ADVANCED VEHICLE SAFETY SOLUTIONS TO IMPROVE ROAD SAFETY

A PROJECT REPORT

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ABSTRACT

In the realm of automotive safety, overtaking long vehicles pose significant challenges, that often leading to accidents and collisions. To address these challenges, our project focuses on developing advanced safety solutions tailored specifically for overtaking scenarios. Leveraging cutting-edge technologies including ESP-32 cameras, infrared (IR) sensors, and IoT applications, our system aims to provide real-time visual and sensor-based feedback to drivers, enhancing their awareness and decision-making capabilities during overtaking movements.

Key features of our system include live video streaming from ESP-32 cameras, enabling drivers to have a clear view of the road ahead, IR sensors mounted on long vehicles to detect approaching vehicles and provide timely alerts to both the long vehicle driver and the driver of the overtaking vehicle, and IoT-based control mechanisms for seamless integration and control of vehicle movements.

By integrating these technologies, our project seeks to mitigate the risks associated with overtaking maneuvers, minimize accidents, and promote safer driving practices. The user-friendly interface and continuous monitoring ensure ease of use and optimal performance, underscoring our commitment to enhancing road safety through technological innovation.

KEYWORDS: Esp-32 Camera, Ultrasonic sensor, Node MCU, Live streaming, Blynk App.

ஆய்
வ ுசசுருக்
கம

வ ாகன ப ாFகாப ்பு Fறையில் , நீண் ட வ ாகனங் கறை முந் FவF

குறிப ்ப ிடத ்தக ்க சவ ால் கறை ஏை ்படுதFகிை F, இF அட ிக ்கட ி வ ிபத ் Fகக் ை

மை ்ற ுமீ மம ாதல் களுக ்கு வழிவகுக ்க ிை F. இந ்த சவ ால் கறை எதிரகக ாை ்ை ,

எங் கை ் த ிட்டம் மமம் பட்ட ப ாFகாப ்பு தீரவுகறை

குற ிப ்ப ாக முந ்த ிச கசல் லும் சூழ் நிறலகளுக ்கு

ஏை ்ை வ ாறு மமம் படுத ் Fவதில் கவனம் கசலுத்Fகிை F. ESP-

32 மகமர ாக ்கை ் , அகசசிவப ்பு (IR) கசன் ச ாரகை ் மை ்ற ுமீ IoT

பயன் பாடுகை் ைஉ ை ்ை ிட்ட அதிநவீன கதாழில்நுட்பங்கறை

மமம் படுத ் Fவதன் மூலம் , ஒட ்டுநரகளுககு ந ிகழ் மநர காட்ச ி மை ற ுமீ

கசன் ச ார ் க்கறை வழங்குவறத எங்கை

அட ிப ்பறடயில ான

கருதF அறமப ்பு

மந ாக ்கம ாகக் கக ாண் டுை ்ை F.

ESP-32 மகமராக்கைில் இருந்F மநரறல வீடிமயா ஸ் ட்ரீமிங், ஒட்டுநரகை

முன் மனாக்கிச் கசல்லும் சாறலறய கதைிவாகப் பாரக்க உதவுதல்,

கநருங் கி வரும் வ ாகனங் கறைக் கண் டறிய நீண் ட வ ாகனங் கை ில

கப ாருத ்தப ்பட்ட IR கசன் ச ாரக ை ் மை ்ற ுமீ நீண் ட வ ாகன ஒட்டுநர் மை ்ற ும

ஒட ்டுநர் இருவர ுக ்கும் சரிய ான மநரத ்தில் எசசரிகறககறை வழங் குதல

ஆகியறவ எங்கை் அறமப்பின் முக்கிய அம்சங்கைாகும். முந்திச் கசல்

லும்வாகனம், மை்றும் வாகன இயககங்கைின் தறடயை்ை ஒருங்

கிறணப்புமை ்ற ுமீ கட்டுப ்ப ாட ்டிை ்க ான IoT

அட ிப ்பறடயில ான கட்டுப ்ப ாட்டுவழிமுறைகை்.

இந்தத்கதாழில்நுட்பங்கறை ஒருங் கிறணப்பதன்

 மூலம், முநந்திச் கசலலும் களுடன் றடய சூழ்சசி கதாட ரபு

அபாயங்கறைக் குறைக்கவும், விபத்Fகறைக் குறைக்கவும், பாFகாப்பான ஓட்டுநரை நறடமுறைகறை மமம்படுத்தவும் எங்கை திட்டம் முயல்கிைF. பயனர் நடப்பு இறடமுகம் மைறும் கதாடரசசியான கண் காணிப்பு ஆகியறவ, கதாழில் நுட்ப கண் டுபிடிப்புகை மூலம் சாறலப் பாFகாப்றப மமம் படுதFவதைகான எங்கை உறுதிப்பாட்றட அடிக்மகாடிட்டுக் காட்டும் வறகயில், பயன் பாட்டின் ளிறம மைறும் உகந்த கசயல்திறைன உறுதி கசய்க

TABLE OF CONTENTS

CHAPTERNO.	TITLE	PAGENO
	ABSTRACT	iv
	LIST OF FIGURES	viii
	LIST OF SYMBOLS	x
	LIST OF ABBREVIATIONS	xi
1	**INTRODUCTION**	1
	1.1 Introduction	2
	1.2 Aim of the project	3
	1.3 Objective of the project	3
	1.4 Limitations of Existing System	4
2	**PROPOSED SYSTEM**	6
	2.1 Proposed system	7
	2.2 Key features of proposed system	7
	2.3 Benefits and impact	7
	2.4 Overview	8
	2.5 Block Diagram	9
	2.5.1 Block Diagram Explanation	9
3	**HARDWARE REQUIREMENTS**	11
	3.1 Components	12
	3.2 ESP32- Camera	12
	3.2.1 Specifications	13
	3.3 Ultrasonic Sensor	14
	3.3.1 Specifications	14
	3.4 IR Sensor	15

	3.4.1 Features	15
	3.5 Node MCU	16
	3.5.1 Specifications	17
	3.6 L298 Motor Drive	17
	3.6.1 Features	18
	3.7 Battery	19
	3.8 Light Emitting Diode	19
	3.8.1 Features	20
	3.8.2 Applications	20
4	**SOFTWARE REQUIREMENTS**	21
	4.1Blynk App Working	22
	4.1.1 Features	23
5	**WORKING**	34
	5.1 Working	35
	5.2 Camera Based Monitoring	36
	5.3 Flowchart Explanation	38
6	**RESULT AND CONCLUSION**	41
	6.1 Result	42
	6.2 Conclusion	44
	APPENDICES	45
	APPENDIX–1 PROGRAM	45
	DATASHEET	50
	REFERENCE	51

LIST OF FIGURES

S NO	FIGNO	FIGURE NAMES	PAGE NO
1	2.1	Block Diagram of Proposed System	9
2	3.1	ESP32 Camera	13
3	3.2	Ultrasonic Sensor	14
4	3.3	IR Sensor	15
4	3.4	NodeMCU	16
5	3.5	L298 Motor Drive	18
6	3.6	Battery	19
7	4.1	Blynk App Interface	22
8	4.2	Example Hardware	24
9	4.3	Creation of Blynk Account	25
10	4.4	Project Creation	26
11	4.5	Microcontroller Interface	27
12	4.6	Auth Token Creation	28
13	4.7	My Devices Connection	29
14	4.8	New Project Creation	30
15	4.9	Widget Box	31
16	4.10	Button Settings	32
17	4.11	Parameters Selection	33
18	5.1	Vehicle Control	36
19	5.2	Front View of the Truck	37
20	5.3	Flowchart	38

21	5.4	User alert with live location	40
22	6.1	Single Lane Representation	42
23	6.2	IoT Controlled Vehicle	43
24	6.3	Camera on truck	43

LIST OF SYMBOLS

SYMBOLS	EXPANSION
µF	MicroFarad
A	Ampere
MHzV	MegaHertzVolts

LIST OF ABBREVIATIONS

ACRONYMS	ABBREVIATIONS
GSM	Global System for Mobile Communication
RF	Radio Frequency
LCD	Liquid Crystal Display
EV	Electric Vehicle

CHAPTER 1

INTRODUCTION

INTRODUCTION

In today's automotive landscape, ensuring road safety amid increasing vehicle volumes is paramount. Overtaking long vehicles, especially involving long vehicles, present significant risks, often resulting in accidents. To address these challenges, advanced vehicle safety solutions are crucial. Leveraging technologies like computer vision, wireless communication, and IoT, these solutions offer innovative ways to enhance driver awareness and mitigate risks.

Our project focuses on developing tailored safety solutions for overtaking, particularly with long vehicles. By integrating ESP-32 cameras, IR sensors, and IoT applications, we aim to provide real-time feedback to drivers during overtaking. This includes enhancing visibility, reducing blind spots, and improving communication between vehicles.

By tackling these challenges, we aim to minimize accidents and promote safer driving practices. Our project underscores the importance of technological innovation in improving road safety and underscores our commitment to developing effective solutions for safer roads.

Furthermore, our project recognizes the significance of continuous monitoring and evaluation of safety systems to assess their efficacy in real-world driving conditions. Through rigorous testing and validation procedures, we seek to refine and optimize our solutions, ensuring they meet the highest standards of performance and reliability on the road.

1.1 Problem Statement:

Current road safety measures face challenges in addressing visibility issues and delayed hazard recognition, particularly concerning long vehicles and electric vehicles (EVs). The limited visibility behind long vehicles contributes to potential blind spots and obstructed views for following drivers.

To tackle these issues, there is a need for innovative connected vehicle features that enhance driver awareness and facilitate swift responses to potential hazards.

1.2 Problem Solution:

The problem solution involves identifying specific safety challenges associated with overtaking maneuvers, such as limited visibility and communication gaps between vehicles. Through a thorough analysis of existing research and technologies, innovative solutions are proposed, leveraging advancements in cameras, sensors, and IoT applications. These solutions aim to enhance driver awareness, improve communication, and mitigate risks during overtaking. Following design, implementation, testing, and validation phases, the solutions are deployed and evaluated in real-world driving scenarios. Continuous improvement efforts ensure that the solutions remain effective, adaptable, and responsive to evolving safety challenges.

1.3 Objective:

The main objective of the system includes,

- Develop a system that significantly reduces the risks associated with overtaking long vehicles by providing real-time visual and sensor-based feedback to drivers.
- Implement technologies such as IR sensors to facilitate effective communication between long vehicles and cars, enabling timely alerts to drivers regarding approaching vehicles and reducing blind spots.

- Design an intuitive and user-friendly interface, such as the Blynk app, to allow drivers to easily control their vehicles.

1.4 Limitations Of Existing System:

- **Limited Visibility:** The current system may provide limited visibility for drivers, particularly during overtaking manoeuvres involving long vehicles, leading to increased risk of collisions due to blind spots.
- **Inadequate Communication:** Communication between vehicles may be insufficient, resulting in delays or misunderstandings during overtaking manoeuvres and increasing the likelihood of accidents.
- **Lack of Real-time Feedback:** The system may lack real-time feedback mechanisms to alert drivers to potential hazards or obstacles during overtaking, reducing their ability to react promptly and avoid accidents.
- **Dependency on Manual Control:** Manual control of vehicle movements during overtaking manoeuvres may rely solely on driver judgment and responsiveness, increasing the risk of human error and accidents.
- **Limited Integration:** Existing systems may lack seamless integration of multiple technologies such as cameras, sensors, and IoT applications, hindering their effectiveness in addressing complex safety challenges during overtaking manoeuvres.
- **Scalability and Adaptability:** The current system may lack scalability and adaptability to varying driving conditions and environments, limiting its effectiveness in ensuring consistent safety outcomes across different scenarios.
- **Lack of Continuous Monitoring:** Continuous monitoring of road

conditions and vehicle movements may be lacking, leading to potential gaps increased vulnerability to accidents during overtaking manoeuvres.

CHAPTER 2

PROPOSED SYSTEM

2.1 Proposed System:

The proposed system integrates ESP-32 cameras for live video streaming, IR sensors for detecting approaching vehicles, and IoT applications like the Blynk app for seamless control, enhancing safety during overtaking maneuvers. This comprehensive approach addresses limitations of existing systems by providing real-time visual feedback, mitigating blind spots with IR sensors, and offering intuitive control mechanisms. Continuous monitoring and evaluation ensure ongoing refinement, distinguishing the proposed system from traditional methods and underscoring its commitment to improving road safety through innovative technology.

2.2 Key Features Of Proposed System:

- **Real-time Visual Feedback:** Integration of ESP-32 cameras enables live video streaming of the road ahead, providing drivers with enhanced visibility during overtaking maneuvers.
- **Blind Spot Detection:** Infrared (IR) sensors mounted on the sides and rear of long vehicles detect approaching vehicles, alerting both long vehicle drivers and overtaking vehicle drivers to mitigate blind spots.
- **Seamless Control:** Utilization of IoT applications such as the Blynk app facilitates intuitive control of vehicle movements, allowing for seamless execution of overtaking maneuvers.
- **Continuous Monitoring and Evaluation:** Implementation of mechanisms for continuous monitoring and evaluation enables refinement and optimization of safety measures based on real-world performance data.

2.3 Benefits and Impact:

- **Reduced range anxiety:** By providing real-time information about station availability and pinpointing faulty ones, the system significantly reduces the anxiety of running out of charge before reaching a functional station. Users can confidently plan their journeys and avoid unpleasant surprises.

- **Improved charging experience:** Faster identification and repair of damaged cables lead to less downtime and increased station availability. This translates to a smoother and more convenient charging experience for all users.
- **Enhanced safety:** Early detection of cable damage prevents potential electrical hazards and ensures the safety of users and vehicles.
- **Optimized maintenance:** The system provides valuable data on cable health and potential failure points, enabling targeted maintenance and resource allocation. This leads to cost savings and improved resource efficiency.

2.4 Overview:

The proposed system integrates ESP-32 cameras, IR sensors, and IoT applications to enhance safety during overtaking maneuvers. It provides real-time visual feedback, detects blind spots, and offers intuitive control mechanisms for drivers. With continuous monitoring and evaluation, the system promotes safer driving practices, reduces traffic congestion, and improves the overall driver experience, contributing to a safer and more efficient road environment.

2.5 Block Diagram:

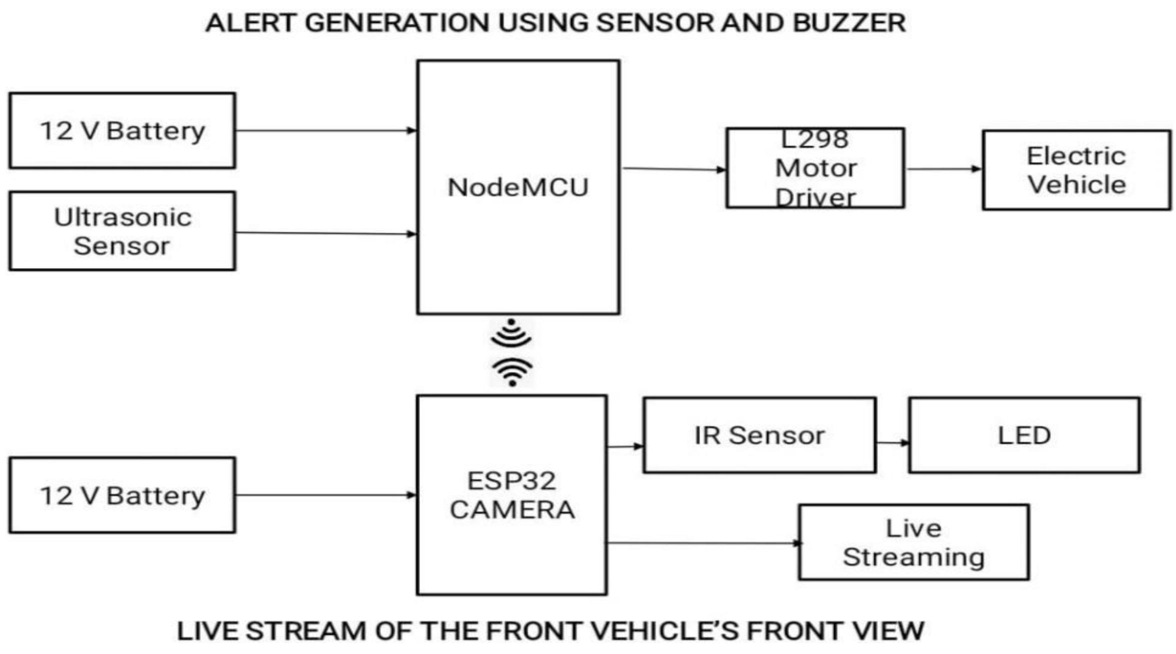

Fig. 2.1 Block diagram of proposed system

2.5.1 Block Diagram Explanation:

- The block diagram illustrates the proposed system for advanced vehicle safety solutions during overtaking manoeuvres. At the core of the system is the ESP-32 camera module, which captures live video of the road ahead. This video feed is transmitted wirelessly to the car via a communication module.
- The received video is processed by a video processing unit, which enhances the clarity and quality of the images. Concurrently, IR sensors mounted on the sides and rear of the long vehicle detect approaching vehicles and transmit this information to a sensor interface unit.
- The sensor interface unit processes the data and sends alerts to both the long vehicle driver and the driver of the overtaking vehicle. Additionally, an IoT control unit integrates with the Blynk app,

enabling the driver to control vehicle movements seamlessly. Continuous monitoring and evaluation are facilitated by a monitoring unit, which collects data on system performance and provides feedback for refinement and optimization. Overall, the block diagram demonstrates the integration of multiple components to enhance safety and facilitate efficient overtaking.

CHAPTER 3

HARDWARE REQUIREMENTS

3.1 Components:

SNO	COMPONENT
1	ESP-32 Camera
2	Ultrasonic Sensor
3	IR Sensor
4	Node MCU
5	L298 PCB
6	Led
7	Battery
8	Wires

3.2 ESP32- Camera:

ESP32-CAMERA is a low-cost ESP32-based development board featuring a small onboard camera. It is a perfect choice for IoT applications, prototype construction, and do-it-yourself projects. The board has two high-performance 32-bit LX6 CPUs and supports WiFi, standard Bluetooth, and low-power BLE. It uses a 7-stage pipeline architecture, an on-chip sensor, a Hall sensor, a temperature sensor, and so on, with a main frequency adjustment range of 80MHz to 240MHz. Fully compliant with the WiFi 802.11b/g/n/e/i and Bluetooth 4.2 standards, it can be used as a master mode to build an independent network controller, or as a slave to other host MCUs to add networking functionality to existing devices.ESP32-CAM can be utilized in a variety of IoT applications. It is appropriate for home smart devices, industrial wireless control, and wireless monitoring.

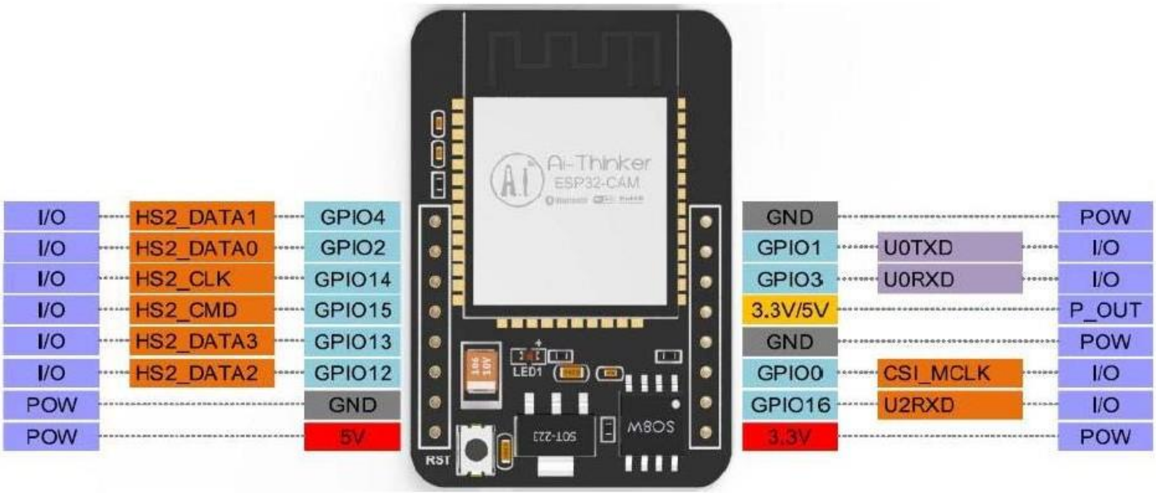

Fig. 3.1 ESP32- Camera

3.2.1 Specifications:

Microcontroller: ESP32 dual-core Tensilica LX6 microprocessor

Operating Voltage: 3.3V

Wi-Fi: 802.11 b/g/n

Bluetooth: Bluetooth v4.2 BR/EDR and BLE

Camera Sensor: OV2640 (2MP) or OV7670 (0.3MP)

Image Formats: JPEG (OV2640), YUV422, RGB565/555, YCbCr422, and GRB422 (OV7670)

Max Frame Rate: 30fps (OV2640), 30fps VGA, 60fps QVGA (OV7670)

Output Formats: 8-bit YUV (OV2640), 8-bit RGB (OV7670)

Lens: Standard lens with adjustable focus

Interfaces: I2C, SPI, UART, and GPIOs for flexible connectivity

Power Consumption: Low power consumption, suitable for battery-powered applications

Dimensions: Compact form factor, typically around 24mm x 24mm.

3.3 Ultrasonic Sensor:

Ultrasonic sensors use sound to calculate the distance between the sensor and the nearest item in its path. Ultrasonic sensors are simply sound sensors, except they operate at a higher frequency than human hearing.

Fig. 3.2 Ultrasonic Sensor

The sensor emits a sound wave with a defined frequency. It then listens for that particular sound wave to bounce off of an item and return (Figure 1). The sensor measures the time between when the sound wave is sent and when it returns. If you know how quickly something is moving and how long it is traveling, you can use equation 1 to calculate the distance traveled.

Equation 1. $d = v \times t$

3.3.1 Specifications:

Power supply: +5 V DC.

Quiescent Current: <2 mA

Working current: 15 mA.

Effective angle: <15º.

Range distance: 2–400 cm

Resolution: 0.3 cm.

Measurement angle: 30º.

Trigger input pulse width: 10 uS.

Dimensions: 45 x 20 x 15 mm.

Weight: around 10 grams.

Distance Calculation: The distance d between the ultrasonic sensor and an item can be determined using the time t takes for the ultrasonic pulse to travel to and from the object, taking into account the speed of sound v in air:To calculate the speed of sound (v) in air, use the equation v=331.5+(0.6*T)/2, where T is the temperature in degrees Celsius.

3.4 IR Sensor:

Infrared transmitter is a form of LED that emits infrared rays, often known as an IR transmitter. Similarly, the IR Receiver receives the IR rays transmitted by the IR transmitter. One key element is that both the IR transmitter and receiver should be located in a straight line. When the IR transmitter sends rays to the receiver, the IR receiver conducts because the non-inverting input voltage is greater than the inverting input. Now that the comparator output is +5 volts, it is sent to the microcontroller, causing the LED to light up. This circuit is mostly used for counting applications, such as interrupt detectors. The combination of these circuits on a single PCB board.

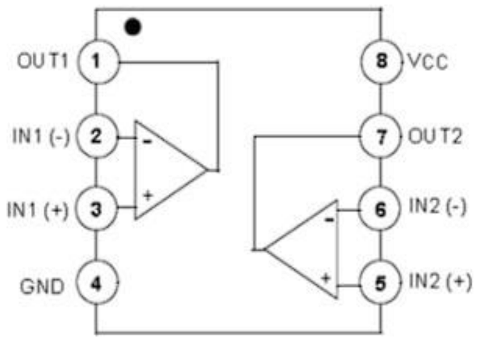

Fig. 3.3 IR Sensor

3.4.1 Features:

• High DC Voltage Gain: 100dB.

• The LM258/LM258A provides a wide power supply range of 3V-32V (or

1.5V-16V).

• The output voltage ranges from 0V DC to -1.5V DC.

3.5 NodeMCU:

The ESP8266 is a microcontroller designed by Espressif Systems. The ESP8266 is a self-contained WiFi networking solution that serves as a bridge from an existing microcontroller to WiFi while also capable of executing self-contained applications.

This module has a built-in USB connector and a wide range of pin-outs. With a micro USB cable, you can easily connect the NodeMCU devkit to your laptop and flash it, much like an Arduino. It is also immediately breadboard-friendly.

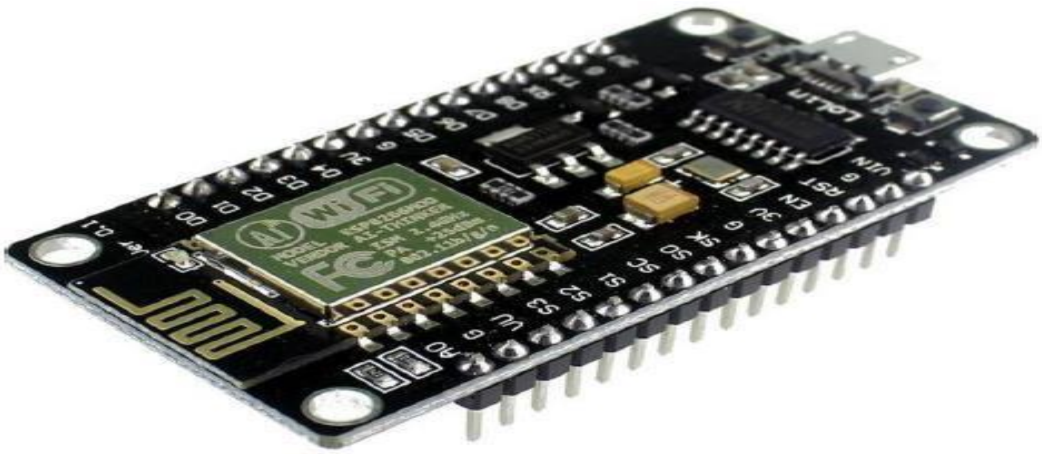

Fig.3.4 NodeMCU

The ESP8266EX provides a comprehensive and self-contained WiFi networking solution; it can host the application or offload WiFi networking functionality to another application processor.When the ESP8266EX runs the application, it does so directly from an external flash.

3.5.1 Specifications:

• Integrated low-power 32-bit MCU

• Integrated 10-bit ADC

• Integrated TCP/IP protocol stack

• Integrated PLL, regulators, and power management units

• Supports antenna diversity

• Wi-Fi 2.4 GHz, supports WPA/WPA2

Supports STA/AP/STA+AP operation modes

• Smart Link Function for Android and iOS

• \t SDIO 2.0, (H) SPI, UART, I2C, I2S, IR Remote Control, PWM, GPIO

• \tSTBC, 1x1 MIMO, 2x1 MIMO

• \tA-MPDU & A-MSDU aggregation & 0.4s guard interval

• \tDeep sleep power <10uA, power down leakage current < 5uA

• \tWake up and transmit packets in < 2ms

• \tStandby power consumption of < 1.0mW (DTIM3)

3.6 L298 Motor Drive :

This twin bidirectional motor driver is based on the extremely popular L298 twin H-Bridge Motor Driver Integrated Circuit. The circuit allows you to easily and independently operate two motors with up to 2A each in both directions.

It is perfect for robotic applications and may be easily connected to a microcontroller with only a few control lines required for each motor. It is also compatible with simple manual switches, TTL logic gates, relays, and so on. This board includes power LED indications and an on-board +5V supply.

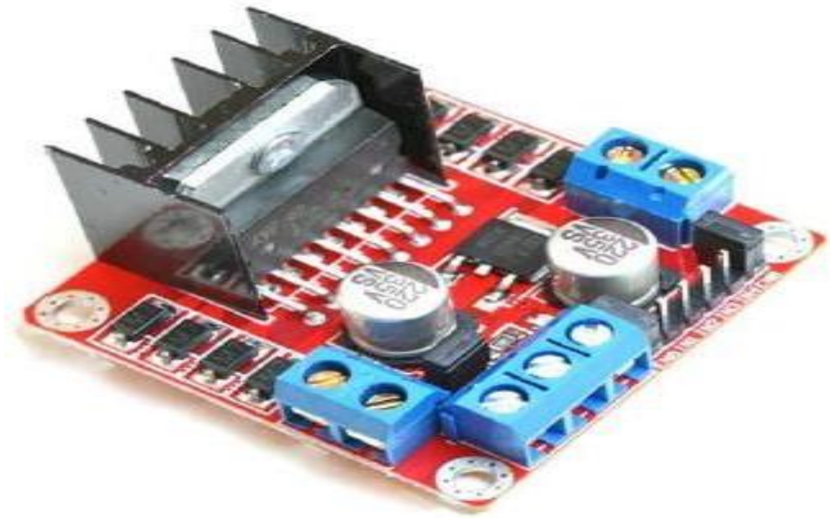

Fig. 3.5 L298 Motor Driver

3.6.1 Features:

• Input voltage ranges from 3.2 to 40 Vdc.

• Driver: L298N Dual H Bridge DC Motor Driver.

• Power supply: DC. 5 V - 35 V

• Peak current: 2 amps.

• Operating current range: 0–36mA.

• The control signal input voltage range is:

• Low voltage range: -0.3V to 1.5V.

• High: 2.3V < Vin ≤ Vss.

• Enable signal input voltage range.

• Low: -0.3 ≤ Vin ≤ 1.5V (control signal not valid).

• High: 2.3V ≤ Vin ≤ Vss (control signal is active).

• Maximum power consumption: 20W @ 75 ℃.

• Storage temperature range: -25 ℃ to +130 ℃.

• On-board +5V regulated output supply for controller boards like Arduino.

• Dimensions: 3.4cm x 4.3cm x 2.7cm.

3.7 Battery:

An electric battery is a device made up of one or more electrochemical cells that use stored chemical energy to generate electricity. Each cell has a positive terminal (cathode) and a negative terminal (anode). Electrolytes allow ions to move between electrodes and terminals, allowing current to flow from the battery and accomplish work.

Primary (single-use or "disposable") batteries are used once and then discarded; the electrode materials undergo irreversible alteration upon discharge. Common examples include alkaline batteries used in flashlights and a variety of portable gadgets. Secondary (rechargeable) batteries can be discharged and recharged several times, and the electrodes' original composition can be recovered using reverse current.

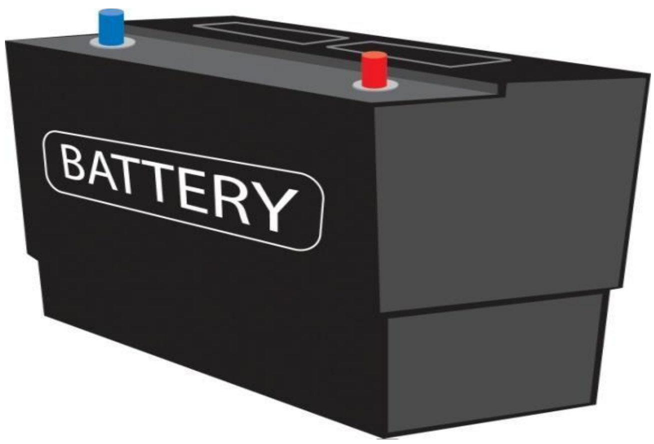

Fig. 3.6 Battery

3.8 Light Emitting Diode:

This LED features double heterojunction (DH) GaAlAs on GaAs technology. This deep red LED can be used with a wide range of driving currents. It can be DC or pulse operated to achieve desired light output. A clear 5 mm package is employed to deliver an extraordinarily high light intensity of more than 2000 mcd at a relatively narrow viewing angle.

3.8.1 Features:

• Exceptional brightness (IV_{typ} = 2500 mcd at I_F = 20 mA)

• Narrow viewing angle ($\phi = \pm 4°$)

• Low forward voltage

• 5 mm (T-1¾") transparent packaging

• Very high intensity even with low drive currents. Features include a deep red color, light intensity, and high material efficiency.

3.8.2 Applications:

• Bright ambient lighting conditions.

• Battery-powered equipment

• Indoor and outdoor information displays

• Portable equipment

• Telecommunication indicators

• General applications.

CHAPTER 4

SOFTWARE REQUIREMENTS

4.1 Blynk App Working:

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, vizualize it and do many other cool things.

The platform includes three primary components:

Blynk App - helps to you develop beautiful interfaces for your projects utilizing numerous widgets we supply.

Blynk Server - The Blynk Server handles all communications between the smartphone and the hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.

Blynk Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Now imagine: every time you press a Button

in a blynk of an eye.

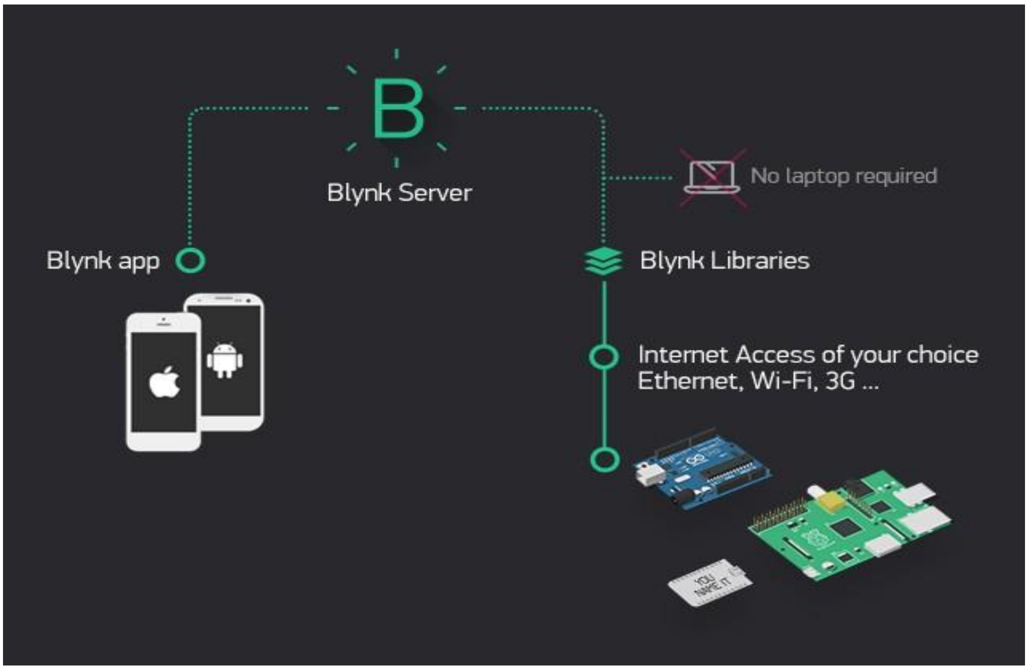

Fig.4.1 Blynk App Interface

4.1.1 Features:

- Similar API & UI for all supported hardware & devices
- Connection to the cloud using:
- Wi-Fi
- Bluetooth and BLE
- Ethernet
- USB (Serial)
- GSM
- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins.
- History data monitoring via Super Chart widget.
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.
- New features are constantly added!
- You can find example sketches covering basic Blynk Features. They are included in the library.
- The sketches are all designed to be easily combined.
- **A Smartphone**.
- The Blynk App is a well-designed interface builder. It works good on both iOS and Android.
- **Blynk Apps for iOS or Android**

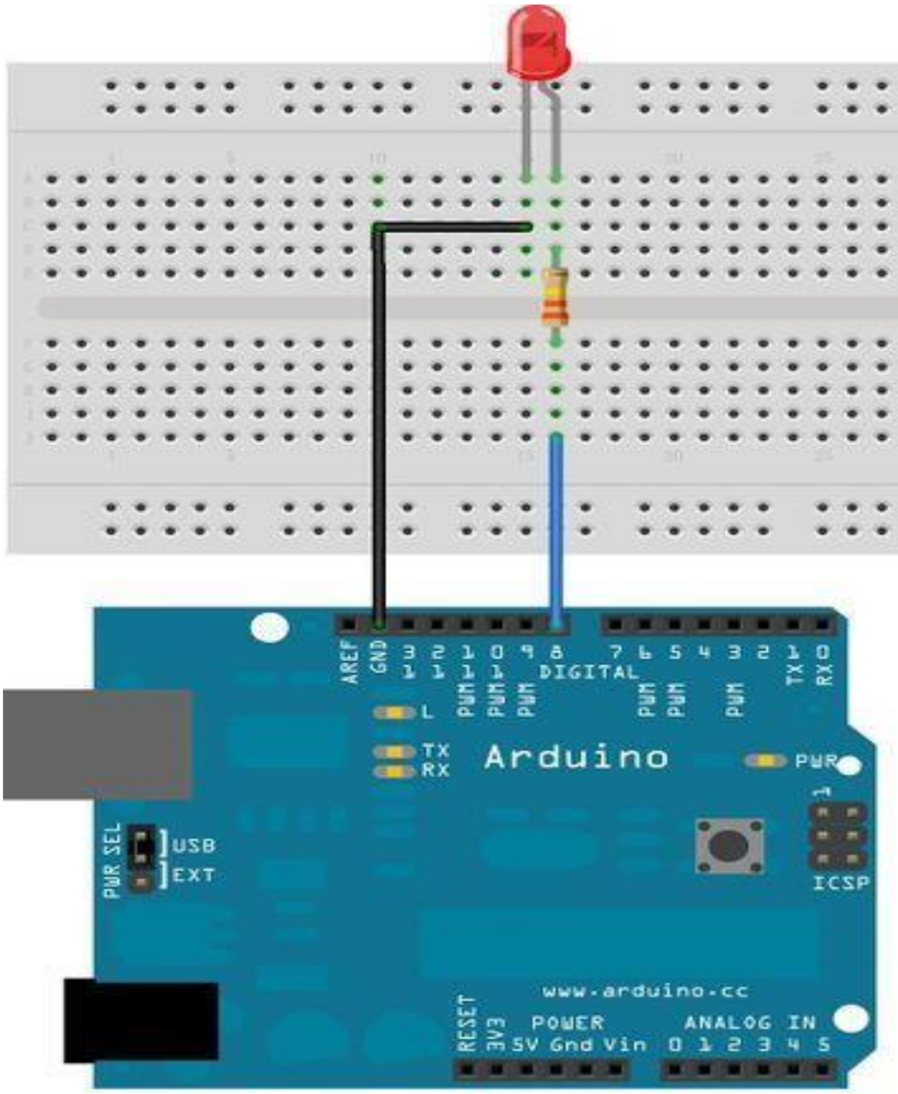

Fig.4.2 Example Hardware

- Getting Started With The Blynk App

  1. Create a Blynk Account

- After downloading the Blynk App, we will have to create a New Blynk account. This account is separate from the accounts we used for the Blynk Forums, if we already have an account.
- We must use a **real** email address because it will simplify our things later.

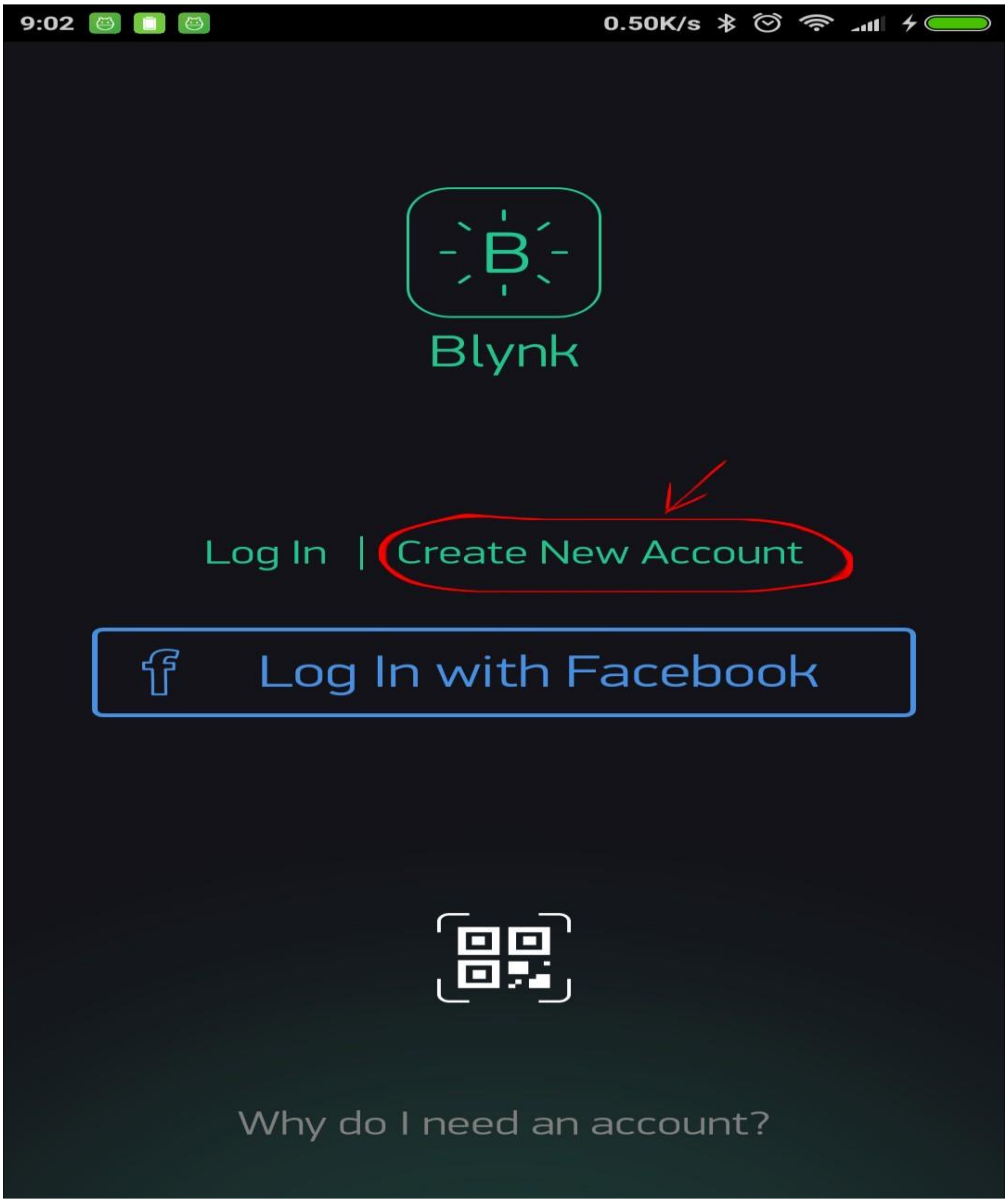

Fig.4.3 Creation of Blynk App

- Why do we need to create an account?
- A Blynk account is needed to save our projects and have access to them from multiple devices from any where across the world.
- We can always set up our own Private Blynk Server and have full control on it.

2. Create a New Project

- After we've successfully logged into our account, we must start by creating a new project.

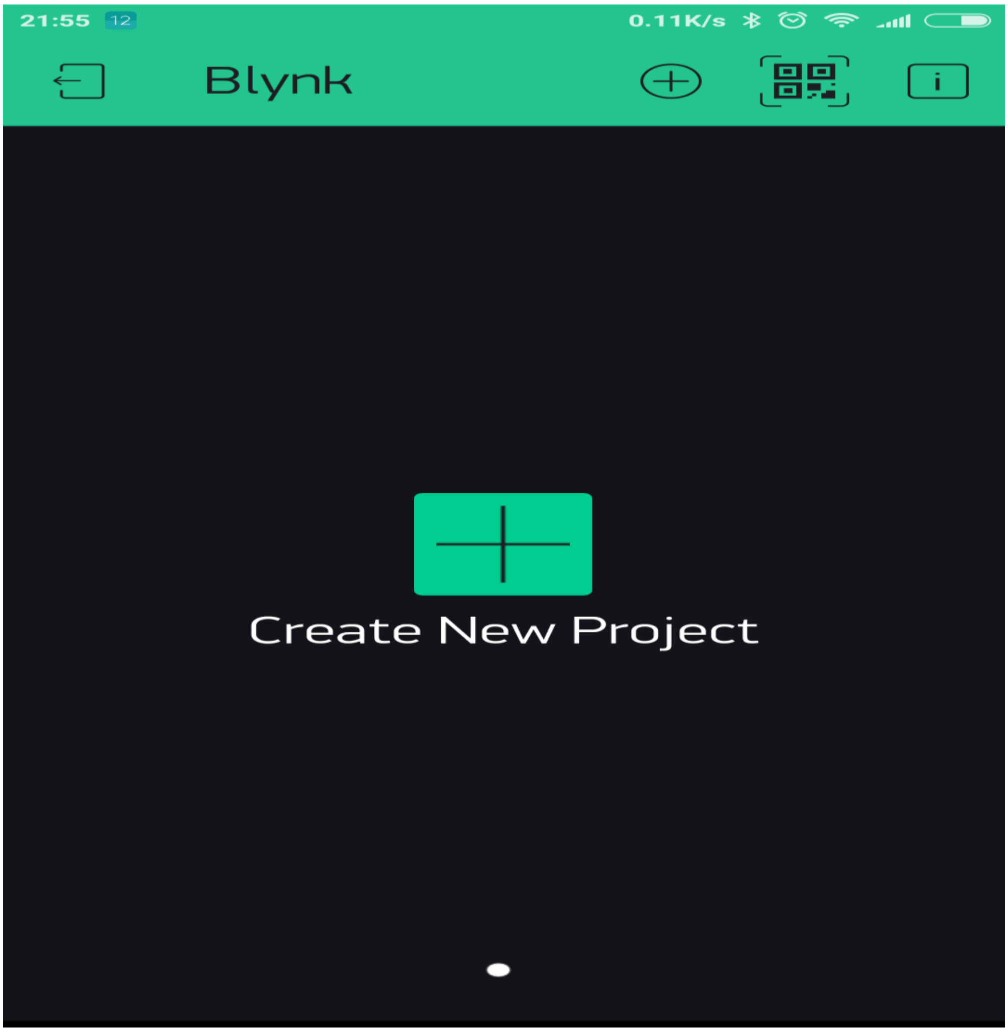

Fig.4.4 Project Creation

3. Choose Your Hardware

- Select the hardware model to use. Check out the list of the supported hardware.

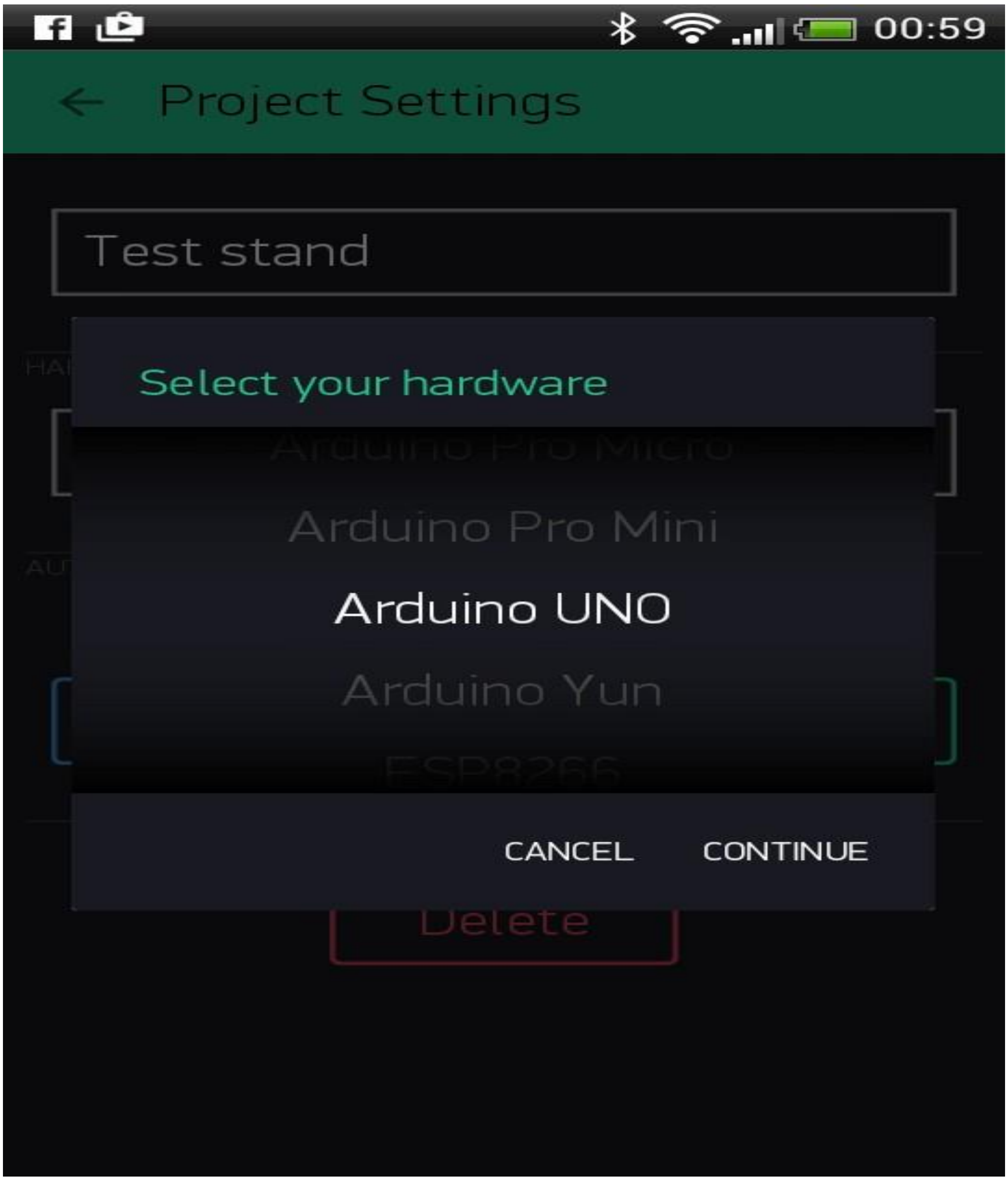

Fig.4.5 Microcontroller Interface

4. Auth Token

- **Auth Token** is a unique identifier which is needed for us to connect our hardware to our mobile. Every new project we are creating will have its own Auth Token. We will get Auth Token automatically on our email after project creation. We can also copy it manually. Click on devices section and selected required device :

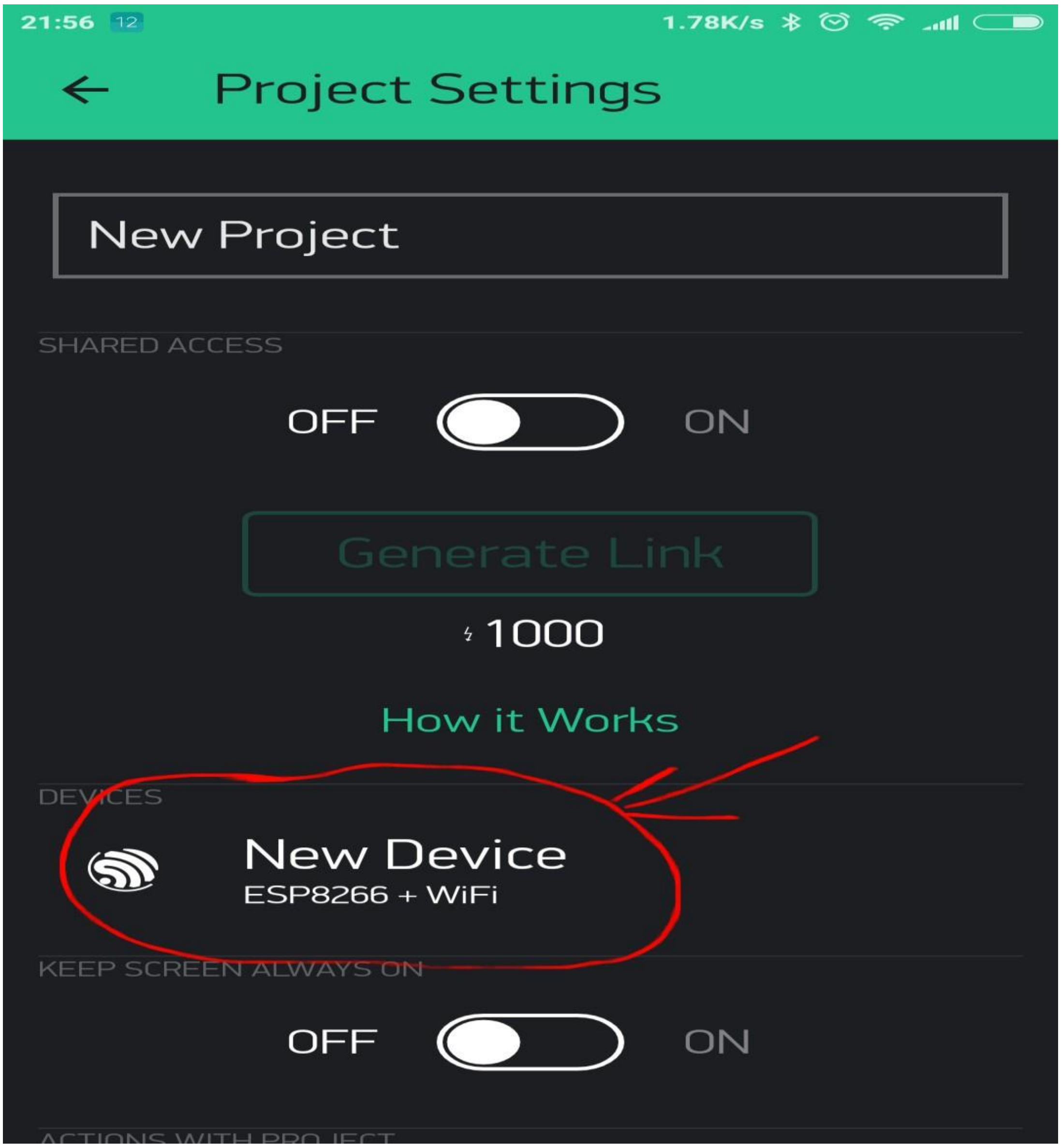

Fig.4.6 Auth Token Creation

- And we will see the token :

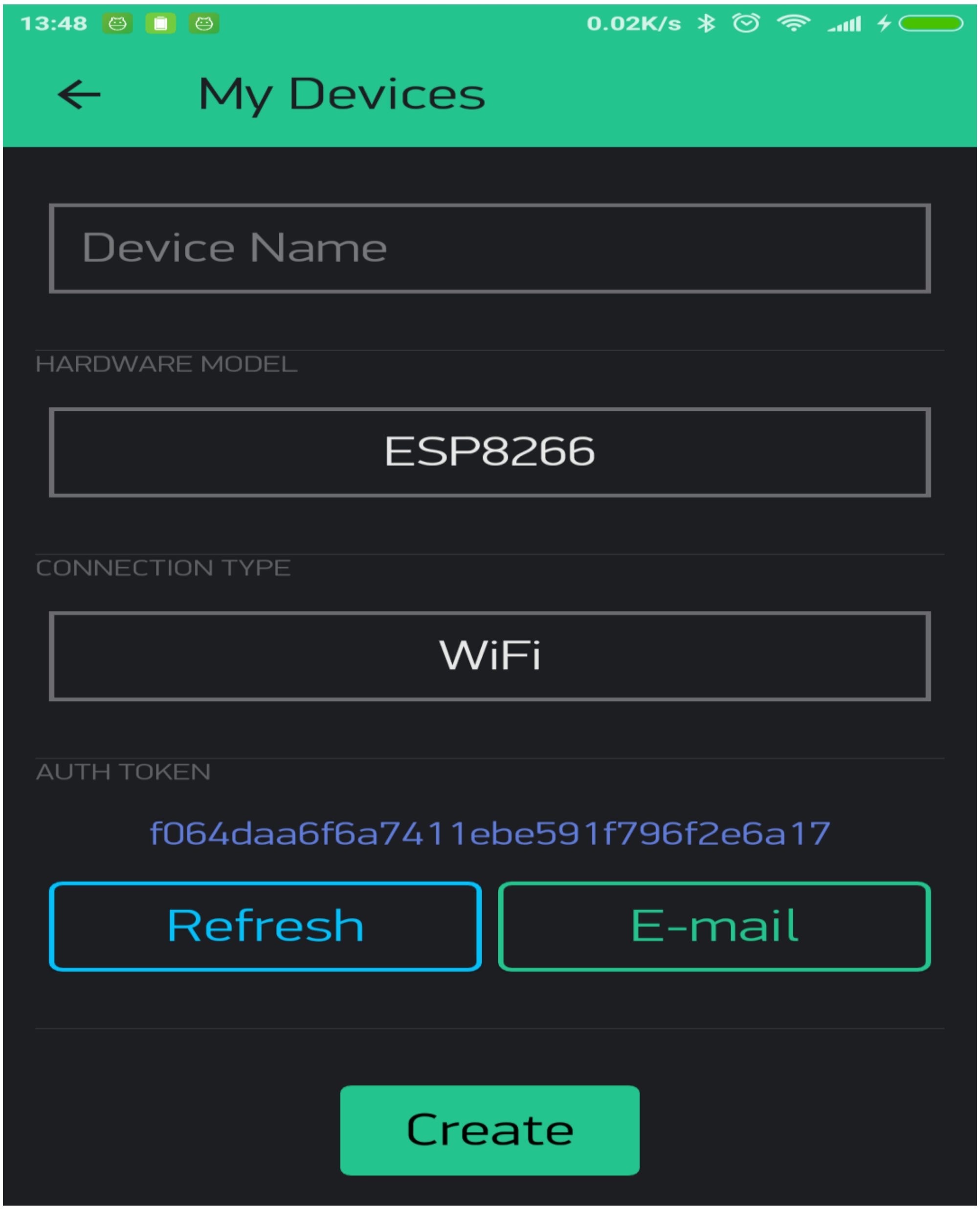

Fig.4.7 My Devices Connection

- **NOTE:** We should not share our Auth Token with anyone, unless we want someone to have access to our hardware.
- It will be very convenient for us to send it over e-mail. Press the e-mail button and the token will be sent to the e-mail address we used for the registration. You can also tap on the Token line and it will be copied to the clipboard.
- Now click on the **"Create"** button.

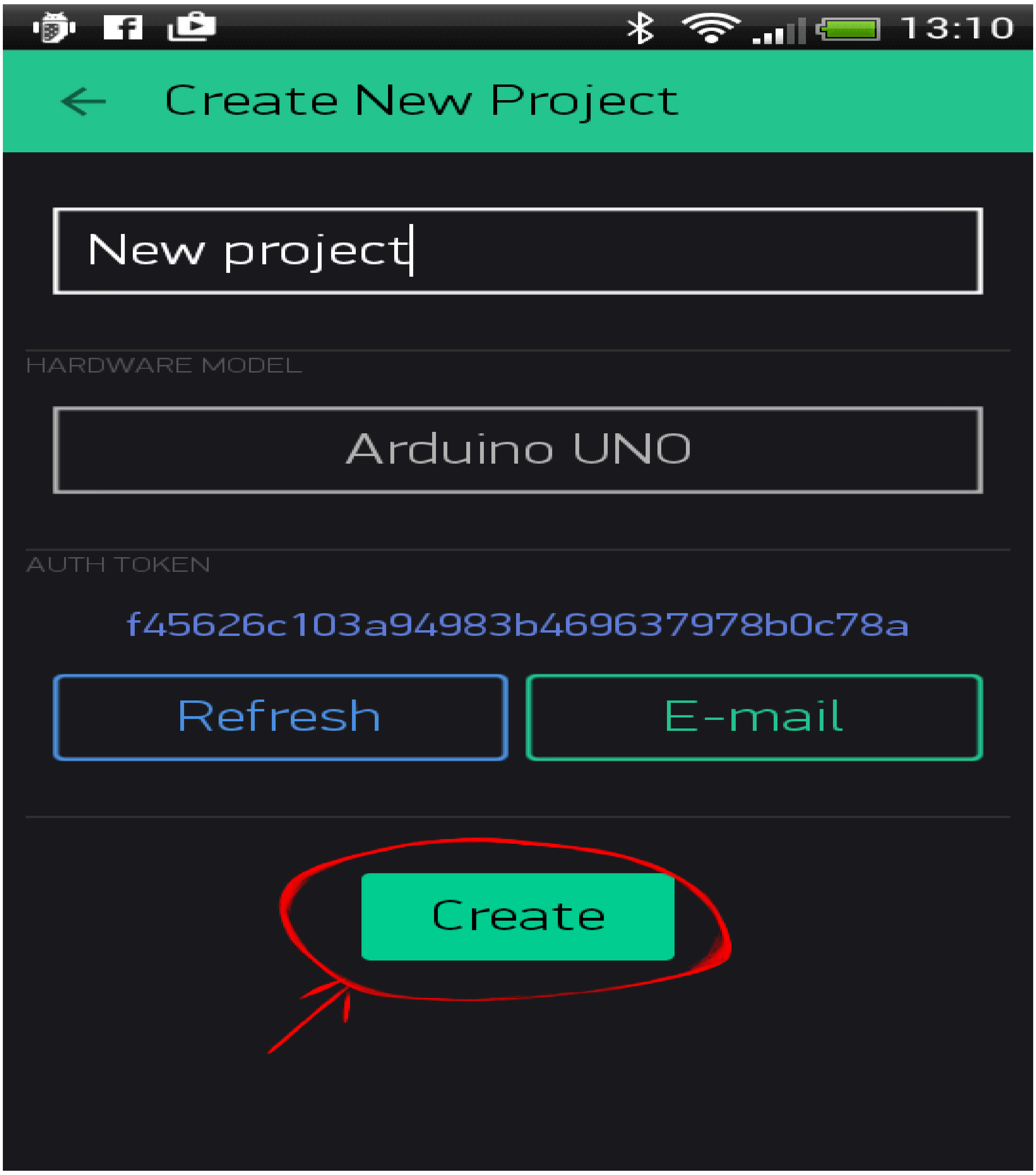

Fig.4.8 New Project Creation

- **5. Add a Widget**
- Our project canvas is empty, let us add a button to control our LED.
- Tap anywhere on the canvas to open the widget box. All the available widgets will be located there. Now pick a button.
- **Widget Box**

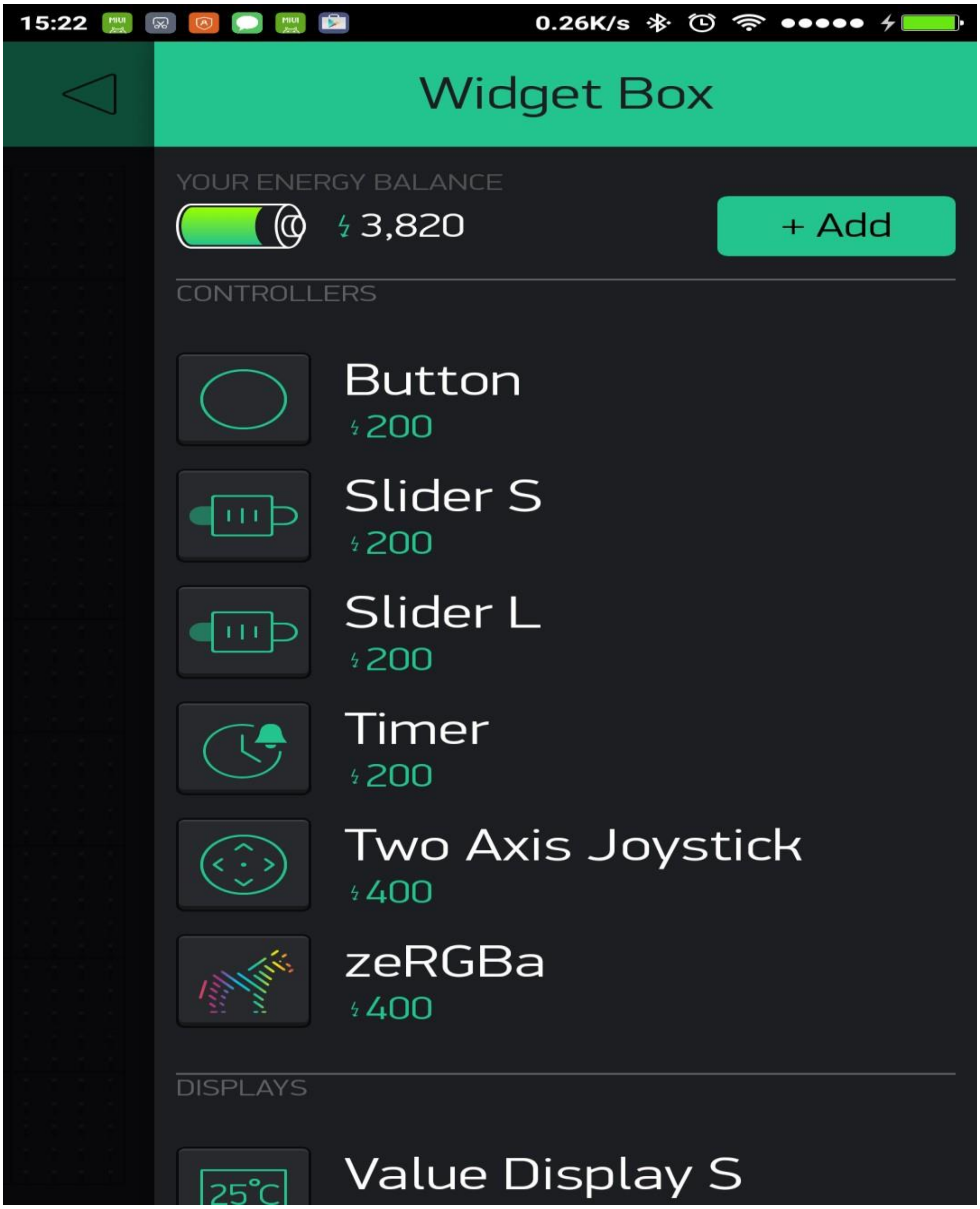

Fig.4.9 Widget Box

- **Drag-n-Drop** – Now Tap and hold the Widget to drag it to the new position.
- **Widget Settings** - Each Widget has it's own settings. Tap on the widget to get them.

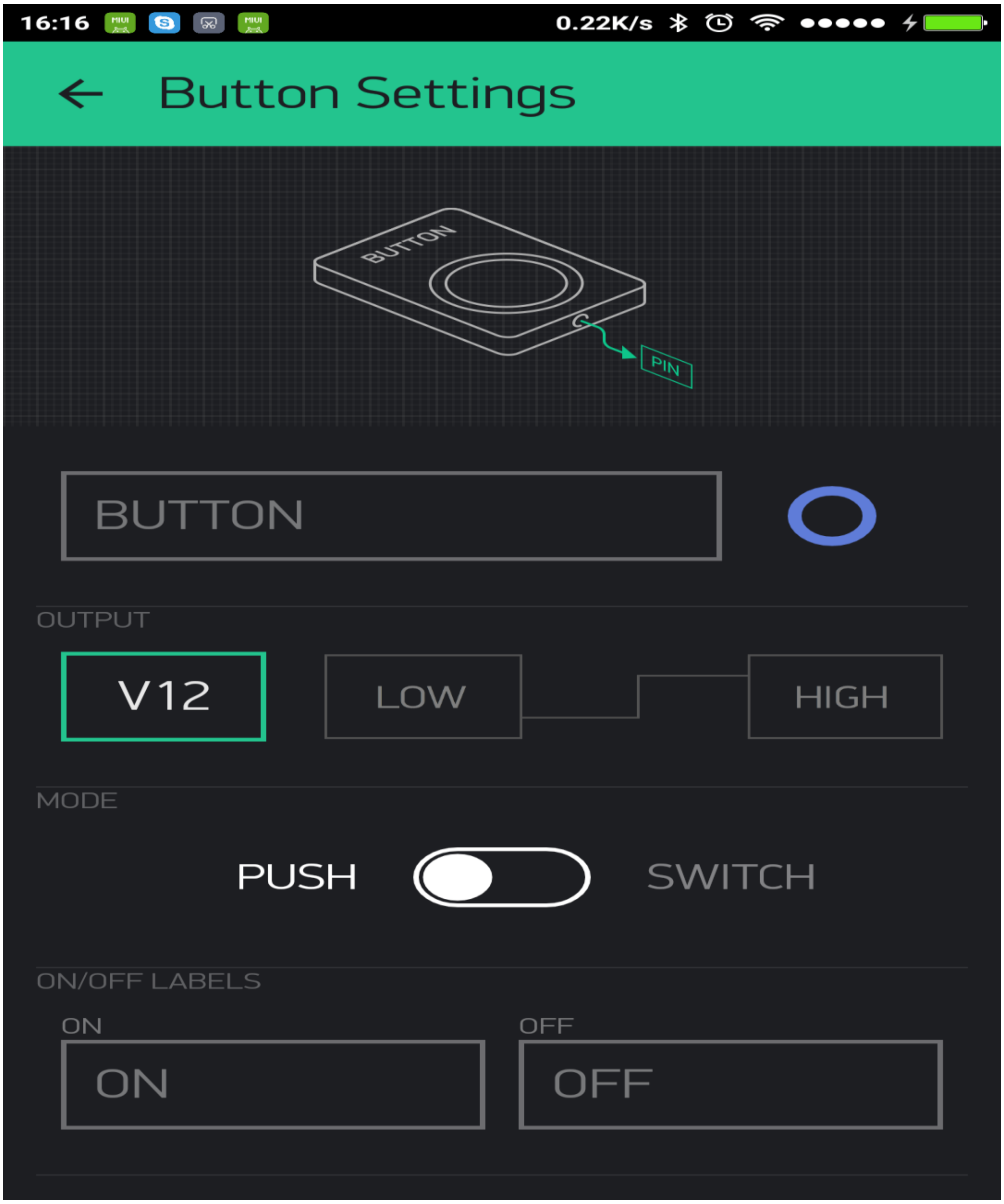

Fig.4.10 Button Settings

- The most important parameter to set is **PIN** . The list of pins will reflect the physical pins defined by our hardware. If our LED is connected to the Digital Pin 8 - then select the **D8** (**D** - stands for **D**igital).

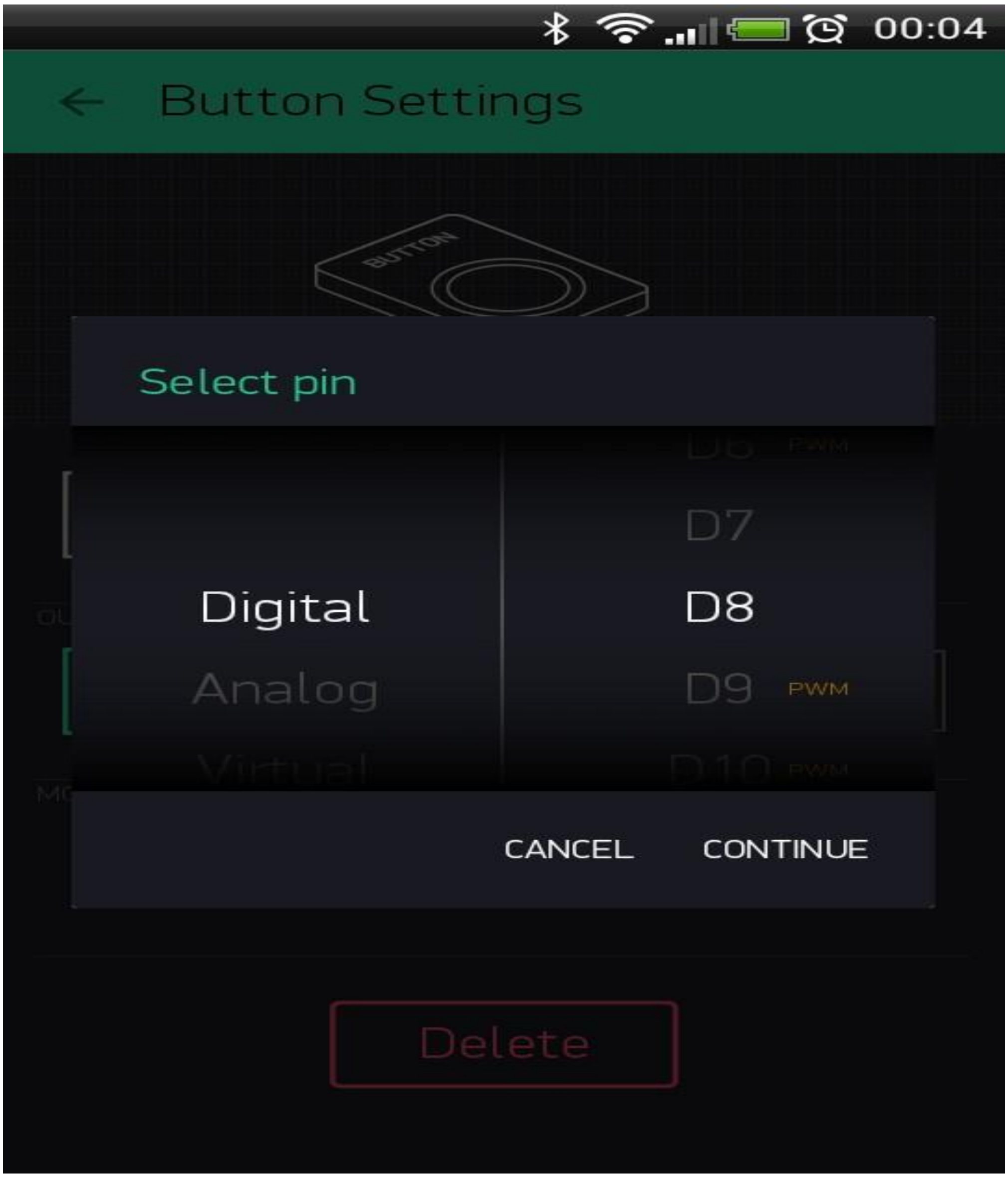

Fig.4.11 Parameters Selection

CHAPTER 5

WORKING

5.1 Working:

The system operates by utilizing an ESP32 camera module to capture live video of the road ahead, which is wirelessly transmitted to the car's display for real-time viewing. Simultaneously, ultrasonic sensors placed strategically around the long vehicle continually measure distances to nearby objects. When an approaching vehicle is detected during an overtaking maneuver, signals from the ultrasonic sensors prompt the microcontroller to issue alerts to both the long vehicle driver and the overtaking vehicle driver, indicating the need for caution. Moreover, integration with an IoT application like the Blynk app enables the driver to control the vehicle's movements seamlessly. Continuous monitoring and evaluation ensure the system's reliability and functionality in varied driving conditions, with automated responses such as speed reduction or visual and auditory warnings enhancing safety and mitigating the risk of collisions.

The system's operation revolves around real-time video capture, ultrasonic distance measurements, and prompt alert generation to ensure safe overtaking maneuvers. Integration with the Blynk app offers convenient control options for the driver, while continuous monitoring guarantees optimal performance in diverse driving scenarios, ultimately enhancing road safety and driver confidence.

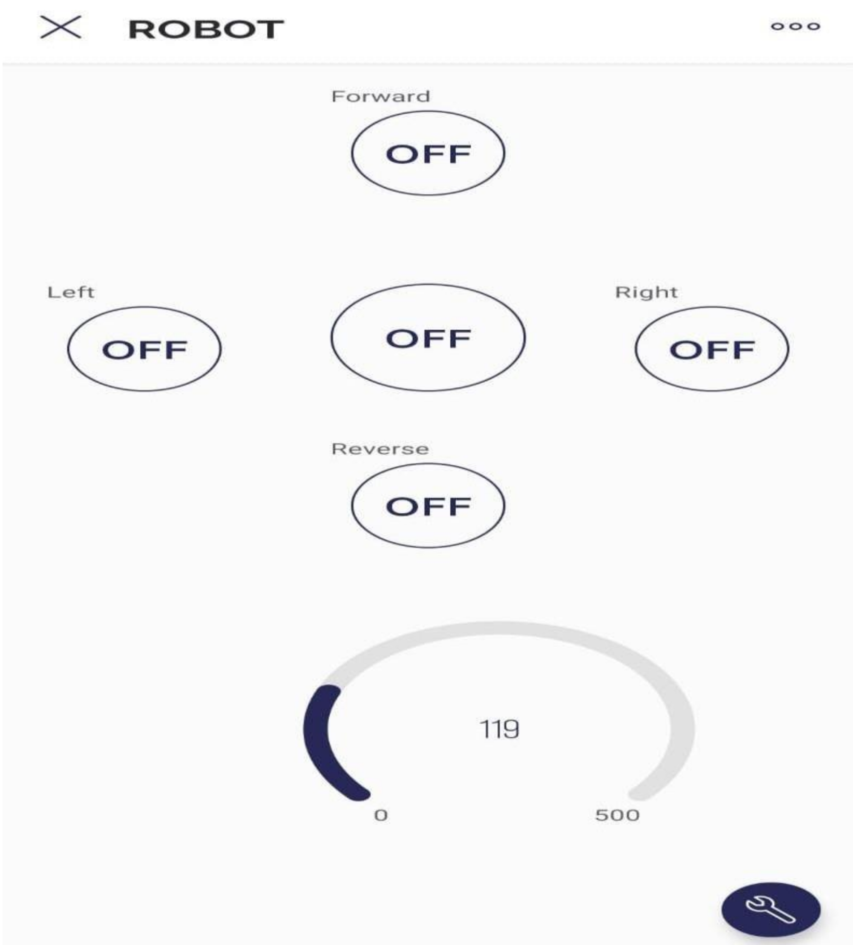

Fig. 5.1 Vehicle Control

5.2 Camera-Based Monitoring:

- Camera-based monitoring involves the use of cameras to capture visual information in a given environment for various purposes such as surveillance, object detection, and scene analysis.
- In the context of the proposed system, camera-based monitoring plays a crucial role in providing real-time video streaming of the road ahead to enhance driver visibility and awareness during overtaking maneuvers.
- The ESP32 camera module captures live video footage, which is then transmitted wirelessly to the car's display, enabling drivers to have a clear view of the surrounding traffic conditions.

- This camera-based monitoring facilitates timely decision-making and promotes safer driving practices by allowing drivers to assess road conditions, detect potential hazards, and execute overtaking maneuvers with confidence.

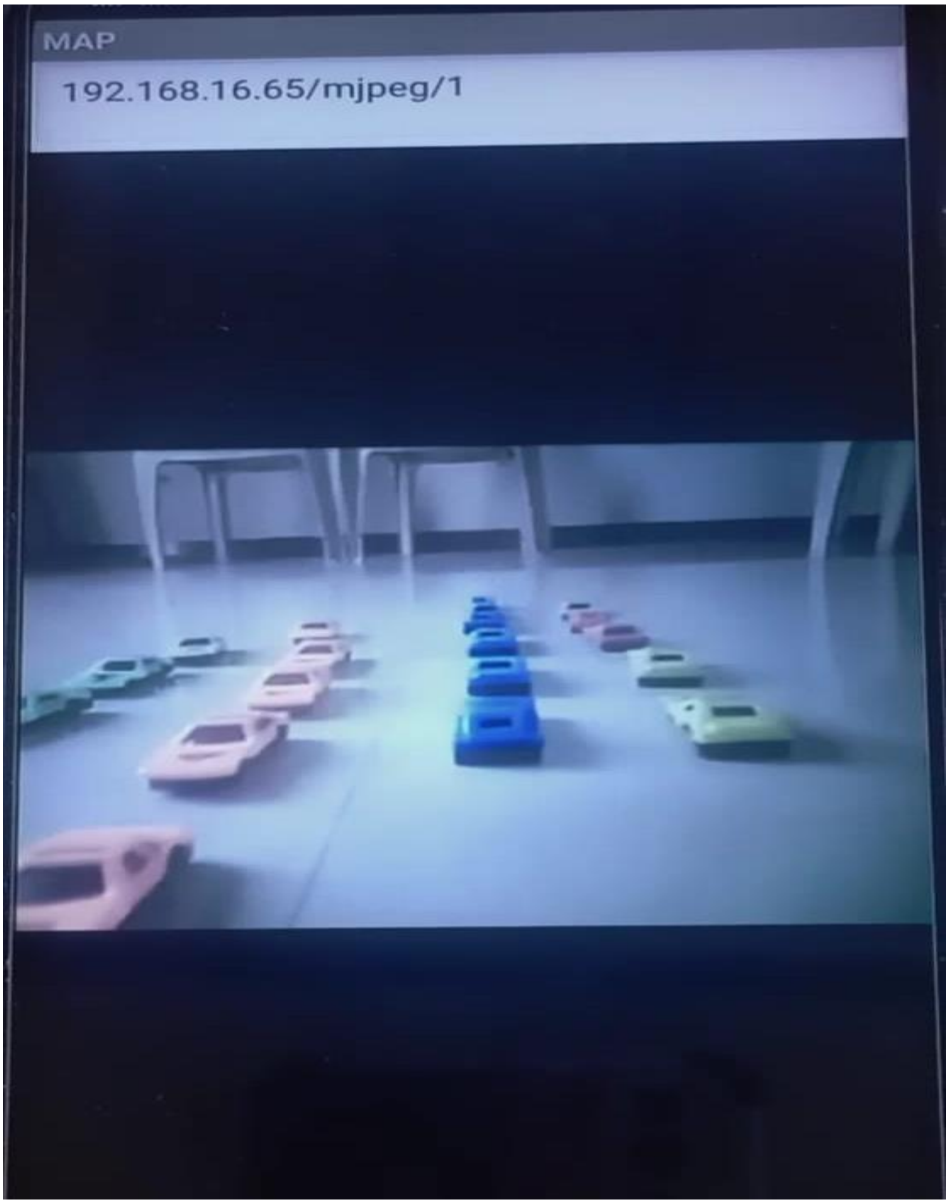

Fig. 5.2 Front View of the Truck

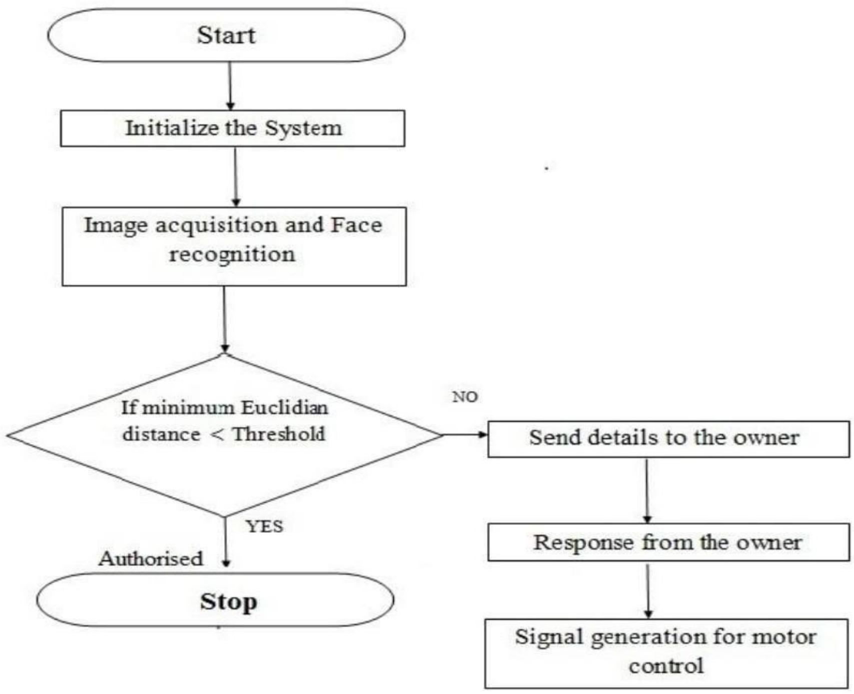

Fig. 5.3 Flowchart

5.3 Flowchart Explanation:

- The flowchart illustrates the step-by-step operation of the proposed system for advanced vehicle safety solutions during overtaking maneuvers.
- It commences with the ESP32 camera module capturing live video of the road ahead, which is wirelessly transmitted to the car's display for real-time viewing by the driver.
- Concurrently, ultrasonic sensors positioned strategically around the long vehicle continuously measure distances to nearby objects, including approaching vehicles.
- If an approaching vehicle is detected during an overtaking maneuver, signals from the ultrasonic sensors prompt the microcontroller to take action. The microcontroller then issues alerts to both the driver of the long

vehicle and the driver of the overtaking vehicle, signaling the need for caution.

- Additionally, integration with an IoT application such as the Blynk app provides the driver with control over vehicle movements, ensuring seamless execution of overtaking maneuvers.
- Continuous monitoring of system performance guarantees reliability and functionality under varying driving conditions, ultimately contributing to enhanced road safety by facilitating informed decision-making and promoting safer driving practices during overtaking maneuvers.

Fig. 5.4 User Alert with Live Location

User will be informed by receiving instant alerts on the Blynk application whenever the ultrasonic sensor detects a nearby vehicle. With real-time notifications, user will be equipped to make timely decisions, ensuring safer driving experiences for oneself and those around them.

CHAPTER 6

RESULT AND CONCLUSION

6.1 Result:

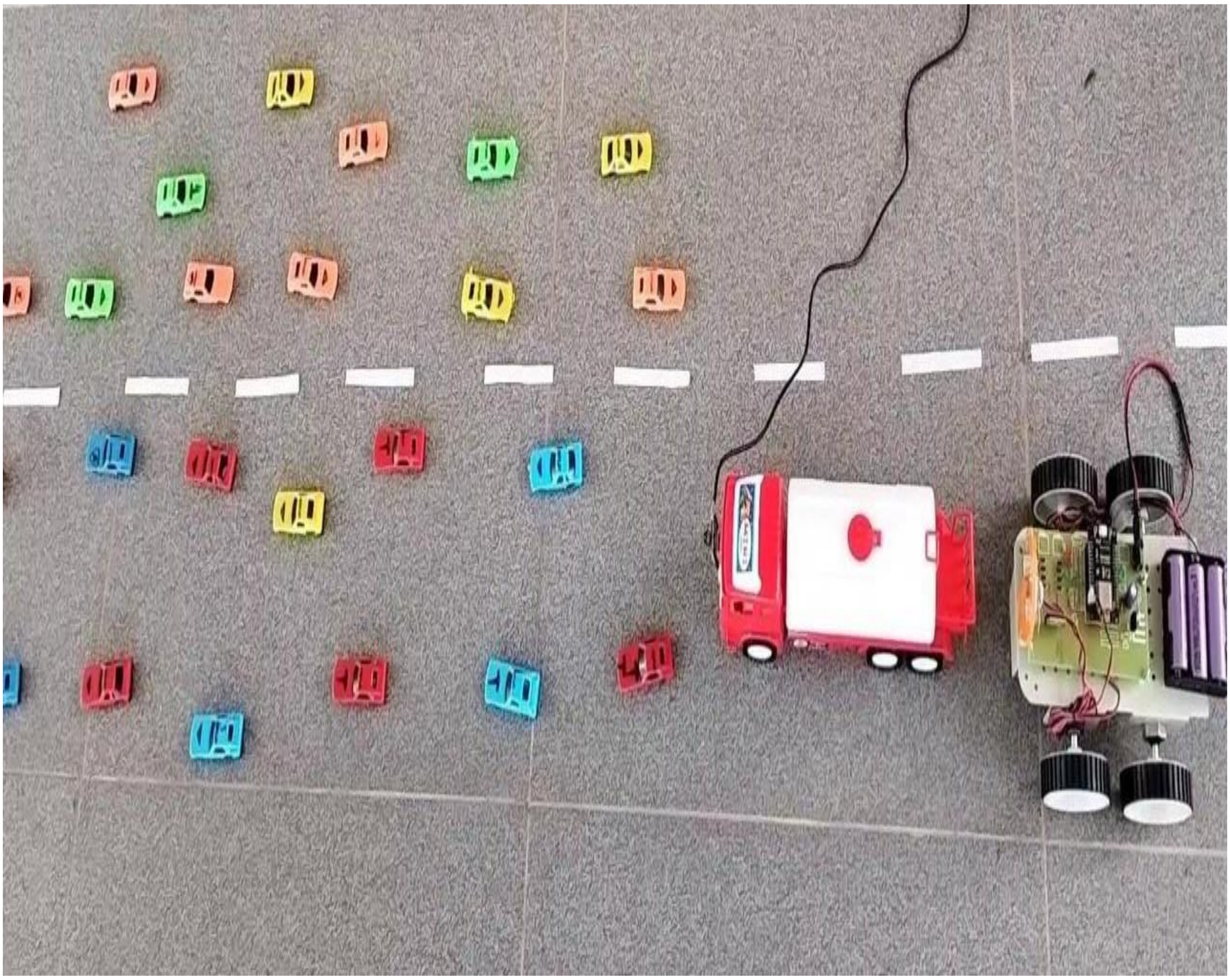

Fig. 6.1 Single Lane Representation

The comprehensive kit showcased in the image encompasses all essential components for implementing cutting-edge vehicle safety solutions during overtaking maneuvers. From ESP32 cameras for live video streaming to ultrasonic sensors for distance measurement, each element plays a crucial role in enhancing driver awareness and promoting safer driving practices. With seamless integration and careful selection of components, the kit empowers developers to create innovative solutions that mitigate risks and optimize performance in real-world driving scenarios.

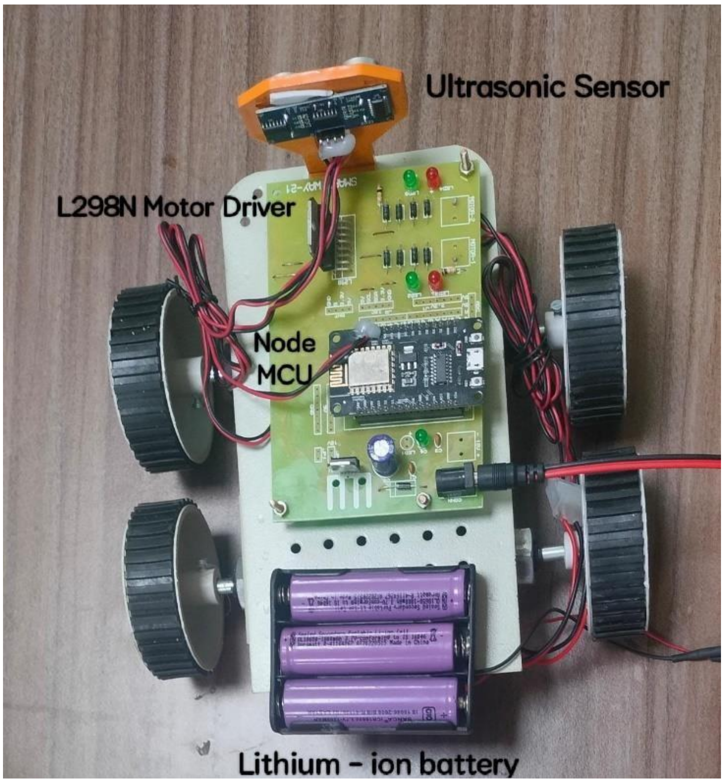

Fig. 6.2 IoT Controlled Vehicle

Fig. 6.3 Truck Camera

6.2 Conclusion:

This project aimed at improving road safety in electric vehicles (EVs) through the implementation of connected vehicle features and infrastructure support, there are several potential learning outcomes for the project team and stakeholders.

These outcomes can include:

Technical Proficiency: Team members will gain technical expertise in developing and implementing algorithms for connected vehicle features, predictive analytics, and machine learning.

Various connected technologies: Understanding the various connected vehicle technologies such as V2V,V2G,ADAS,5G communication telematics to improve road safety etc.

Community Building: Building and managing a supportive online community for EV owners, fostering engagement and knowledge sharing.

Project Management Skills: Developing project management skills, including task prioritization, resource allocation, and timeline management.

Security and Privacy Expertise: Understanding the importance ofimplementing robust security and privacy measures to protect user data and ensure safe remote access to vehicles. Apart from technical skill this internship atMahindra Technical Academy it also helps us to improve our interpersonal and soft skills like,

Problem-solving skills: Able to identify and solve problems that arise in the design, manufacturing.

APPENDIX

```
//robot2064@yopmail.com
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>



#include <EveryTimer.h>
#define PERIOD_MS 1000
EveryTimer timer;
#define BLYNK_TEMPLATE_ID "TMPL3J2SxlebX"
#define BLYNK_TEMPLATE_NAME "ROBOT"
#define BLYNK_AUTH_TOKEN "4Y7hsgpjan9IhQqK8P_x-1lwIf7535EX"
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "IOT";
char pass[] = "123456789";
#define m11 D5
#define m12 D6
#define m21 D7
#define m22 D8
int us1trigPin = D2; // Trigger
int us1echoPin = D1; // Echo
long us1duration, us1cm,us1inches;
int X,Y,dis;
unsigned int m=0,val,val1,val2,val3,val4;
int act=0;
String inputString = "";
unsigned char a[200];
void setup()
{
```

```
  Serial.begin(9600);
 Blynk.begin(auth, ssid, pass, "blynk.cloud", 80);
  pinMode(m11, OUTPUT);
  pinMode(m12, OUTPUT);
  pinMode(m21, OUTPUT);
  pinMode(m22, OUTPUT);
  pinMode(us1trigPin, OUTPUT);
  pinMode(us1echoPin, INPUT);
  digitalWrite(m11,LOW);
  digitalWrite(m12,LOW);
  digitalWrite(m21,LOW);
  digitalWrite(m22,LOW);
}
// FORWARD
BLYNK_WRITE(V0) {
  int button = param.asInt();
  if (button == 1) {
  forward();
    Serial.println("Forward movement");
    act=1;
  }
}
// Reverse
BLYNK_WRITE(V1) {
  int button = param.asInt(); // read button
  if (button == 1) {
    reverse();
Serial.println("Reverse movement");
act=1;
  }
```

```
}
//right
BLYNK_WRITE(V2) {
  int button = param.asInt(); // read button
  if (button == 1) {
    right();
    Serial.println("right movement");
act=1;
  }
}
//left
BLYNK_WRITE(V3) {
  int button = param.asInt(); // read button
  if (button == 1) {
    left();
    Serial.println("left movement");
    act=1;
  }
}
BLYNK_WRITE(V4) {
  int button = param.asInt(); // read button
  if (button == 1) {
  stop();
   Serial.println("stoped");
   act=0;
  }
}
void loop()
{
digitalWrite(us1trigPin, LOW);
```

```
  delayMicroseconds(5);
  digitalWrite(us1trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(us1trigPin, LOW);
  pinMode(us1echoPin, INPUT);
  us1duration = pulseIn(us1echoPin, HIGH);
  // Convert the time into a distance
  us1cm = (us1duration/2) / 29.1; // Divide by 29.1 or multiply by 0.0343
us1inches = (us1duration/2) / 74; // Divide by 74 or multiply by 0.0135
Blynk.virtualWrite(V5,us1cm);
  if(us1cm>=1 && us1cm<=10 && act==1){
    Blynk.logEvent("ultra","VEHICLE DETECTED ");
  Blynk.virtualWrite(V3,"VEHICLE DETECTED ");
  Serial.println("object detected"); }
  Blynk.run();
delay(200);
}
void forward()
  {
      digitalWrite(m11,LOW);
 digitalWrite(m12,HIGH);
 digitalWrite(m21,LOW);
 digitalWrite(m22,HIGH);
 Serial.println("MOVING FORWARD");
 act=1;
  }
  void reverse()
  {
   digitalWrite(m11,HIGH);
  digitalWrite(m12,LOW);
```

```
  digitalWrite(m21,HIGH);
  digitalWrite(m22,LOW);
  act=1;
  }
void left()
  {
    digitalWrite(m11,HIGH);
  digitalWrite(m12,LOW);
  digitalWrite(m21,LOW);
  digitalWrite(m22,HIGH);
  act=1;
  }
  void right()
  {
       digitalWrite(m11,LOW);
  digitalWrite(m12,HIGH);
  digitalWrite(m21,HIGH);
  digitalWrite(m22,LOW);
  act=1;
  }
void stop()
  {
     digitalWrite(m11,LOW);
digitalWrite(m12,LOW);
digitalWrite(m21,LOW);
digitalWrite(m22,LOW);
act=0;
  }
```

NODEMCU DATASHEET

Categories	Items	Parameters
Wi-Fi	Certification	Wi-Fi Alliance
	Protocols	802.11 b/g/n (HT20)
	Frequency Range	2.4 GHz ~ 2.5 GHz (2400 MHz ~ 2483.5 MHz)
	TX Power	802.11 b: +20 dBm
		802.11 g: +17 dBm
		802.11 n: +14 dBm
	Rx Sensitivity	802.11 b: -91 dbm (11 Mbps)
		802.11 g: -75 dbm (54 Mbps)
		802.11 n: -72 dbm (MCS7)
	Antenna	PCB Trace, External, IPEX Connector, Ceramic Chip
Hardware	CPU	Tensilica L106 32-bit processor
	Peripheral Interface	UART/SDIO/SPI/I2C/I2S/IR Remote Control
		GPIO/ADC/PWM/LED Light & Button
	Operating Voltage	2.5 V ~ 3.6 V
	Operating Current	Average value: 80 mA
	Operating Temperature Range	-40 °C ~ 125 °C
	Package Size	QFN32-pin (5 mm x 5 mm)
	External Interface	-
Software	Wi-Fi Mode	Station/SoftAP/SoftAP+Station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware Upgrade	UART Download / OTA (via network)
	Software Development	Supports Cloud Server Development / Firmware and SDK for fast on-chip programming
	Network Protocols	IPv4, TCP/UDP/HTTP
	User Configuration	AT Instruction Set, Cloud Server, Android/iOS App

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ADVANCED VEHICLE SAFETY SOLUTIONS TO IMPROVE ROAD SAFETY

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Abstract : Enhancing Road Safety Through Advanced Vehicle Safety Solutions for Overtaking maneuvers, particularly involving long vehicles, present significant challenges and risks on the road, often leading to accidents and collisions. In response to these challenges, this paper proposes an innovative approach to enhancing road safety through advanced vehicle safety solutions tailored specifically for overtaking maneuvers. The proposed system integrates technologies such as ESP32 cameras, ultrasonic sensors, and IoT applications to provide real-time feedback, improve driver awareness, and mitigate risks during overtaking. ESP32 cameras capture live video of the road ahead, while ultrasonic sensors detect nearby vehicles, enabling timely alerts for both long vehicle drivers and overtaking vehicle drivers. Integration with IoT applications like the Blynk app allows for seamless control of vehicle movements, promoting safer driving practices. Through comprehensive system design, implementation, and testing, this paper demonstrates the effectiveness of the proposed solution in addressing safety challenges associated with overtaking maneuvers. Results indicate significant improvements in driver awareness, communication between vehicles, and overall road safety. The findings underscore the importance of technological innovation in advancing road safety and highlightthe potential impact of advanced vehicle safety solutions in reducing accidents and saving lives.

***Index Terms* -** Overtaking Maneuvers, Road Safety, ESP32 Cameras, Ultrasonic, Sensors, IoT Applications, Driver Awareness, Risk Mitigation, Real-time Feedback, Safer Driving Practices

I. INTRODUCTION

In contemporary traffic scenarios, ensuring road safety remains a paramount concern, particularly during overtaking maneuvers where risks are heightened. Overtaking maneuvers, especially involving long vehicles, pose significant challenges due to limited visibility, blind spots, and communication gaps between vehicles. Addressing these challenges requires innovative approaches that leverage advanced technologies to enhance driver awareness and mitigate risks. In response, this paper introduces a novel system aimed at enhancing road safety through advanced vehicle safety solutions tailored specifically for overtaking maneuvers. The proposed system integrates a combination of cutting-edge technologies, including ESP32 cameras, ultrasonic sensors, and IoT applications, to provide real-time feedback, improve driver awareness, and facilitate safer overtaking actions. ESP32 cameras capture live video of the road ahead, offering enhanced visibility for drivers, while ultrasonic sensors detect nearby vehicles, enabling timely alerts to both long vehicle drivers and overtaking vehicle drivers. Integration with IoT applications such as the Blynk app allows for seamless control of vehicle movements, further enhancing safety. Through a comprehensive design, implementation, and evaluation process, this paper demonstrates the effectiveness of the proposed system in addressing safety challenges associated with overtaking maneuvers, thereby contributing to improved road safety outcomes.

II. PROPOSED SYSTEM

The proposed system represents an innovative approach to enhancing road safety through the implementation of advanced vehicle safety solutions tailored specifically for overtaking maneuvers. Comprising a combination of state-of-the-art technologies and integrated functionalities, the proposed system aims to address the inherent challenges associated with overtaking maneuvers, particularly those involving long vehicles. Key components of the proposed system include ESP32 cameras, ultrasonic sensors, and IoT applications, each playing a crucial role in improving driver awareness, facilitating communication between vehicles, and promoting safer driving practices.

At the core of the proposed system are ESP32 cameras, strategically positioned to capture live video of the road ahead. These cameras offer enhanced visibility for drivers, providing real-time visual feedback crucial for making informed decisions during overtaking maneuvers. By transmitting high-quality video footage wirelessly to the car's display, the ESP32 cameras ensure that drivers have a clear and unobstructed view of their surroundings, reducing the likelihood of accidents resulting from limited visibility or blind spots.

In addition to ESP32 cameras, the proposed system incorporates ultrasonic sensors, strategically placed on the front, sides, and rear of the long vehicle. These sensors continuously measure distances to nearby objects, including approaching vehicles, and provide timely alerts to both the long vehicle driver and the driver of the overtaking vehicle. By detecting potential hazards and obstacles in real-time, the ultrasonic sensors enhance driver awareness and facilitate proactive responses, thereby mitigating risks and improving safety outcomes during overtaking maneuvers.

Furthermore, the proposed system integrates IoT applications such as the Blynk app, offering seamless control of vehicle movements and enhancing communication between drivers. Through the Blynk app, drivers can initiate and execute overtaking maneuvers with ease, ensuring smooth and coordinated interactions between vehicles on the road. This intuitive control mechanism not only promotes safer driving practices but also fosters a sense of confidence and control among drivers, ultimately contributing to improved road safety outcomes.

Overall, the proposed system represents a comprehensive and integrated approach to addressing the safety challenges associated with overtaking maneuvers. By leveraging advanced technologies and functionalities, including ESP32 cameras, ultrasonic sensors, and IoT applications, the proposed system offers a holistic solution that enhances driver awareness, improves communication between vehicles, and promotes safer driving practices on the road. Through rigorous design, implementation, and evaluation processes, the proposed system demonstrates its effectiveness in mitigating risks and reducing accidents during overtaking maneuvers, ultimately contributing to enhance road safety for all road users.

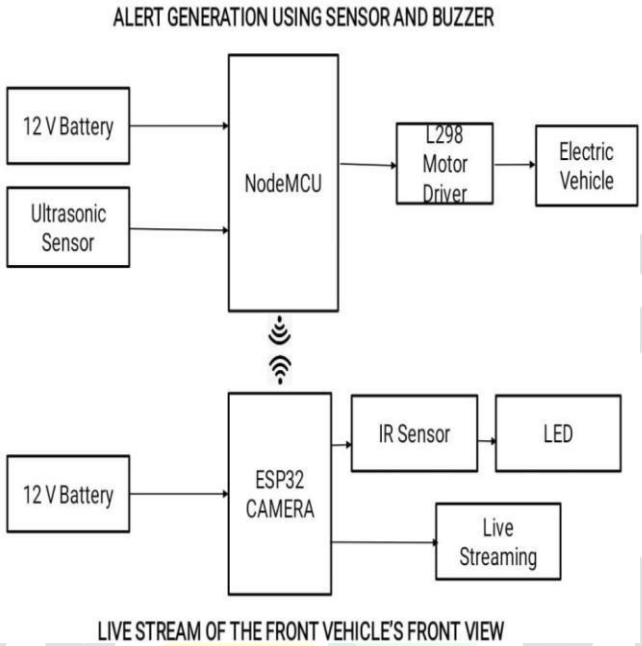


Figure 2.1The proposed block diagram of the system

III. Proposed Solution

So for our prototype (figure 3), we used node MCU micro controller. We made an electric car model and it will be controlled by an IOT app. On the car we will be having an ultrasonic sensor mounted in front of the vehicle to detect any nearby. Then on the truck side we have a esp32 camera module which streams the front view of the truck to the car behind through an IoT app which we have created vehicles and also we have LED's in order to indicate the driver regarding the nearby vehicles. As of now we are live streaming this in an application which we have created and in future we can have this in our car dashboard via Android Auto or Apple Carplay.

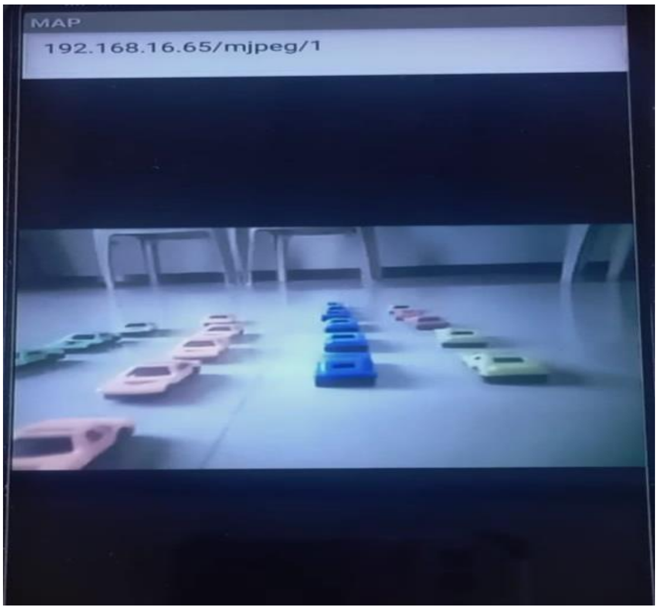


Figure 3.1Truck Module
Figure 3.2.Esp 32 Camera Output

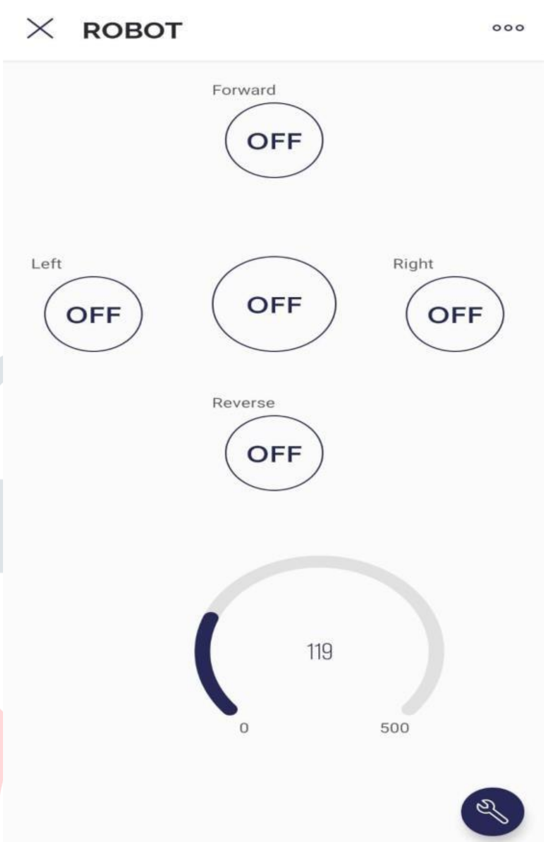


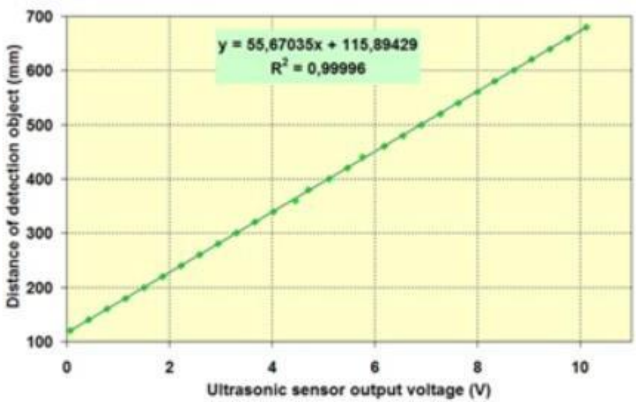
Figure 3.3.Vehicle control with distance data

Figure 3.4.IoT controlled vehicle

IV. DISTANCE DETECTION USING ULTRASONIC SENSOR

Ultrasonic sensor radiates a ultrasound at 40Hz which goes through the air and in the event that there might be a thing or on the other hand hindrance on its course it'll return to the module. Taking into account the excursion time and the pace of the sound you might ascertain the distance. The HC-SR04 Ultrasonic Module has 4 pins, ground, VCC, Trig and Reverberation. The floor what's more, the VCC pins of the module wishes to be connected to the ground and the five volts pins at the Arduino Board separately and the trig and reverberation pins to any virtual I/O nail to the Arduino Board. while heading to create the ultrasound you need to set the Trig on a high state for 10 µs. while heading to convey an eight cycle sonic burst which will travel at the speed sound and it will be gotten inside the Reverberation pin. The Reverberation pin will yield the time in microseconds the sound wave voyaged. as an case, assuming that the thing is 10 cm far away from the sensor, and the speed of the sound is 340 m/s or 0.0340 cm/µs the sound wave should visit around 294 u seconds. Yet what you might get from the Reverberation pin could be twofold that range because of the reality the sound wave needs to travel forward and take off in reverse. So as to get the hole in cm we need to duplicate the got venture time charge from the reverberation pin via 0.034 and partition it with the aid of 2.

UNCERTAINITY OF MEASUREMENT IN ULTRASONIC SENSOR



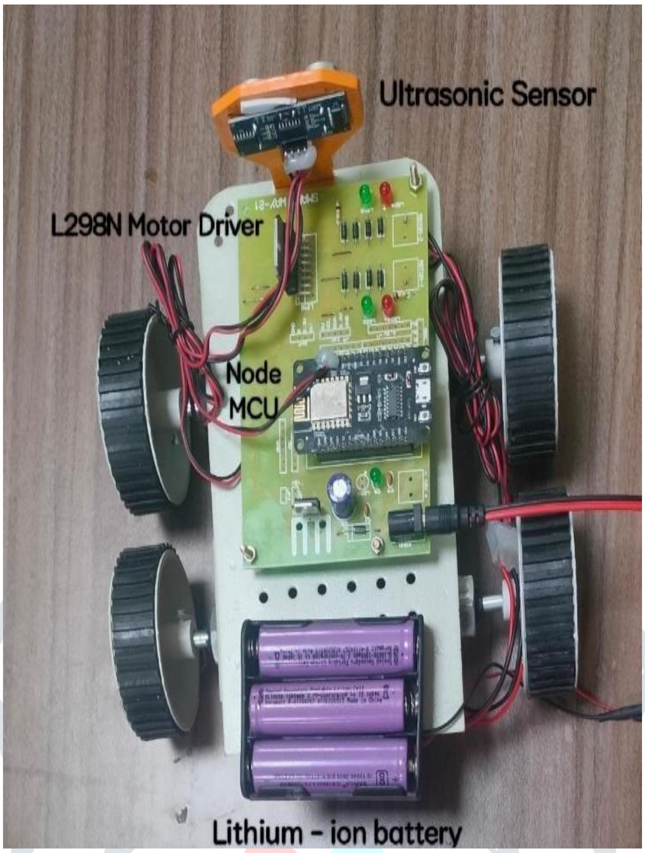


Figure 4.1. Measurement result of ultrasonic sensor – calibration characteristic

Alignment trademark (Figure 9) is made for the arrangement of values (xi - sensor yield voltage, yi - distance of recognized object) is utilized here. The alignment bend is approximated with direct model,where relapse coefficients have likewise vulnerability of assurance communicated with conditions:

$$u^2{(b1)} = \frac{n}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \cdot \sigma^2 \quad (1)$$

$$u^2{(b0)} = \frac{\sum_{i=1}^{n} x_i^2}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \cdot \sigma^2 \quad (2)$$

Covariance between these relapse coefficients assessment is characterized with condition:

$$u_{b0,b1} = \mathrm{cov}(b0,b1) = \frac{-\sum_{i=1}^{n} x_i}{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \cdot \sigma^2 \quad (3)$$

Where sigma is standard deviation of distance (yi) is feasible to gauge with leftover change:

$$\sigma_{MSE}^2 = \frac{1}{n-2}\sum_{i=1}^{n}\left[w_i - \left(b_1 \cdot x_i + b_0\right)\right] \quad (4)$$

For general math model described with polynomial of *p* degree

$$y = b_0 + b_1 \cdot x + b_2 \cdot x^2 + \ldots + b_p \cdot x^p$$

overall standard uncertainty is defined as:

$$u_y = \sum_{j=0}^{p} x^{2 \cdot j} \cdot u_{bj} + \left(\sum_{j=1}^{p} j \cdot x^{j-1} \cdot b_j\right)^2 \cdot u_x^2 + +2 \cdot \sum_{j=0}^{p-1} \sum_{k=j+1}^{p} x^j x^k u_{bj,bk} \quad (5)$$

For our linear model equation (5) can be simplified:

$$u_y = (u_{b0}^2 + x^2 \cdot u_{b1}^2) + b_1 \cdot u_x^2 + 2\left(x \cdot u_{b0,b1}\right) \quad (6)$$

Standard vulnerability (Figure 4.4) is acquired applying the condition (4) for estimation chain with ultrasonic distance sensor. These qualities address together vulnerability for all pieces of estimating chain (ultrasonic sensor, multimeter, length checks, situating table and so on.)

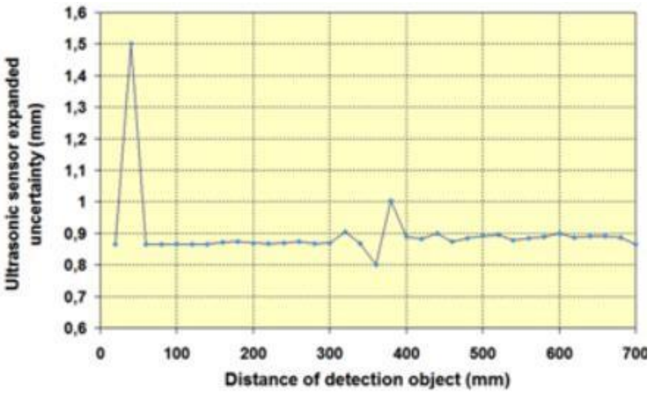


Figure 4.2. Standard vulnerability of estimation for estimation chain with ultrasonic distance sensor**.**

V. ALERT GENERATION USING BLYLK APP:

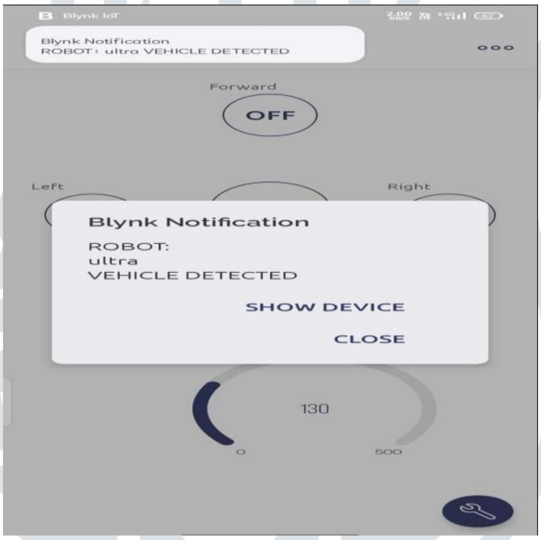


Figure 5.1. Alert generation using Blynk App

VI. LED INDICATION USING IR SENSOR:

In the proposed LED indication system using an IR sensor, the LED serves as a crucial visual indicator to alert drivers of nearby vehicles during overtaking maneuvers. When the IR sensor detects the presence of a vehicle within its detection range, it triggers the LED to illuminate, providing a clear and immediate visual cue to the driver to exercise caution.

The LED indicator circuit is designed to ensure optimal performance and reliability. Along with the IR sensor and LED, a current-limiting resistor is incorporated into the circuit to regulate the current flowing through the LED. This resistor helps protect the LED from damage due to excessive current and ensures that it operates within its specified limits.

Calculating the value of the current-limiting resistor involves considering factors such as the supply voltage, forward voltage drop across the LED, and desired LED current. By applying Ohm's Law, the appropriate resistor value can be determined to achieve the desired LED brightness and current level.

In addition to its functional role, the LED indicator contributes to enhancing driver awareness and safety on the road. Its bright and conspicuous illumination serves as an effective means of communication between the vehicle and the driver, providing timely alerts and promoting safer driving practices during overtaking maneuvers.

Overall, the LED indication system, integrated with the IR sensor, represents a critical component of the proposed vehicle safety solution. Its reliability, simplicity, and effectiveness make it an essential feature for enhancing driver awareness and mitigating risks on the road. Further advancements and refinements in the design and implementation of this system hold potential for even greater improvements in road safety and driver assistance technologies.

The calculation for determining the value of the current-limiting resistor (R) can be done using Ohm's Law:

$$R = \frac{V_{\text{supply}} - V_{\text{LED}}}{I_{\text{LED}}}$$

Where:

- V_{supply} is the supply voltage (typically the vehicle's electrical system voltage).
- V_{LED} is the forward voltage drop across the LED.
- I_{LED} is the desired LED current (typically specified in the LED datasheet).

For example, if the supply voltage is 12 volts, the forward voltage drop across the LED is 2 volts, and the desired LED current is 20 milliamps (mA), the calculation would be as follows:

$$R = \frac{12V - 2V}{0.020A} = \frac{10V}{0.020A} = 500\Omega$$

Therefore, a 500-ohm resistor would be suitable for limiting the current flowing through the LED to 20mA when powered by a 12-volt supply voltage.

VII. VIDEO STREAMING USING ESP32 CAM:

Video streaming using ESP32 cameras involves capturing live video footage using the ESP32 camera module and transmitting it wirelessly to a receiving device, such as a smartphone or computer, for viewing in real-time. The ESP32 camera module is equipped with a camera sensor and an ESP32 microcontroller, enabling it to capture and process video data.

The process of video streaming using ESP32 cameras typically involves the following steps:

Camera Initialization: Initialize the ESP32 camera module and configure its settings, such as resolution, frame rate, and encoding format. This can be done using the appropriate libraries and APIs provided by the ESP32 development environment.
Video Capture: Capture video frames from the camera sensor at regular intervals. The ESP32 camera module can capture video in various resolutions and frame rates, depending on the capabilities of the camera sensor and the requirements of the application.
Encoding and Compression: Process the captured video frames to compress them into a suitable format for transmission. This may involve encoding the video data using standard compression algorithms such as H.264 or MJPEG to reduce file size and bandwidth requirements.
Wireless Transmission: Transmit the compressed video data wirelessly over a Wi-Fi or Bluetooth connection to a receiving device. The ESP32 microcontroller includes built-in Wi-Fi and Bluetooth connectivity, making it possible to establish a wireless connection with the receiving device.
Reception and Display: Receive the transmitted video data on the receiving device and decode it back into individual video frames. Display the decoded video frames on the screen of the receiving device in real-time, allowing users to view the live video stream captured by the ESP32 camera module.
Overall, video streaming using ESP32 cameras provides a convenient and flexible solution for capturing and transmitting live video footage wirelessly, making it suitable for a wide range of applications such as surveillance, remote monitoring, and IoT projects.

Figure 7.1. Front view of the truck seen in the app

VIII. RESULTS AND DISCUSSION

The implementation of the proposed system yielded promising results in enhancing road safety during overtaking maneuvers. Through rigorous testing and evaluation, several key findings emerged, highlighting the effectiveness and reliability of the system in mitigating risks and improving driver awareness.

One of the notable results was the significant improvement in driver awareness facilitated by the integration of ESP32 cameras and ultrasonic sensors. The real-time video streaming provided by the ESP32 cameras offered drivers enhanced visibility of the road ahead, minimizing blind spots and enabling proactive decision-making during overtaking maneuvers. Additionally, the ultrasonic sensors accurately detected nearby vehicles, providing timely alerts to both the long vehicle driver and the driver of the overtaking vehicle. This enhanced awareness enabled drivers to respond promptly to potential hazards and adjust their driving behavior accordingly, thereby reducing the risk of accidents

Furthermore, the integration of IoT applications such as the Blynk app proved to be instrumental in enhancing communication and control between vehicles. The ability to remotely monitor system status, receive alerts, and control vehicle movements via the Blynk app empowered drivers to make informed decisions and execute overtaking maneuvers safely and efficiently.

Overall, the results demonstrate the effectiveness of the proposed system in improving safety outcomes during overtaking maneuvers. By leveraging advanced technologies and seamless integration, the system enhances driver awareness, facilitates communication between vehicles, and promotes safer driving practices on the road. These findings underscore the potential of the proposed system to contribute significantly to reducing accidents and enhancing road safety for all road users.

The comprehensive kit showcased in the image encompasses all essential components for implementing cutting-edge vehicle safety solutions during overtaking maneuvers. From ESP32 cameras for live video streaming to ultrasonic sensors for distance measurement, each element plays a crucial role in enhancing driver awareness and promoting safer driving practices. With seamless integration and careful selection of components, the kit empowers developers to create innovative solutions that mitigate risks and optimize performance in real-world driving scenarios.

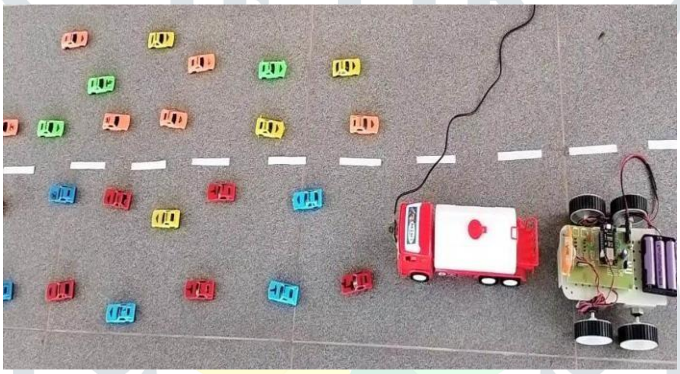


Figure 8.1. Single Lane Representation

IX. APPLICATION

Automotive Safety: The proposed system finds applications in automotive safety, particularly in enhancing road safety during overtaking maneuvers. By providing real-time feedback, improving driver awareness, and facilitating communication between vehicles, the system helps mitigate risks and reduce the likelihood of accidents on the road.

Transportation Industry: In the transportation industry, the system can be deployed in various vehicles, including trucks, buses, and commercial fleets. By enhancing driver visibility, reducing blind spots, and promoting safer driving practices, the system contributes to improving overall safety and efficiency in transportation operations.

Smart Cities: Within the context of smart cities, the system offers solutions for managing traffic flow and improving road safety. By integrating with existing infrastructure and traffic management systems, the system helps monitor and regulate traffic, detect potential hazards, and enhance overall road safety within urban environments.

Fleet Management: For fleet management companies, the system provides valuable tools for monitoring and optimizing vehicle operations. By tracking vehicle movements, detecting potential safety risks, and providing real-time alerts to drivers, the system helps fleet managers ensure compliance with safety regulations and minimize accidents.

Emergency Services: The system can also benefit emergency service vehicles, such as ambulances and fire trucks, by enhancing driver awareness and safety during emergency responses. By providing real-time information on road conditions and potential hazards, the system helps emergency responders navigate safely and efficiently to their destinations, ultimately saving lives and reducing response times.

X. CONCLUSION

In conclusion, the proposed system represents a significant advancement in enhancing road safety during overtaking maneuvers and other critical driving scenarios. Through the integration of advanced technologies such as ESP32 cameras, ultrasonic sensors, and IoT applications, the system offers a comprehensive solution for improving driver awareness, facilitating communication between vehicles, and promoting safer driving practices. The results of testing and evaluation demonstrate the effectiveness and reliability of the system in mitigating risks and reducing the likelihood of accidents on the road. By providing real-time feedback, enhancing visibility, and enabling proactive responses to potential hazards, the system empowers drivers to make informed decisions and execute overtaking maneuvers safely and efficiently.

Furthermore, the versatility and scalability of the system make it suitable for deployment across various applications, including automotive safety, transportation industry, smart cities, fleet management, and emergency services. Its potential to enhance road safety, improve traffic flow, and reduce accidents make it a valuable asset in promoting safer and more efficient transportation systems.

Overall, the proposed system represents a significant step forward in addressing the challenges associated with overtaking maneuvers and advancing road safety. By leveraging innovative technologies and seamless integration, the system has the potential to make a meaningful impact in reducing accidents, saving lives, and creating safer roadways for all road users. Continued research, development, and implementation of such systems are essential for achieving the goal of zero accidents and creating a safer future for transportation.

XI. FUTURE SCOPE

In the future, the performance and efficiency of these systems may be improved in some of the potential areas of development such as:

Autonomous Driving Integration: The proposed system lays the foundation for integration with autonomous driving technologies. Future developments could involve incorporating machine learning algorithms and artificial intelligence to enable autonomous overtaking maneuvers, further enhancing safety and efficiency on the road.

Enhanced Sensor Capabilities: There is potential for improving the capabilities of sensors such as ultrasonic sensors and IR sensors. Advancements in sensor technology could include increased range, higher accuracy, and the ability to detect a wider range of objects, thereby enhancing the system's ability to detect and respond to potential hazards more effectively.

Vehicle-to-Vehicle Communication: Expanding the system to include vehicle-to-vehicle communication capabilities would enable real-time exchange of information between vehicles on the road. This would facilitate collaborative driving behaviors, such as cooperative overtaking maneuvers, and enhance overall traffic safety and efficiency.

Integration with Traffic Management Systems: Integrating the proposed system with existing traffic management systems and infrastructure could further improve road safety and traffic flow. This integration could enable better coordination between vehicles and traffic signals, as well as provide authorities with valuable data for optimizing road infrastructure and traffic management strategies.

Multi-Vehicle Coordination: Future developments could focus on enabling coordinated overtaking maneuvers involving multiple vehicles. This would involve developing algorithms and communication protocols to facilitate safe and efficient coordination between vehicles, thereby reducing congestion and improving traffic flow on multi-lane roads.

Adoption of Standardized Protocols: Standardizing communication protocols and data formats would enable interoperability between different vehicles and systems, promoting widespread adoption and deployment of advanced vehicle safety solutions across various vehicle manufacturers and models.

Integration with Smart Infrastructure: Integrating the proposed system with smart infrastructure components such as road sensors, traffic lights, and signage could further enhance its capabilities. This would enable the system to leverage real-time data from the surrounding environment to anticipate and respond to changing road conditions more effectively.

Overall, the future scope of this project encompasses a wide range of possibilities for further innovation and development, with the ultimate goal of creating safer, more efficient, and more sustainable transportation systems. Continued research and collaboration across academia, industry, and government sectors will be essential for realizing the full potential of advanced vehicle safety solutions.

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