Wheel Chair

❖Eye tracking module using Raspberry Pi 4

❖Home automation system using Node MCU

SMART WHEELCHAIR

❖Eye tracking module using Raspberry Pi 4:

a. Camera Module is used to capture eye movements.
b. The eye movement is tracked using the python eye tracking model using Raspberry Pi 4.
c. The position of the pupil is transferred to Node MCU.

SMART WHEELCHAIR

❖ Wheel Chair

a. Wheel chair is also controlled on the basis of the control signal received from Raspberry Pi 4.
b. The wheel chair operates at low speed for safety.

SMART WHEELCHAIR

❖ Home automation system using Node MCU:

a. From the position received from Raspberry Pi 4, appropriate decision is taken by the Node MCU.
b. Control by Node MCU include the switches of light and fan.

WHEEL CHAIR DESIGN

❖During the movement of a wheelchair, there are some resistances that appear.

1. Rolling resistance
2. Aerodynamic resistance
3. Inertial resistance

Calculation of Rolling Resistance

❖When an unformulated wheel is wrapped in unformed ground or, respectively, a fully resilient wheel is wound on a fully developed ground, there is no resistance to the movement.

❖In reality both the ground and the wheel suffer from deformations.

$$T_r = N \times a \text{ ------}(1)$$

❖To balance this torque, it is necessary to develop a torque opposite to this.

❖This torque equals the product of the pulling force F_r and the dynamic radius of the wheel.

Calculation of Rolling Resistance

❖Vertical force (F_z) which expresses the mass of a body in strength equals to:

$$F_z = m \times g \text{ ------------}(2)$$

where m is the body mass and g is the acceleration of gravity.

❖ The rolling resistance F_r is described by the following formula:

$$F_r = F_z \times \mu_r \text{ ------------}(3)$$

Where μ_r is the rolling resistance coefficient which is estimated for the wheelchairs with non- pneumatic wheels on concrete, with the value of μ_r = 0.015.

Calculation of Rolling Resistance

- For the calculation of the wheelchair rolling resistance is taken into account the masses of :
  - Wheelchair, $m_1 = 7kg$
  - User, $m_2 = 100kg$
  - Battery, $m_3 = 2 \times 2.5kg = 5kg$
  - Motor, $m_4 = 2 \times 2.35kg = 4.7kg$
  - Auxiliary weight, $m_5 = 200g$

Total weight, $M = m_1 + m_2 + m_3 + m_4 + m_5$

$$= 7 + 100 + 5 + 4.7 + 0.2 = 116.9kg \approx 117kg$$

Calculation of Rolling Resistance

$$F_z = M \times g \text{ ----------(4)}$$

$$F_z = 117 \times 9.81$$

$$F_z = 1147.77\ N$$

M is the total mass in kilogram

$$F_r = F_z \times \mu_r \text{ ------------(5)}$$

$$F_r = 1147.77 \times 0.015$$

$$F_r = 17.2\ N$$

Calculation of Rolling Resistance

- When climbing a vehicle due to road inclination, a resulting force from the weight of the vehicle appears as shown in Fig 2.
- This force opposes the movement of the vehicle when it is on the hill.

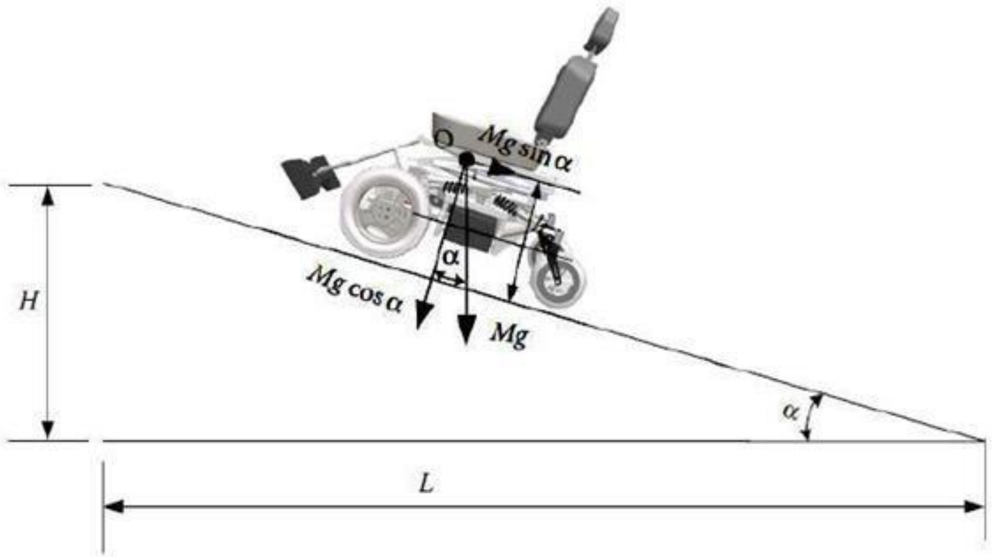


Fig 2. Forces in road inclinations.

Calculation of Rolling Resistance

- ❖ The ascent resistance F_B is calculated from the following formula:

$$F_B = F_z \times \sin\alpha \text{--------------}(6)$$

Where F_z is vertical force in newtons and α is the angle of the road inclination.

- ❖ Tilt of the road is the ratio of the height H to the distance L (Fig 1) and expresses the height to be developed at a distance of 100 km:

$$i = H/L = \tan\alpha \approx \sin\alpha \text{------------}(7)$$

- ❖ To find the angle α, in order to calculate the ascent resistance, the right formula is the following:

$$\alpha = \tan^{-1}(i)$$

Calculation of Rolling Resistance

- Thus, for a pavement slope of 10° the vehicle has an ascent resistance equals to:

$$F_B = 1147.77 \times Sin10 = 199.31\ N$$

$$F_t = F_r + F_B = 17.2 + 199.31 = 216.51\ N$$

Where F_t is the total traction force which is the sum of ascent resistance F_B and the rolling resistance F_r

- The torque needed on the wheel to overcome these resistors is calculated by the formula:

$$F_t = M_k \times i_{tot}/r_t \Rightarrow M_k = F_t \times r_t / i_{tot}$$

Where M_k is the torque on the wheel in Nm

Calculation of Rolling Resistance

The r_t the radius of the wheel and i_{tot} its gear transmission ratio from the motor to the wheel.

- The motors have a diameter of 12inch (308mm) with a working voltage of 24V, 250Watt and a fixed gear transmission ratio of 23: 1.
- The maximum torque that can be produced by the motor according to its operating diagram is 20Nm and is enough to overcome the climb and roll resistors.

$$F_t = M_k \times i_{tot} / r_t$$

$$M_k = F_t \times r_t / i_{tot}$$

$$= 216.15 \times 0.154 / 23$$

$$= 1.5\ Nm$$

Calculation of Rolling Resistance

- According to standard values maximum speed of motor is 220 rpm and the maximum speed that the wheelchair can develop is 12Km/h.
- This is calculated by the following formula:

$N = V \times 60/2 \times \pi \times r$

$V = N \times 2 \times \pi \times r / 60$

$= 216.51 \times 2 \times \pi \times 0.154/60$

$V = 3.50\ m/s$

$V = 12.6\ Km/h$

Where *V* is the maximum speed that wheelchair can achieve in *Km/h*, *n* is motors speed in rpm and r is wheelchair's wheel radius in *m*.

Calculation of Power

- ❖Work results when a force acts upon an object to cause a displacement (or a motion) or, in some instances, to hinder a motion.
- ❖Three variables are of importance in this definition
  - ➢Force
  - ➢Displacement
  - ➢The extent to which the force causes or hinders the displacement
- ❖Each of these three variables find their way into the equation for work.

$$W = F \times \chi$$

Where W is the work in *Joules*, F is force in N and χ *i*s the displacement in meters

Calculation of Power

- ❖ Considering the above mathematical formulas and knowing the velocity it follows that:

$$P = F_t \times V_t$$

Where P is the power in *watts* F_t is the traction force in N and V_t *is* the velocity in *m/s.*

- ❖ Theoretically, the power given to the vehicle, when it moves at the maximum speed (3.50m/s) it can develop:

$$P = F_t \times V_t$$

$$P = 17.2N \times 3.50\ m/s$$

$$P = 60.2\ Watt$$

Calculation of Power

- The needed energy to drive the vehicle for one hour is calculated by the formula:

$$E = P \times t$$

$$E = 0.0602KWh$$

Where E is the energy in KWh, P is power in *watt* and t is the time in *hours*.

- According to the formula below, the vehicle needs 2.50Ah to move one hour at maximum speed.

Calculation of Power

$$E = Q_x \times V/1000$$

$$Q_x = 0.0602 \times 1000/24$$

$$Q_x = 2.50Ah$$

❖Where *E* is the energy needed in *Ah*, Q_x is the capacity of the battery in Ah and *V is* the voltage of the battery used in the experiment equal to 24V.

EYE TRACKING ALGORITHM

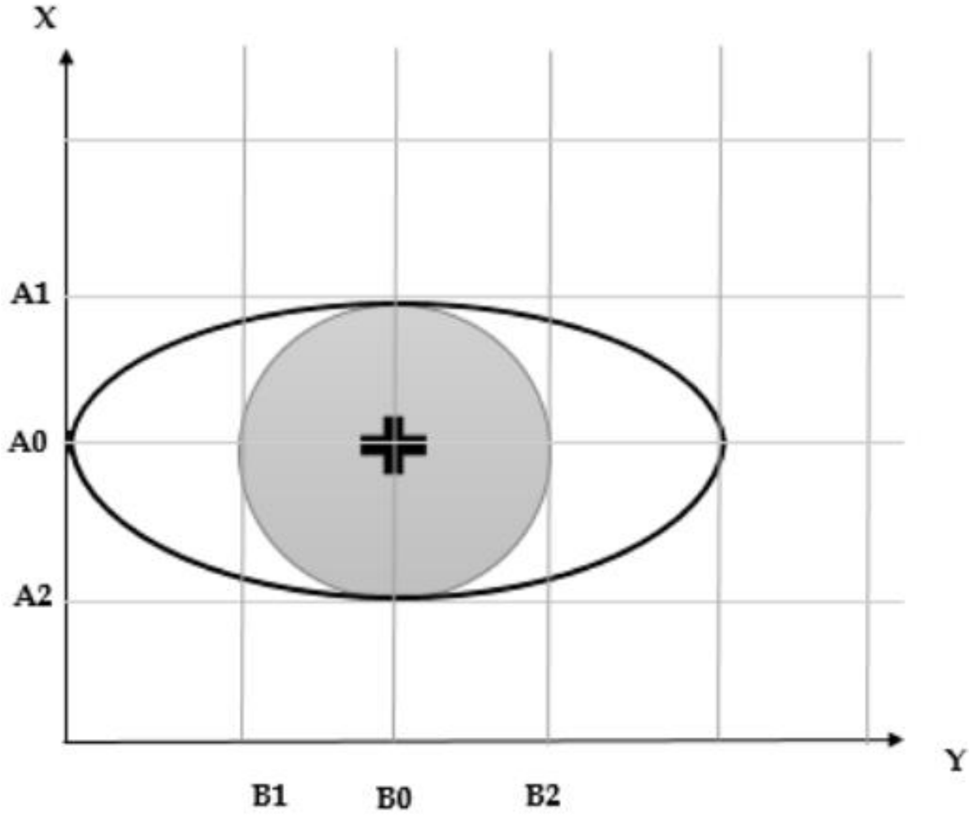


Fig 3. Detection of Pupil in Eye Tracking Algorithm

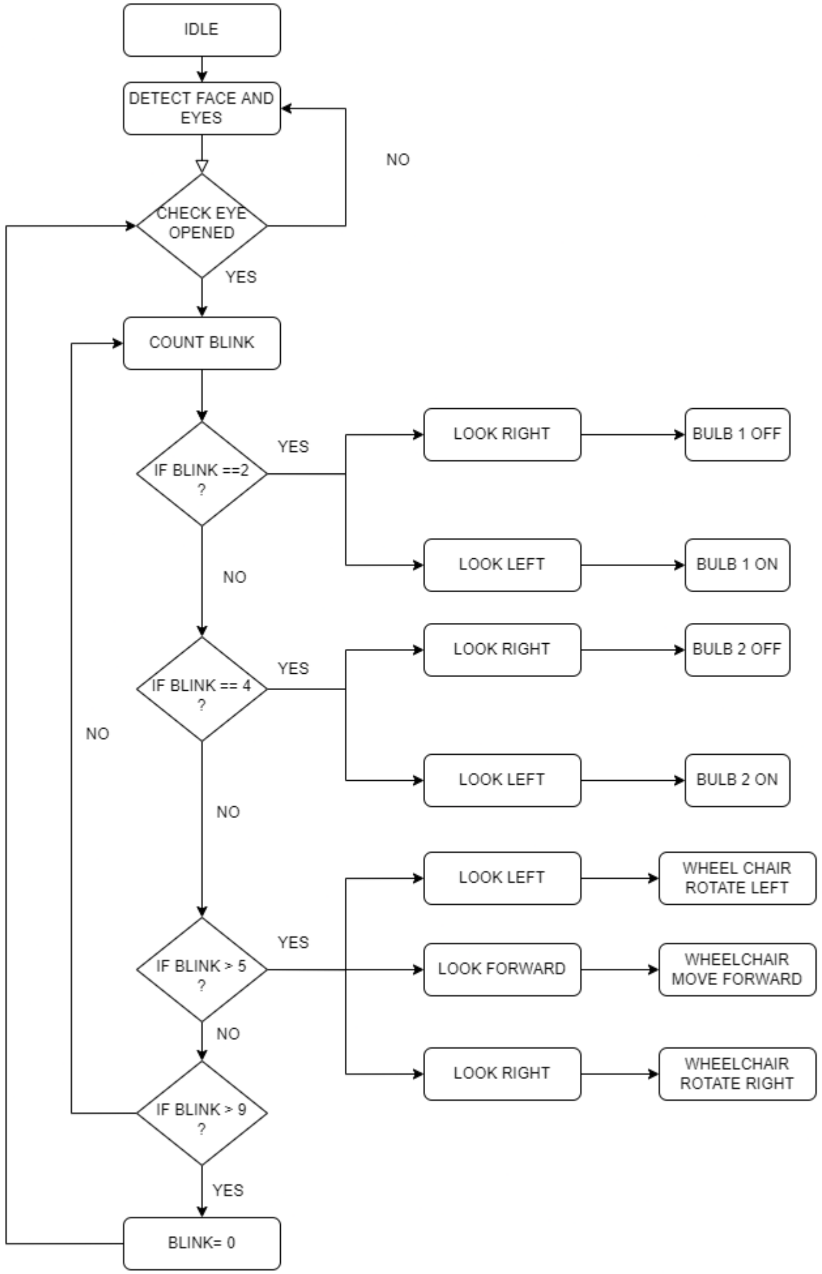


Fig 4. Flow Chart of Eye Tracking Program

HOME AUTOMATION SYSTEM

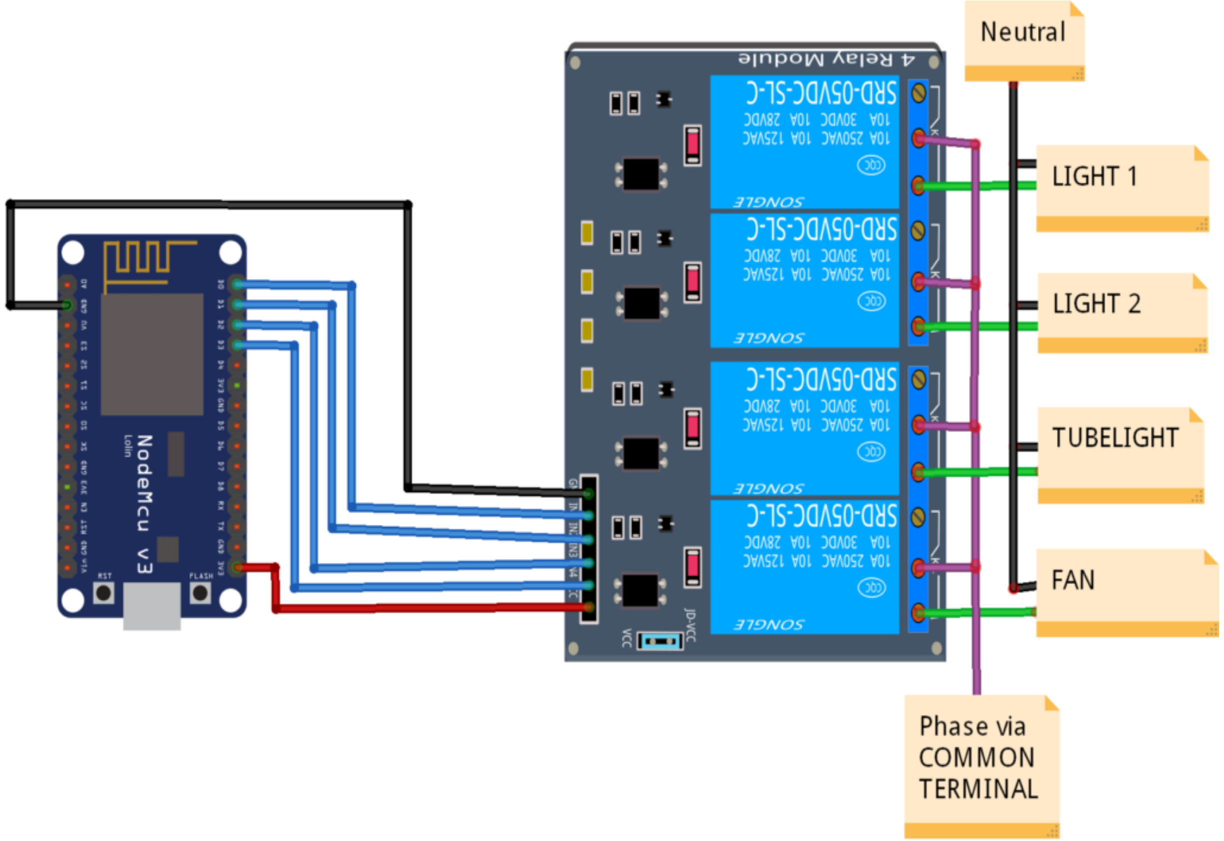


Fig 5. Home Automation System Using Node MCU and Bluetooth Module

SIMULATION OF WHEELCHAIR

❖Simulation of Smart Wheel Chair

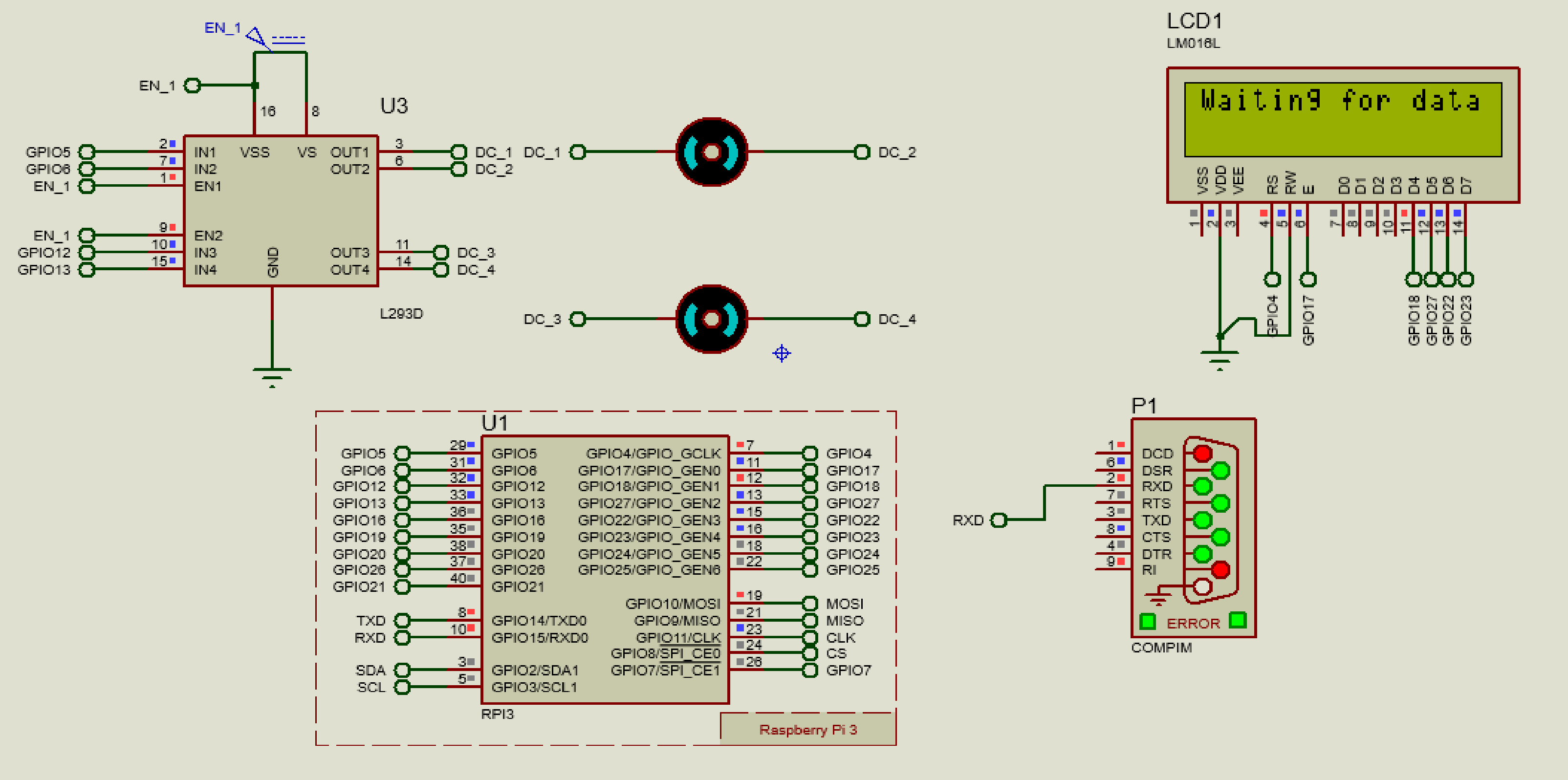


Fig 6. Simulation Model of Smart Wheelchair

SIMULATION OF WHEELCHAIR

- Simulation of Smart Wheel Chair

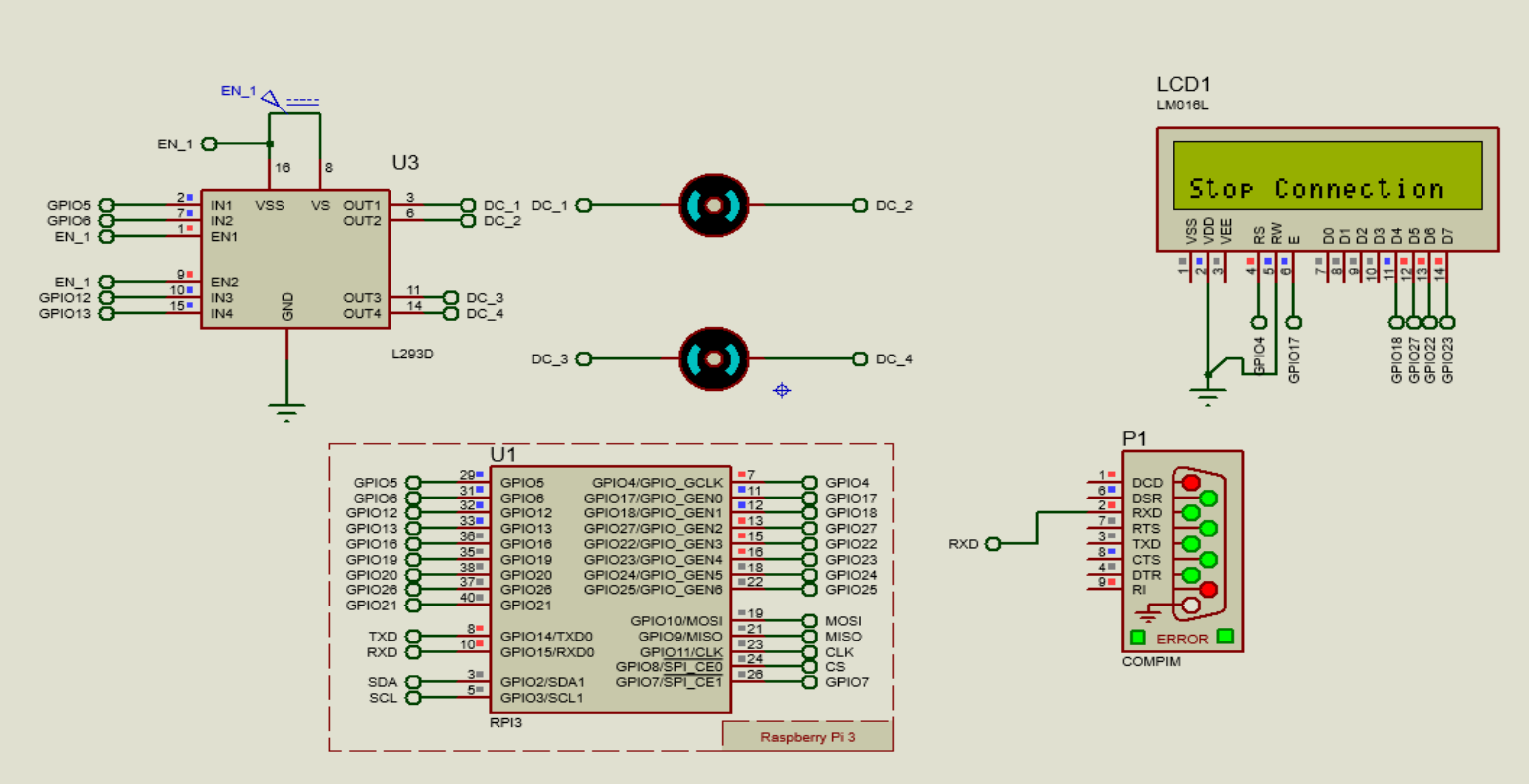


Fig 7. Simulation Model of Smart Wheelchair

SIMULATION OF WHEELCHAIR

❖Simulation of Smart Wheel Chair

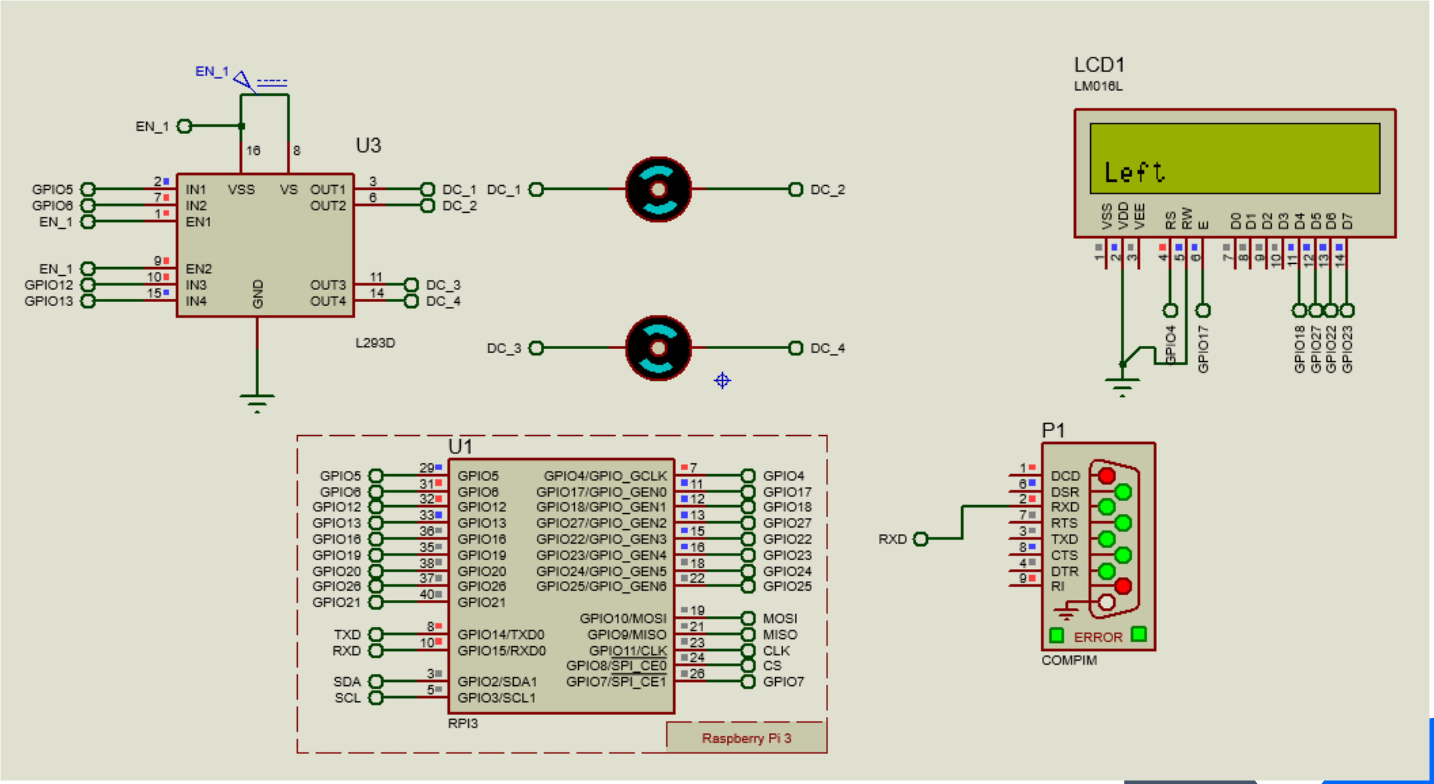


Fig 8. Simulation Model of Smart Wheelchair

SIMULATION OF WHEELCHAIR

❖Simulation of Smart Wheel Chair

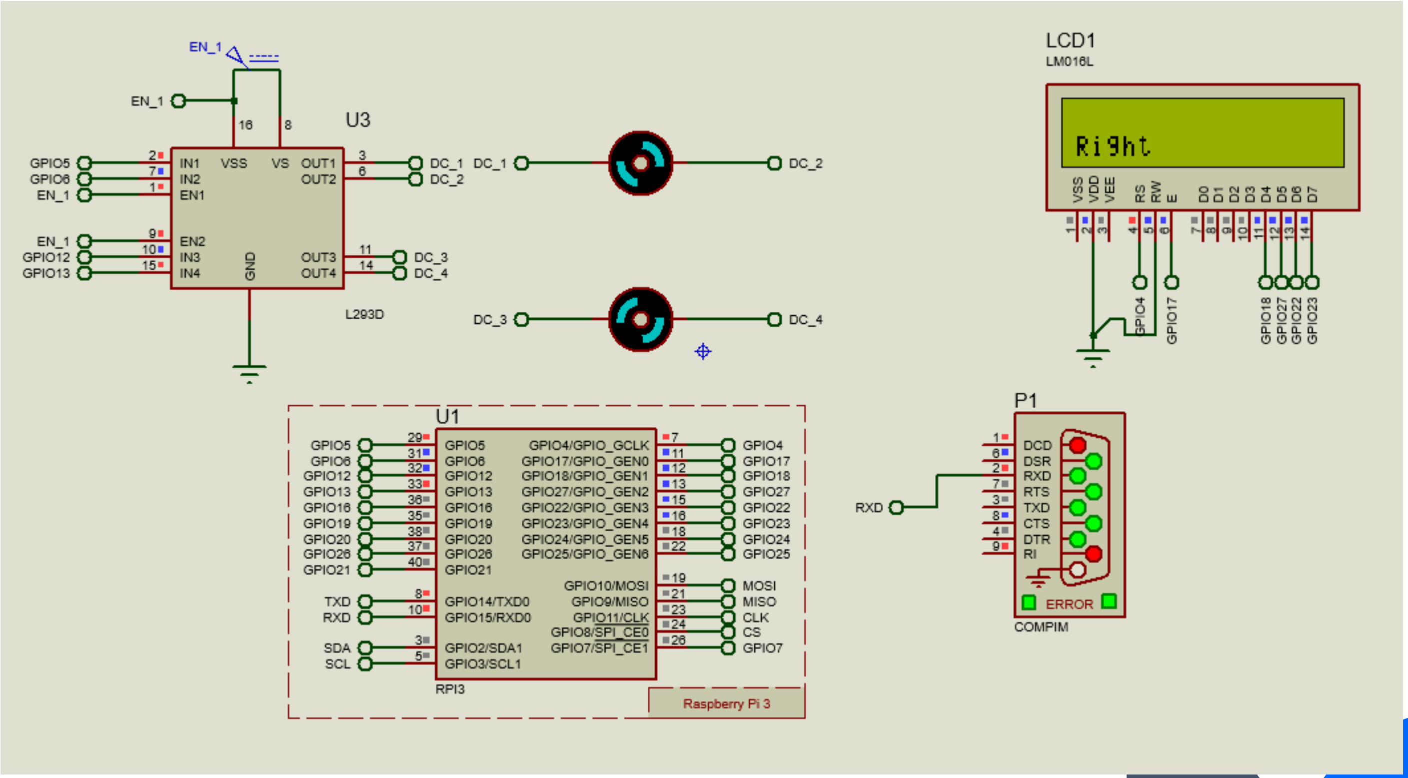


Fig 9. Simulation Model of Smart Wheelchair

SIMULATION OF WHEELCHAIR

❖ Simulation of Smart Wheel Chair

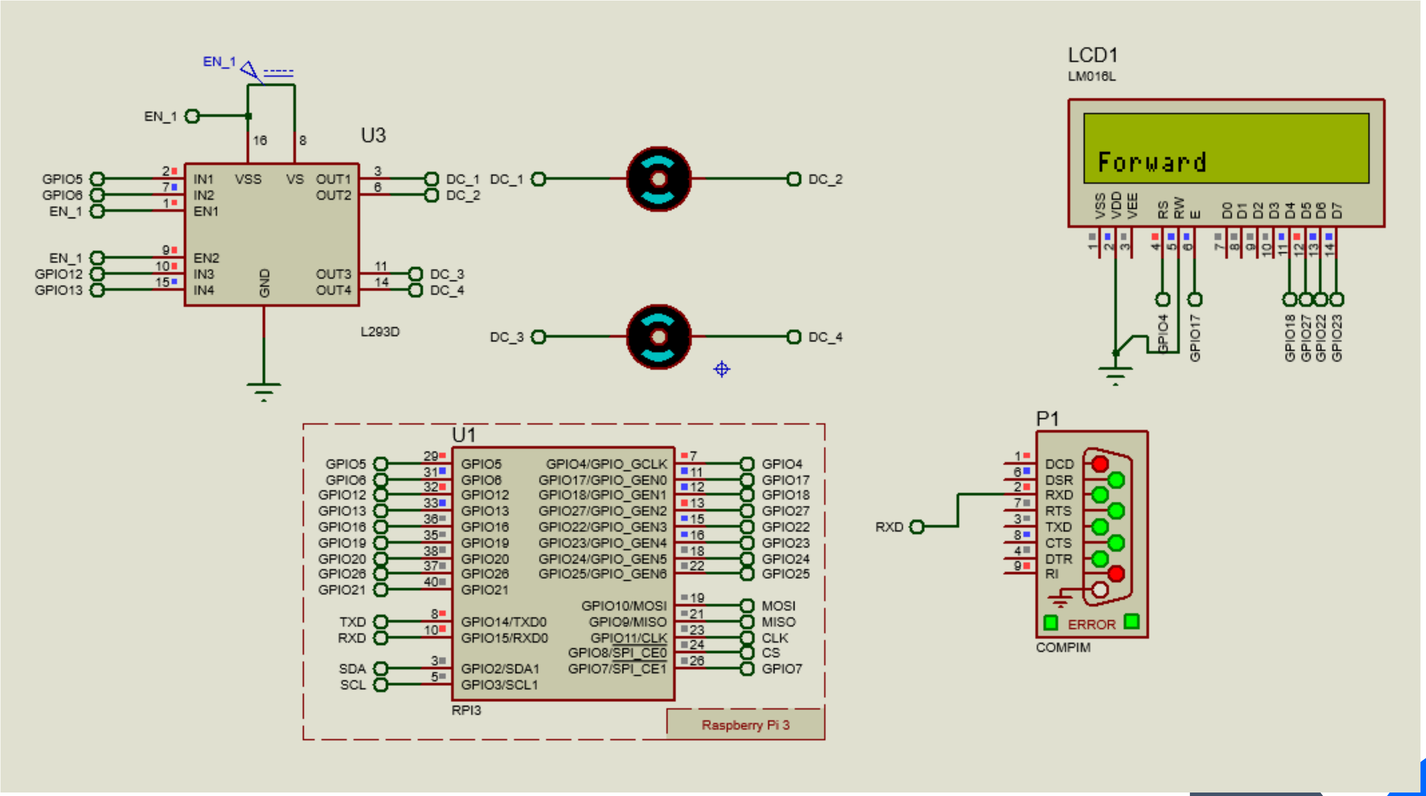


Fig 10. Simulation Model of Smart Wheelchair

EYE TRACKING

❖Eye tracking program is developed and its results are shown below.

Fig 11.Straight

Fig 12. Closed

EYE TRACKING

❖Eye tracking program is developed and its results are shown below.

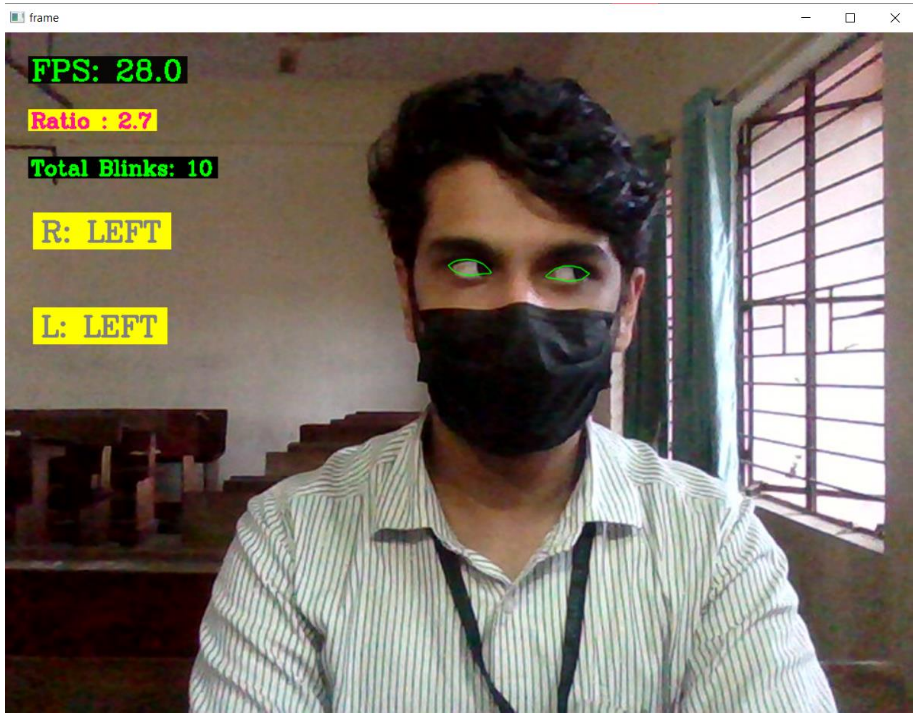


Fig 13. Left

Fig 14. Right

RASPBERRY PI 4 CONFIGURATION

- Hardware required:
    a. Raspberry Pi 4
    b. RJ45 LAN cable
    c. 32GB SD card and adapter
- Software required:
    a. Raspberry Pi OS
    b. VNC Viewer and VNC Server
    c. PuTTY Software

RASPBERRY PI INTERFACE

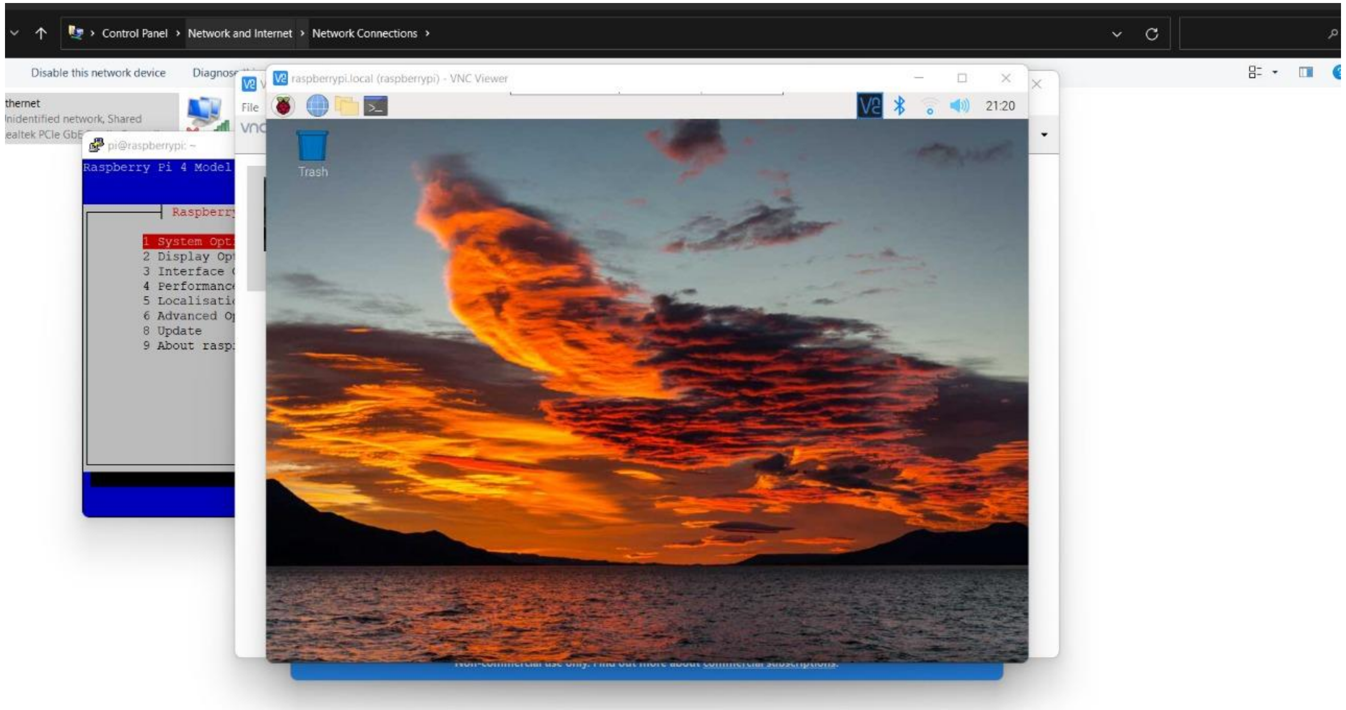


Fig 15. Raspbian OS Desktop Interface

EYE TRACKING PROGRAM

Tested eye tracking program on Raspberry Pi 4

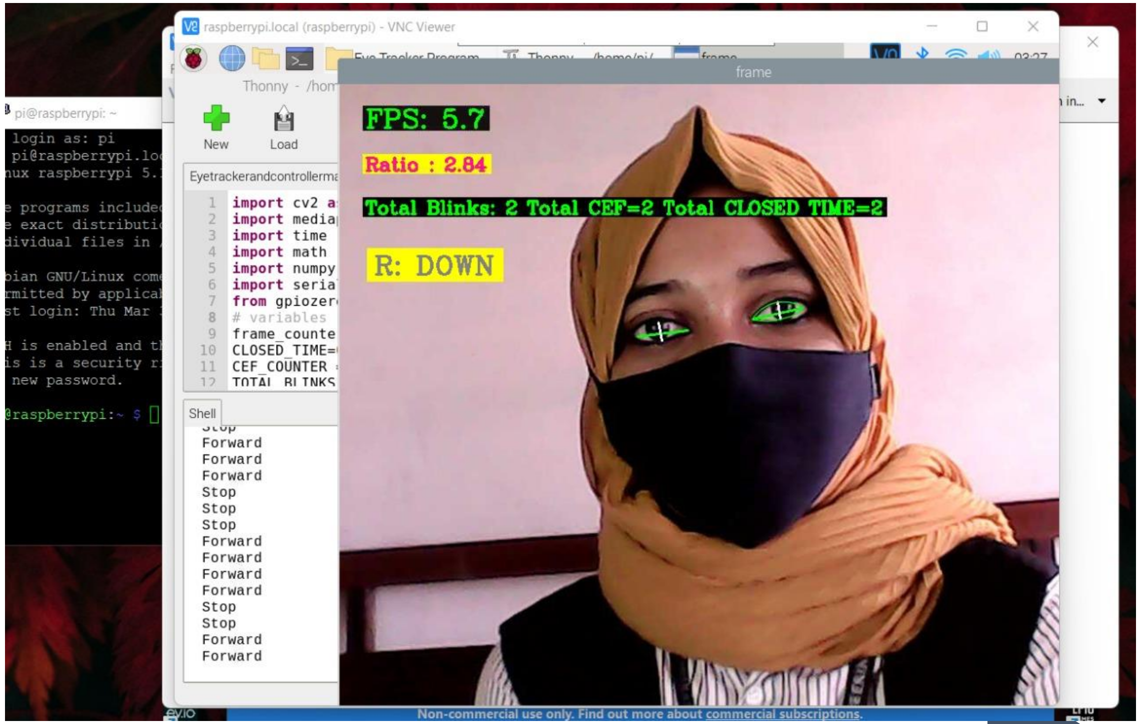


Fig 16. Eye tracking program on Raspberry Pi 4

WORKING MODEL

❖Implementation of smart wheelchair

Fig 17. Smart wheelchair

WORKING MODEL

❖Hardware setup for eye tracking and wheelchair control

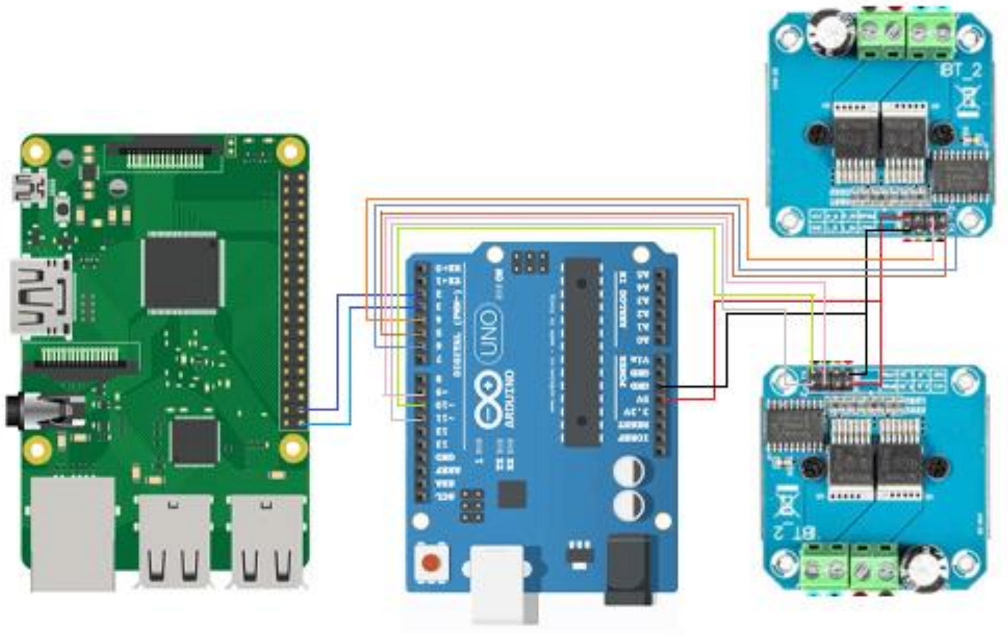


Fig 18. Circuit inside controller setup

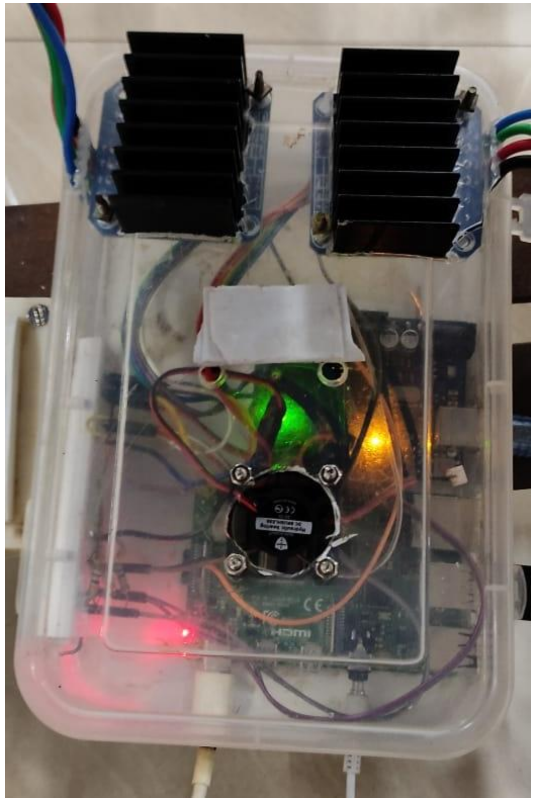


Fig 19. Wheelchair control setup

WORKING MODEL

❖Conversion to electric wheelchair.

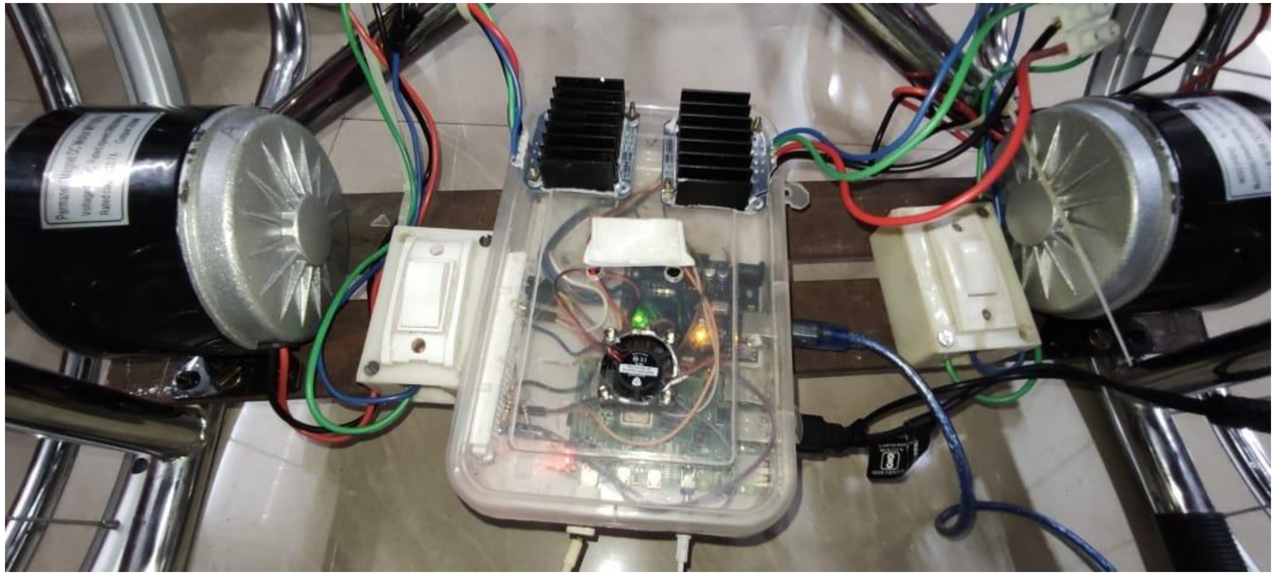


Fig 20. Electric conversion of wheelchair

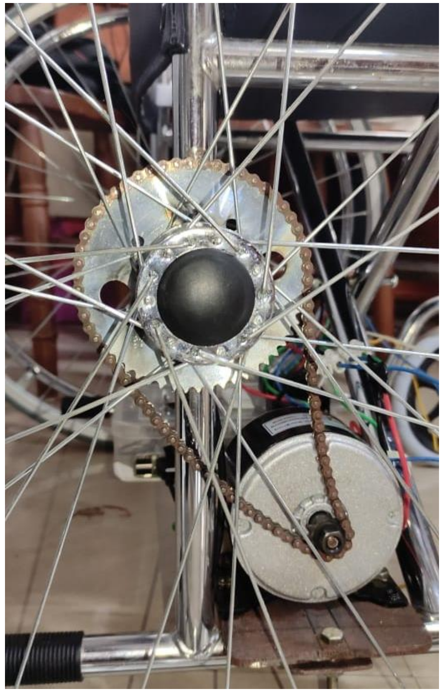


Fig 21. Chain and sprocket arrangement

WORKING MODEL

❖Camera arrangement in wheelchair

Fig 22. Camera setup

WORKING MODEL

❖Implementation of Home Automation System

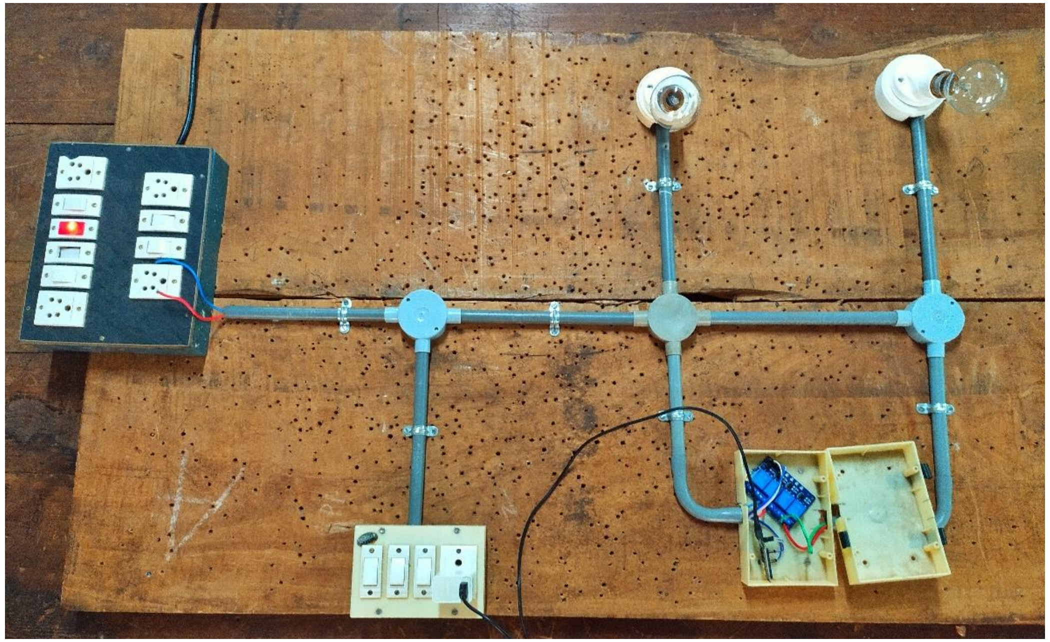


Fig 23. Home Automation System

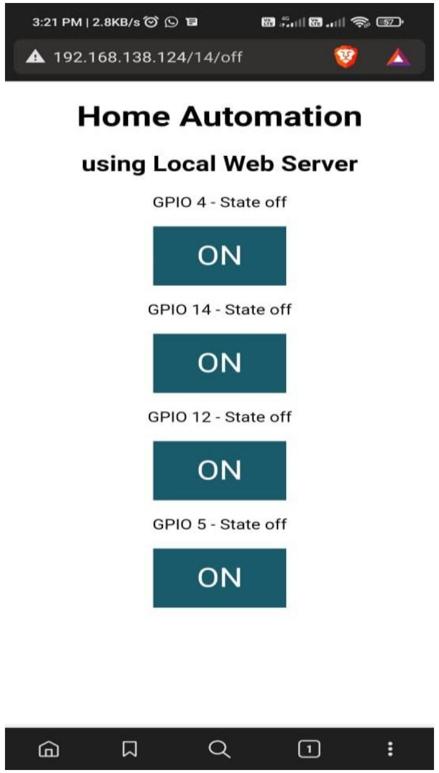
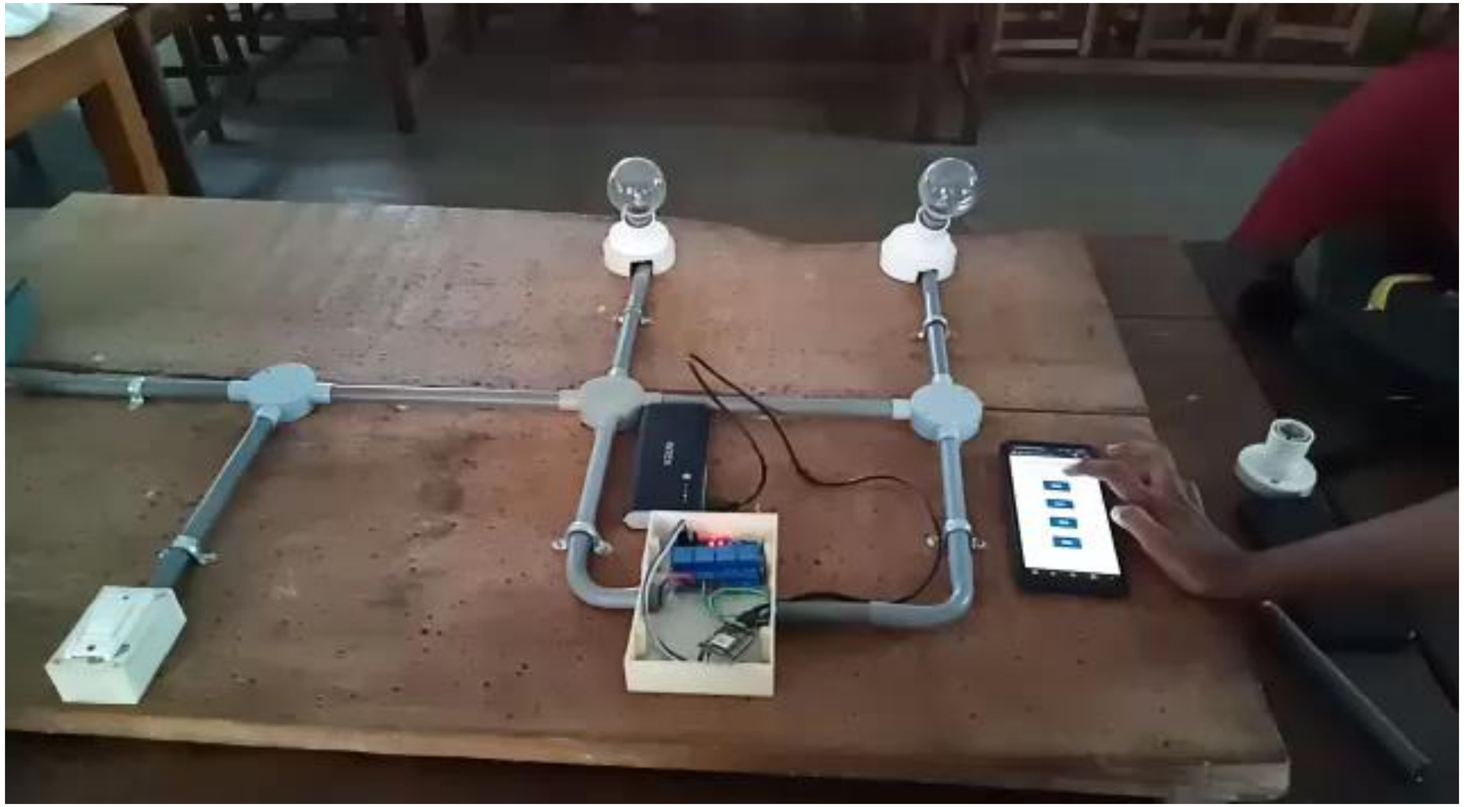


Fig 24. Web server interface for Home Automation System

WORKING MODEL



❖**Fig 23.** Control of Home Automation System with external device

WORKING OF WHEELCHAIR

❖Home automation by eye tracking.

Fig 24. First bulb control

Fig 25. Second bulb Control

WORKING OF WHEELCHAIR

❖Forward movement of wheelchair

Fig 26. Forward Movement

WORKING OF WHEELCHAIR

❖Left movement of wheelchair

Fig 27. Left Movement

WORKING OF WHEELCHAIR

❖Right movement of wheelchair

Fig 28. Right Movement

LIMITATIONS

- Detection is difficult in dim light.
- Chain and sprocket system is not efficient.
- Detection is difficult for users wearing spectacles and eye liner.
- Breaking is not provided.

FUTURE SCOPES

- Use of night vision cameras helps in dim light instead of normal camera.
- Use of hub motors improves the efficiency of the wheelchair.
- Breaking and speed control with the help of position sensors in the wheels.

CONCLUSION

- Designed and implemented the electric smart wheelchair.
- Wheelchair is controlled by tracking eye movement.
- The basic devices like fan, bulb, etc. can be controlled either by eye tracking or by web server.
- Limitations of the wheelchair is identified.

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THANK YOU

ESTIMATION OF COMPONENTS

Table 1. Estimation

SL No.	Component Name	Quantity	Price (Rs)
1	250W, 24V, 13.7A Motor	2	4600
2	4 Channel Relay(Peak 30V DC Supply)	1	240
3	12V, 7.2Ah Battery	4	3000
4	15V,2.2A Battery Charger	1	250
5	Node MCU	1	500
6	Ultrasonic Sensors	4	400
7	DC Wire Socket	1	10
8	Raspberry Pi 4	1	5100
9	Webcam	1	1500
10	Wheelchair	1	7000

ESTIMATION OF COMPONENTS

Table 1. Estimation (Contd..)

SL No.	Component Name	Quantity	Price
11	BTS7960B Bridge Motor Driver	2	1600
12	Fan	1	220
13	Sprocket and Chain	2	550
14	Camera Mount	1	200
Total			25170

COMPONENTS

Fig 30. Components

COMPONENTS

Fig 31. Raspberry Pi 4

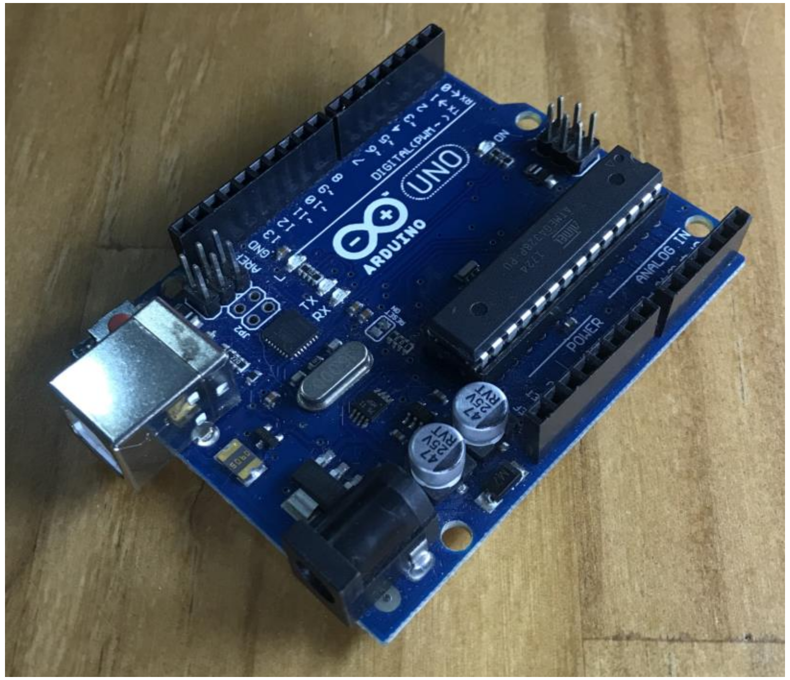

Fig 32. Arduino Uno

COMPONENTS

Fig 33. 250W, 24V, 13.7A Motor

Fig 34. 4 Channel Relay(Peak 30V DC Supply)

COMPONENTS

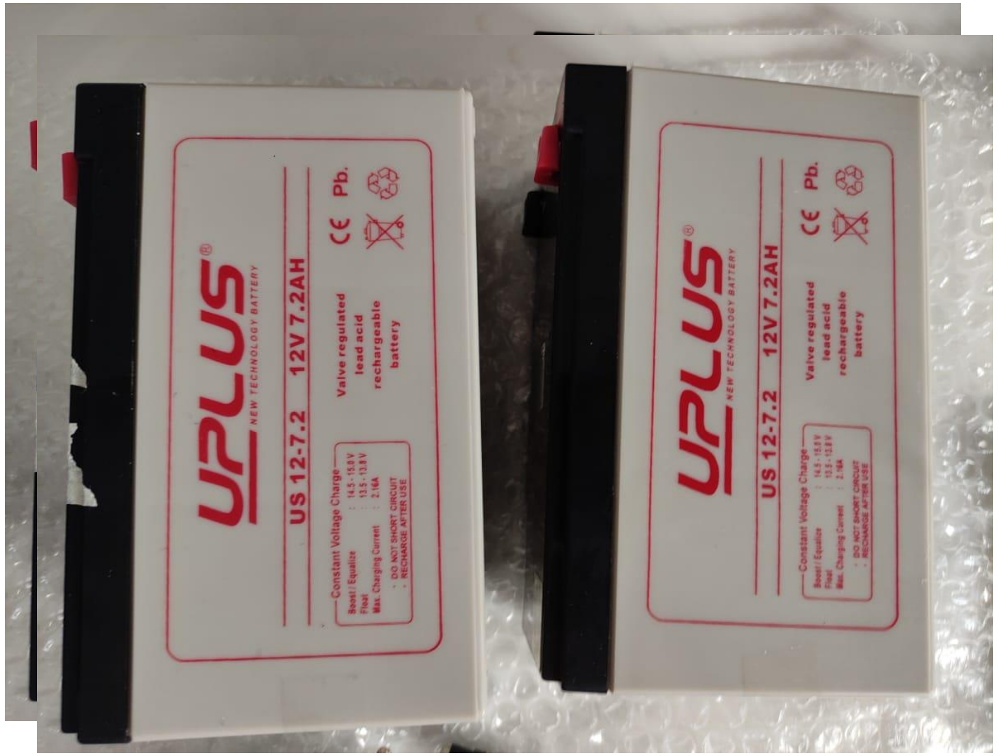

Fig 35. 12V, 7.2Ah Battery

Fig 36. Battery Charger and Connector

COMPONENTS

Fig 37. Node MCU

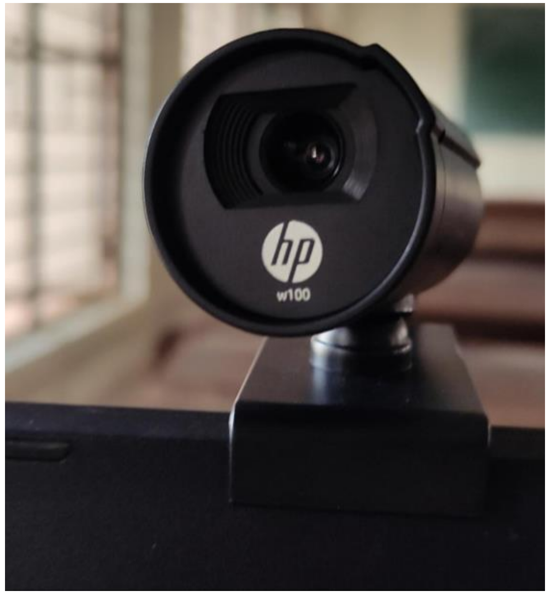

Fig 38. Webcam

COMPONENTS

Fig 39. Node MCU

Fig 40. Cooling Fan