VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A PROJECT REPORT ON

"MULTIFUNCTION VEHICLE SAFETY AND SECURITY SYSTEMS USING IOT"

A dissertation work submitted in partial fulfillment of the requirement for the award of the degree of

BACHELOR OF ENGINEERING
IN
COMPUTER SCIENCE & ENGINEERING

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Bengaluru-91

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CERTIFICATE

This is to certify that the Project work entitled "**MULTIFUNCTIONAL VEHICLE SAFETY AND SECURITY SYSTEMS USING IOT "** is a bonafide work carried out by **ANUSHA JOSHI (1EW21CS017) ,BINDUSHREE KM (1EW21CS029) , HARSHITHA R (1EW21CS054)** in partial fulfillment for the award of Bachelor of Engineering in Computer Science and Engineering of the Visvesvaraya Technological University, Belgaum during the academic year 2024-2025. It is certified that all the suggestions/corrections indicated for Internal Assessment have been incorporated in the report deposited in the department library. The project report has been approved as it satisfies the academic requirements in respect to project work prescribed for the said degree.

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DECLARATION

ANUSHA JOSHI (1EW21CS017) ,BINDUSHREE KM (1EW21CS029) , HARSHITHA R (1EW21CS054),students of eighth semester Bachelor of Engineering in the Department of Computer Science and Engineering of East West Institute of Technology, Bangalore – 560091, hereby declare that the project entitled " **MULTIFUNCTIONAL VEHICLE SAFETY AND SECURITY SYSTEMS USING IOT "** has been carried out by us under the supervision of Internal Guide **Prof. PADMAVATHI B**, Assistant Professor, Department of Computer Science and Engineering, EWIT, Bangalore submitted in the fulfillment of the course requirements for the award of the degree of Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University during the academic year 2024-25.

Date:

Place: Bengaluru

Signature:

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ABSTRACT

As vehicular safety and security concerns continue to rise, there is a pressing need for advanced systems that can proactively address these challenges. This project introduces a Multifunctional Vehicle Security System utilizing the ESP32 microcontroller, designed to enhance vehicle safety, promote responsible driving, and ensure real-time monitoring of critical parameters. The system integrates various sensors and components, including a Light Dependent Resistor (LDR) for high beam detection, a tilt sensor for accident detection, ultrasonic sensors for object and blind spot monitoring, and an alcohol sensor to assess driver sobriety. In addition to these features, the system employs Bluetooth technology to deliver voice alerts directly to the driver, ensuring they are promptly informed of any potential hazards or critical situations. The incorporation of GPS functionality allows for precise location tracking, enhancing the system's ability to send real-time location updates via Telegram messaging in emergencies, such as accidents or unauthorized vehicle movement.

TABLE OF CONTENTS

TABLE OF FIGURES

INTRODUCTION

CHAPTER 1

INTRODUCTION

In recent years, road safety has become a significant global concern, with increasing traffic congestion and the rising incidence of accidents leading to injuries and fatalities. As technology advances, the integration of intelligent systems into vehicles has emerged as a vital strategy to enhance driver safety and prevent accidents. The advent of microcontrollers, sensors, and communication technologies provides opportunities to develop sophisticated vehicle security solutions that address these pressing issues.This project focuses on the development of a Multifunctional Vehicle Security System utilizing the ESP32 microcontroller, known for its versatility and built-in Wi-Fi capabilities. By integrating various sensors, including Light Dependent Resistors (LDRs), tilt sensors, ultrasonic sensors, and alcohol detection modules, the system aims to provide comprehensive monitoring and control of critical parameters affecting vehicle safety. The incorporation of an LDR allows the system to detect high beam lights from oncoming vehicles, automatically adjusting the vehicle’s lights to enhance visibility and reduce glare for other drivers. The tilt sensor plays a crucial role in detecting accidents by monitoring the vehicle's orientation, ensuring prompt alerts are sent to emergency contacts. Ultrasonic sensors are employed to monitor distances to nearby objects, facilitating awareness of blind spots and preventing collisions.

Additionally, the system integrates an alcohol detection sensor that measures the driver's blood alcohol concentration, preventing vehicle operation if the level exceeds a safe limit. To enhance driver awareness, voice alerts via Bluetooth are provided, delivering critical information and warnings directly to the driver in real time. Furthermore, GPS functionality enhances the system's capabilities by tracking the vehicle's location and providing real-time updates through Telegram messaging in case of emergencies. This feature not only assists in accident situations but also deters vehicle theft by allowing owners to monitor their vehicle's location remotely. Overall, this Multifunctional Vehicle Security System aims to create a safer driving environment, promote responsible driving behavior, and leverage modern technology to mitigate risks associated with road travel. By integrating these innovative features into a single cohesive system, we strive to enhance the overall safety and security of vehicles, thereby contributing to a more responsible and secure driving culture. Road safety has become a global concern with rising accidents and fatalities. Advances in technology have made intelligent systems essential to improve driver safety and prevent accidents. This project introduces a

Multifunctional Vehicle Security System using the ESP32 microcontroller, known for its versatility and built-in Wi-Fi capabilities. The system integrates Light Dependent Resistors (LDRs), tilt sensors, ultrasonic sensors, and alcohol detection modules to monitor critical vehicle safety parameters. The LDR detects high beam lights from oncoming vehicles, adjusting the vehicle's lights to reduce glare and enhance visibility. Tilt sensors identify accidents by monitoring vehicle orientation and send immediate alerts to emergency contacts. Ultrasonic sensors monitor blind spots and measure distances to nearby objects, preventing collisions. The alcohol detection module restricts vehicle operation if the driver's blood alcohol concentration exceeds the safety limit. Bluetooth-based voice alerts provide real-time warnings to improve driver awareness and response. GPS functionality enhances safety by tracking the vehicle's location and sending real time updates through Telegram messaging during emergencies. This feature aids in locating vehicles during accidents and deters theft through remote monitoring. The system integrates these advanced technologies to create a safer driving environment, promote responsible driving, and reduce road risks. By combining all features into one solution, it ensures enhanced safety, real-time monitoring, and secure vehicle operation, contributing to better road safety outcome.

1 WHAT IS INTERNET OF THINGS

IoT systems allow users to achieve deeper automation, analysis, and integration within a system. They improve the reach of these areas and their accuracy. IoT utilizes existing and emerging technology for sensing, networking, and robotics. IoT exploits recent advances in software, falling hardware prices, and modern attitudes towards technology. Its new and advanced elements bring major changes in the delivery of products, goods, and services; and the social, economic, and political impact of those changes.

1.1 KEY FEATURES OF IOT

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. IoT essentially makes virtually anything "smart", meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer. A brief review of these features is given below.

1.1.1 Connectivity: New enabling technologies for networking, and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.

1.1.2 Sensors: IoT loses its distinction without sensors. They act as defining instruments which transform IoT from a standard passive network of devices into an active system capable of real-world integration.

1.1.3 Active Engagement: Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.

1.2 ADVANTAGES OF IOT

The advantages of IoT span across every area of lifestyle and business. Here is a list of someof the advantages that IoT has to offer:

1.2.1 Improved Customer Engagement: Current analytics suffer from blind-spots and significant flaws in accuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.

1.2.2 Technology Optimization: The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.

1.2.3 Reduced Waste: IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to more effective management of resources.

1.2.4 Enhanced Data Collection: Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces, and places it exactly where humans really want to go to analyse our world. It allows an accurate picture of everything.

1.3 DISADVANTAGES OF IOT

Though IoT delivers an impressive set of benefits, it also presents a significant set of challenges.

Here is a list of some its major issues:

1.3.1 Security: IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers.

1.3.2 Privacy: The sophistication of IoT provides substantial personal data in extreme detail without the user's active participation.

1.3.3 Complexity: Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.

SUMMARY

This chapter deals with the introduction to IOT. It also gives brief explanation about the key-elements. It also specifies their advantages and disadvantages.

LITERATURE SURVEY

CHAPTER 2

LITERATURE SURVEY

Literature finds Recent advancements in automotive safety systems have led to the development of integrated solutions combining multiple technologies to enhance driver safety and vehicle security. Tan et al. (2024) explored automatic dimming systems for high beam headlights, emphasizing the importance of reducing glare to improve night-time visibility. These systems, using Light Dependent Resistors (LDRs) and microcontrollers, automatically adjust light intensity, improving road safety. Similarly, Gupta et al. (2024) introduced accident detection systems using tilt sensors and accelerometers to detect sudden motion changes, facilitating quick emergency responses. This integration has proven effective under simulated conditions, significantly reducing response times. Kaur et al. (2024) investigated the use of ultrasonic sensors for object and blind spot detection, which enhance situational awareness and minimize collisions. However, the detection range can be limited in high-speed scenarios. Zhang et al. (2024) developed alcohol detection technologies using the MQ-3 sensor to prevent drunk driving, while Liu et al. (2024) highlighted the utility of voice alert systems in delivering critical information without distracting the driver, especially when paired with Bluetooth technology. Additionally, Kumar et al. (2024) demonstrated the effectiveness of GPS-based tracking systems in improving vehicle security, enabling real-time location monitoring, which aids in vehicle recovery in theft situations. Patel et al. (2024) proposed integrating multiple safety features into a cohesive framework, combining sensor technologies for comprehensive hazard management. The integration of such systems not only enhances functionality but also improves driver awareness, reducing the risk of accidents. Despite the advantages of these technologies, challenges such as sensor calibration, false positives, and high implementation costs remain. Nonetheless, integrating these safety systems into a single vehicle framework promises significant improvements in overall vehicle safety, security, and driver assistance. Moreover, the integration of these technologies into a unified system offers a holistic approach to vehicle safety, reducing the need for separate, standalone systems. This approach allows for seamless communication between different safety features, ensuring timely and efficient responses to potential hazards. However, challenges such as system complexity, maintenance, and troubleshooting arise when managing such integrated solutions.

2.1 TITLE: Intelligent Lighting Control System for Automotive Applications.

PUBLISHED YEAR: 2022

DESCRIPTION

This study explores the use of Light Dependent Resistors (LDRs) and microcontrollers to detect high beam headlights from oncoming vehicles and automatically adjust the light intensity. The main findings highlight that automatic dimming significantly reduces glare, improves visibility for both the driver and oncoming vehicles, and enhances overall road safety. The system serves as a strong foundation for integrating automatic dimming technology into vehicle systems. By incorporating this solution into our project, we aim to improve night driving conditions, reduce glare, and enhance road safety, making the system more effective in ensuring safe driving.

ADVANTAGE

Significantly reduces glare, improving night driving safety. Automated system requires minimal driver interaction, enhancing usability.

DISADVANTAGE

Sensor calibration needs to be precise, which can be challenging. Reduced effectiveness in adverse weather conditions such as fog or heavy rain.

2.2 TITLE: Accident Detection Systems

PUBLISHED YEAR: 2023

DESCRIPTION

This research presents a vehicle accident detection system using tilt sensors and accelerometers to monitor sudden motion changes and automatically alert emergency services. The system effectively integrates real-time monitoring with communication technologies, demonstrating high reliability in detecting accidents in simulated conditions. It highlights the potential of tilt sensors to improve emergency response times. In our project, we incorporate these sensors to enable immediate accident detection and notification to emergency services. This integration aligns with our goal of enhancing vehicle security and driver safety by ensuring quicker responses in critical situations.

ADVANTAGE

Quick emergency alert notifications can save lives. Straightforward integration with existing vehicle systems. Reliable in detecting significant motion impacts

DISADVANTAGE

False positives can occur due to abrupt vehicle movements not related to accidents. Dependency on network connectivity for alert transmission.

2.3 TITLE: Object and Blind Spot Detection

PUBLISHED YEAR: 2023

DESCRIPTION

This study examines the effectiveness of ultrasonic sensors in detecting objects and monitoring blind spots in automotive applications. The key findings highlight that ultrasonic sensors offer accurate proximity data, which is crucial for blind spot monitoring. These sensors significantly enhance driver awareness by reliably detecting nearby objects, thus supporting the prevention of collisions. The research concludes that integrating ultrasonic sensors into vehicle systems can improve safety, particularly in blind spots and during parking maneuvers. This technology is a valuable addition to multifunctional vehicle security systems, aiming to enhance overall safety and reduce collision risks.

ADVANTAGE

Quick emergency alert notifications can save lives. Straightforward integration with existing vehicle systems. Reliable in detecting significant motion impacts

DISADVANTAGE

False positives can occur due to abrupt vehicle movements not related to accidents. Dependency on network connectivity for alert transmission.

2.4 TITLE: Alcohol Detection Technologies

PUBLISHED YEAR: 2024

DESCRIPTION

This research introduces an alcohol detection system utilizing the MQ-3 sensor, which measures alcohol concentration in a driver's breath to help prevent drunk driving. Key findings highlight the sensor's high sensitivity to alcohol vapors, enabling early detection of alcohol consumption. The system has been successfully integrated with vehicle systems to prevent the vehicle from operating when alcohol is detected, significantly reducing the risk of drunk driving incidents.

The inclusion of alcohol detection in the project contributes to promoting responsible driving and minimizing accidents caused by impaired driving. This feature strengthens the overall goal of improving vehicle security and safety in the multifunctional system. The system's advantages include enhanced safety through accurate alcohol detection and the ability to prevent vehicle operation under the influence, thus reducing the likelihood of accidents.

ADVANTAGE

High sensitivity to detecting alcohol, enhancing safety.Prevents operation of the vehicle under the influence, reducing accidents.

DISADVANTAGE

Potential for false positives from other substances.System requires regular calibration and maintenance to ensure

SUMMARY

This chapter focus on literature survey, which gives brief explanations about existing systems

PROBLEM STATEMENT

CHAPTER 3

PROBLEM STATEMENT

Road safety remains a critical global issue, with accidents often caused by impaired driving, poor situational awareness, and inadequate emergency communication. High beam headlights create dangerous glare, while blind spots increase the risk of collisions. Many drivers are unaware of their alcohol levels, further contributing to impaired driving. Current vehicle security systems lack integration, making it challenging to address these problems effectively. A comprehensive solution combining high beam detection, object monitoring, alcohol detection, voice alerts, and GPS tracking is needed to enhance safety, awareness, and security using advanced technology like the ESP32 microcontroller.

SUMMARY

This chapter focus on the problems of the current project. It also has some problem identifications of the system.

GOALS OF PROJECT

CHAPTER 4

GOALS OF PROJECT

1. Implement high beam detection and automatic light adjustment to enhance road safety.
2. Develop accident detection using a tilt sensor to trigger emergency alerts and fast response.
3. Integrate ultrasonic sensors for object and blind spot monitoring to prevent collisions.
4. Incorporate alcohol detection to promote responsible driving by disabling vehicle operation if alcohol levels are high.
5. Enable real-time GPS tracking and communication through Bluetooth and Telegram for location updates and emergency alerts.

SUMMARY

This project develops a system enhances driver safety, promotes responsible driving, and ensures proactive vehicle security through real-time alerts and location updates.

PROPOSED SYSTEM

CHAPTER 5

PROPOSED SYSTEM

The proposed Multifunctional Vehicle Security System addresses these gaps by introducing an integrated, sensor-driven solution that proactively enhances safety and security. Built around the ESP32 microcontroller, this system combines multiple features into a unified platform to ensure comprehensive vehicle safety. The core components include:

- **LDR for High Beam Detection**: The system detects high-beam lights from oncoming traffic and automatically dims the vehicle's headlights to reduce glare and improve visibility for all drivers.
- **Tilt Sensor for Accident Detection**: Any significant tilt, indicative of a collision or rollover, triggers an emergency alert system that sends real-time location data to predefined contacts via Telegram.
- **Ultrasonic Sensors**: These sensors monitor the surroundings for objects or vehicles in blind spots, alerting the driver to potential hazards.
- **Alcohol Sensor**: The system assesses the driver’s sobriety, disabling the ignition if alcohol is detected beyond a safe threshold.
- **Bluetooth Integration**: Voice alerts are delivered to the driver in real-time, providing immediate feedback on detected hazards or system triggers.
- **GPS Module**: Provides precise location tracking and facilitates emergency communication by sending real-time location updates.
- **Relays for Dynamic Adjustments**: Enables adaptive control of vehicle functions, such as adjusting light intensity based on environmental conditions.

By integrating these features, the proposed system not only improves vehicle security but also promotes responsible driving and reduces accident risks through proactive monitoring and timely interventions.

5.1 SYSTEM ARCHITECTURE

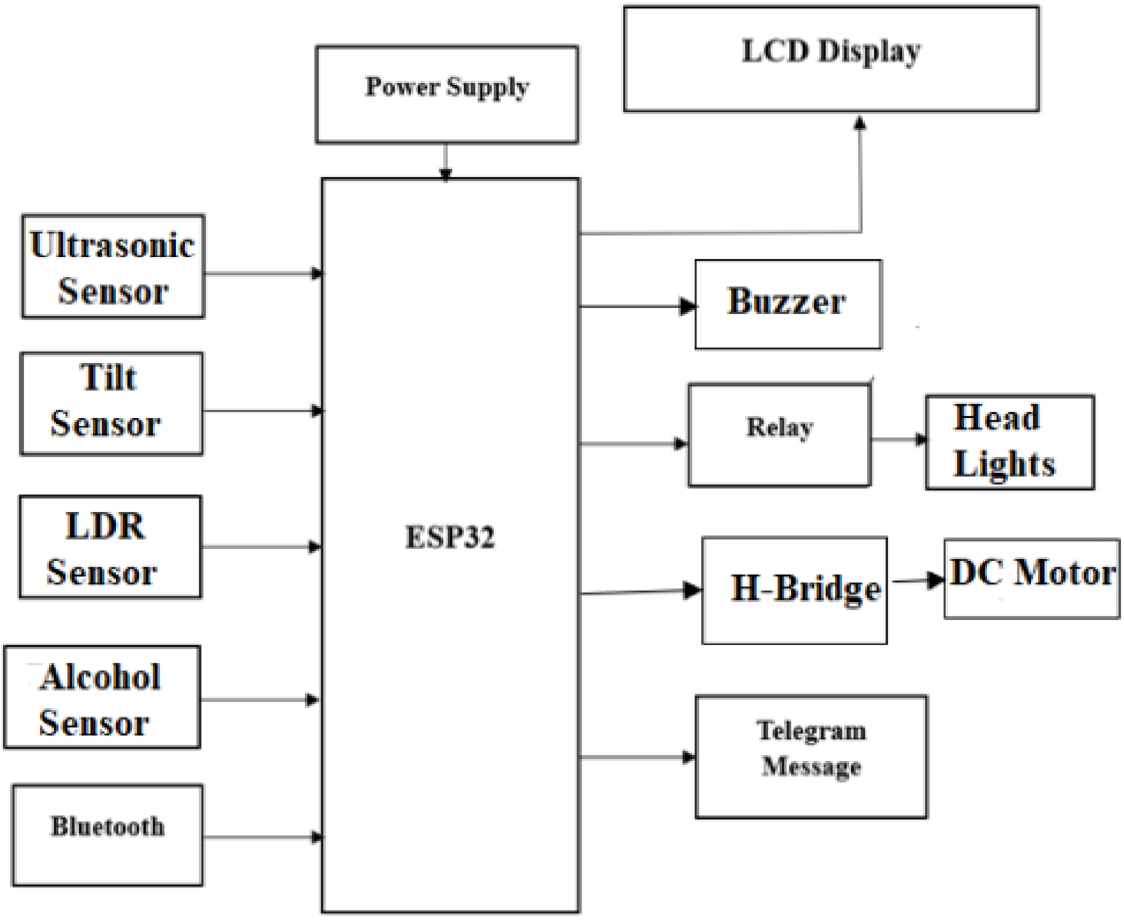


Fig 5.1 System Architecture

The The design and implementation of the Multifunctional Vehicle Security System leverage the ESP32 microcontroller as the central processing unit to integrate and manage multiple components. The system starts by connecting essential sensors: a Light Dependent Resistor (LDR) for automatic headlight dimming in response to high beams, a tilt sensor for accident detection, ultrasonic sensors for blind spot and object monitoring, and an alcohol sensor for assessing driver sobriety.

To enhance user interaction, Bluetooth connectivity enables real-time voice alerts to drivers about detected hazards or critical events. Additionally, GPS functionality is incorporated to provide precise vehicle tracking. In emergencies such as accidents or unauthorized movement, the system uses the Telegram messaging service to send real-time alerts to preconfigured contacts, including the vehicle's location.

For accident detection, the tilt sensor measures angular changes to detect rollovers or collisions. The ESP32 processes the sensor data and triggers emergency alerts, ensuring swift response. Similarly, the alcohol sensor evaluates the driver’s breath and inhibits vehicle operation if alcohol levels exceed safety thresholds.

The ultrasonic sensors are programmed to continuously monitor the distance to nearby objects. By providing real-time feedback, these sensors help prevent collisions, especially in tight parking spaces or during lane changes. The system's relays dynamically adjust headlight intensity based on data from the LDR, ensuring optimal visibility and safety.

The dynamic adjustment of headlight intensity, controlled by the LDR through relays managed by the ESP32, ensures optimal illumination in varying lighting conditions, reducing glare for oncoming traffic while maintaining the driver’s visibility, an essential feature for nighttime and low-visibility driving.

Altogether, this system exemplifies a harmonious integration of cutting-edge hardware and software, delivering a multifaceted solution that addresses critical safety concerns while enhancing the overall driving experience, marking a significant step forward in the evolution of intelligent vehicle safety systems.

Comprehensive testing ensures the accuracy and reliability of each feature. Scenarios such as high beam detection, emergency braking situations, and driver sobriety checks are simulated to validate the system’s performance. Feedback from users and testers helps refine the system for practical deployment.

5.2 DATA FLOW DIAGRAM

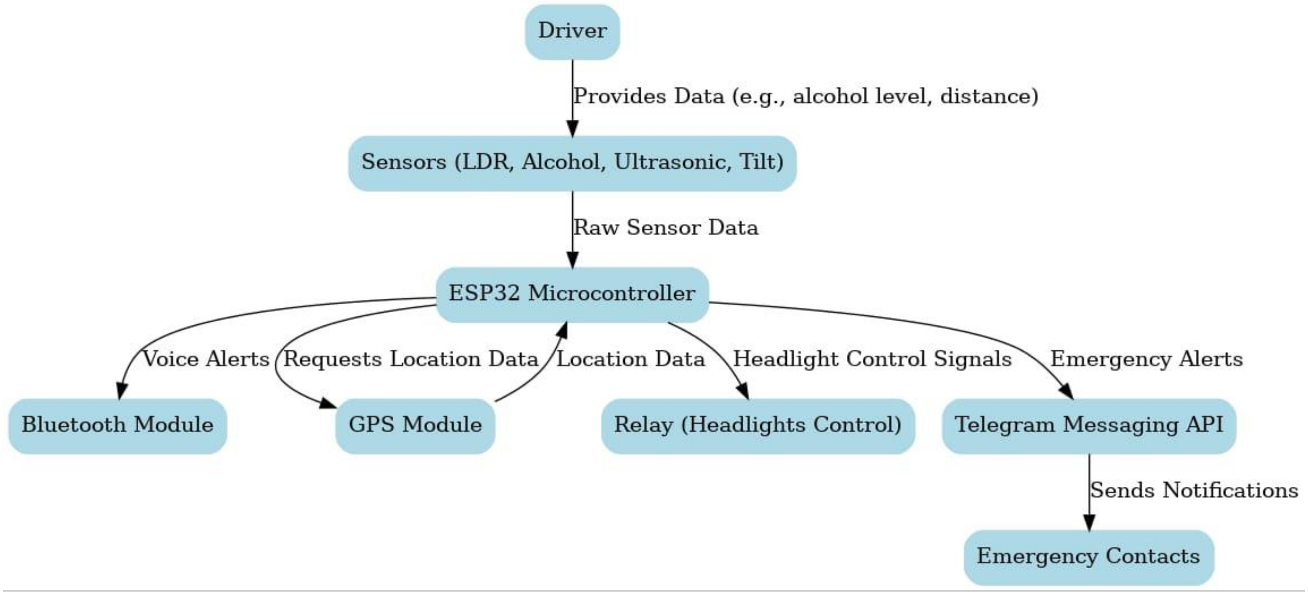


Fig 5.2 Data Flow Diagram

A data flow diagram (DFD) shows how data flows through a system in a visual manner. The proper number of connections demand can be graphically displayed using a simple and concise DFD. High resolution video and images can be captured.

This diagram illustrates a vehicle safety and emergency management system centered around the ESP32 microcontroller, which processes inputs from various sensors and coordinates outputs to enhance safety. The sensors—LDR, alcohol, ultrasonic, and tilt—collect data on ambient light, driver intoxication, distance to obstacles, and vehicle orientation. The ESP32 processes this data and triggers appropriate responses, including voice alerts via a Bluetooth module, location requests through a GPS module, and automatic headlight control via a relay. In emergencies, such as detecting alcohol or an accident, the system uses the Telegram Messaging API to send alerts with location data to predefined emergency contacts. This integrated system ensures driver assistance, automation of key vehicle functions, and timely intervention in critical situations, promoting safety and efficiency.

5.3 USE CASE DIAGRAM

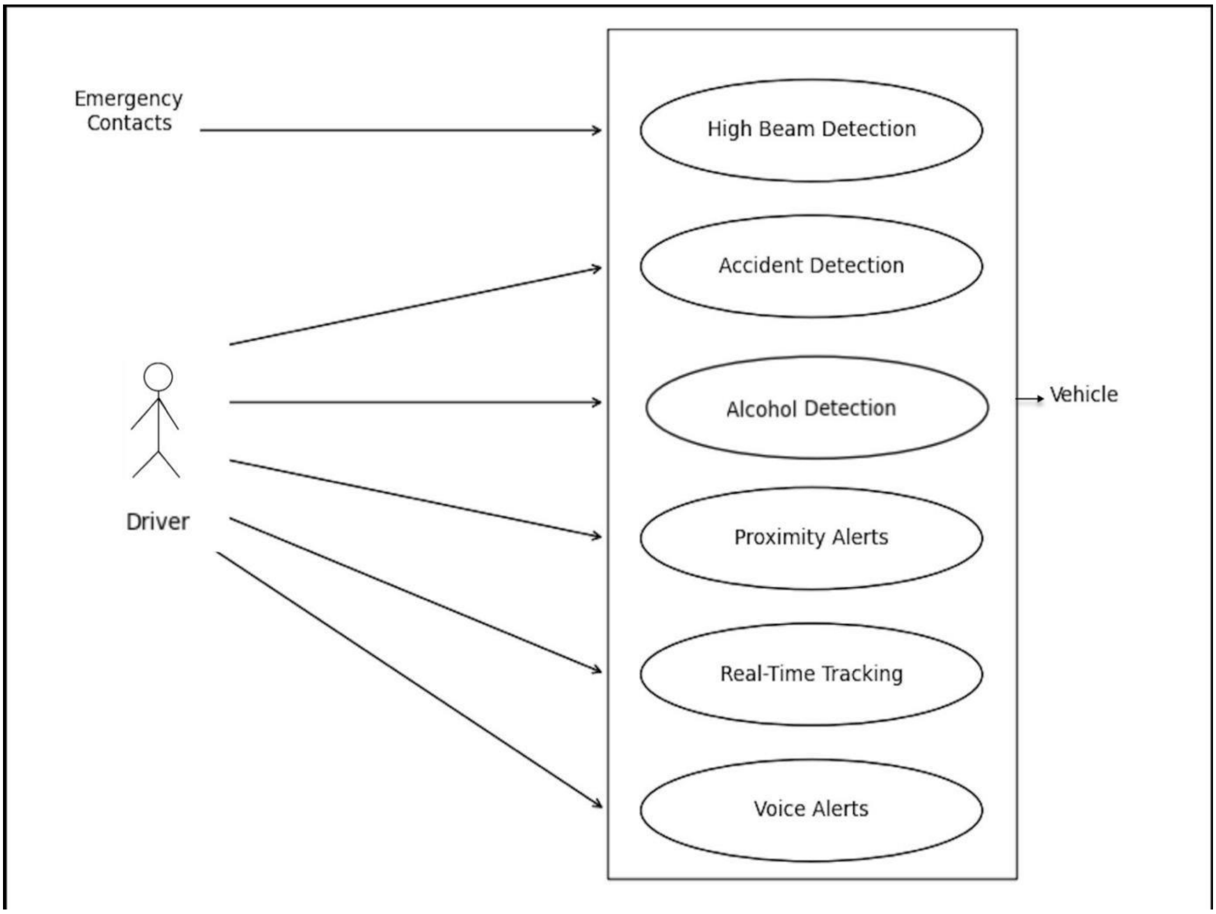


Fig 5.3 Use Case Diagram

The main objective is to provide all users who can use the system with a visual representation of all its functional requirements. The presentation that follows provides a high-level design and the basic sequence of events for the system as seen by each user.

A technique for compressing details about a system and the users within it is a use case diagram. It typically takes the form of a visual depicting the interactions between different system components. In our project, the driver interacts with sensors and output devices in the vehicle safety system. Sensors capture data, and based on the analysis, output devices like relays, GPS, and Bluetooth modules ensure safety through notifications and alerts. In summary, the use case diagram serves as a compact yet detailed representation of the Multifunctional Vehicle Security System, illustrating the critical interplay between the driver, sensors, and output devices to deliver a robust and effective safety solution.

5.4 FLOW CHART

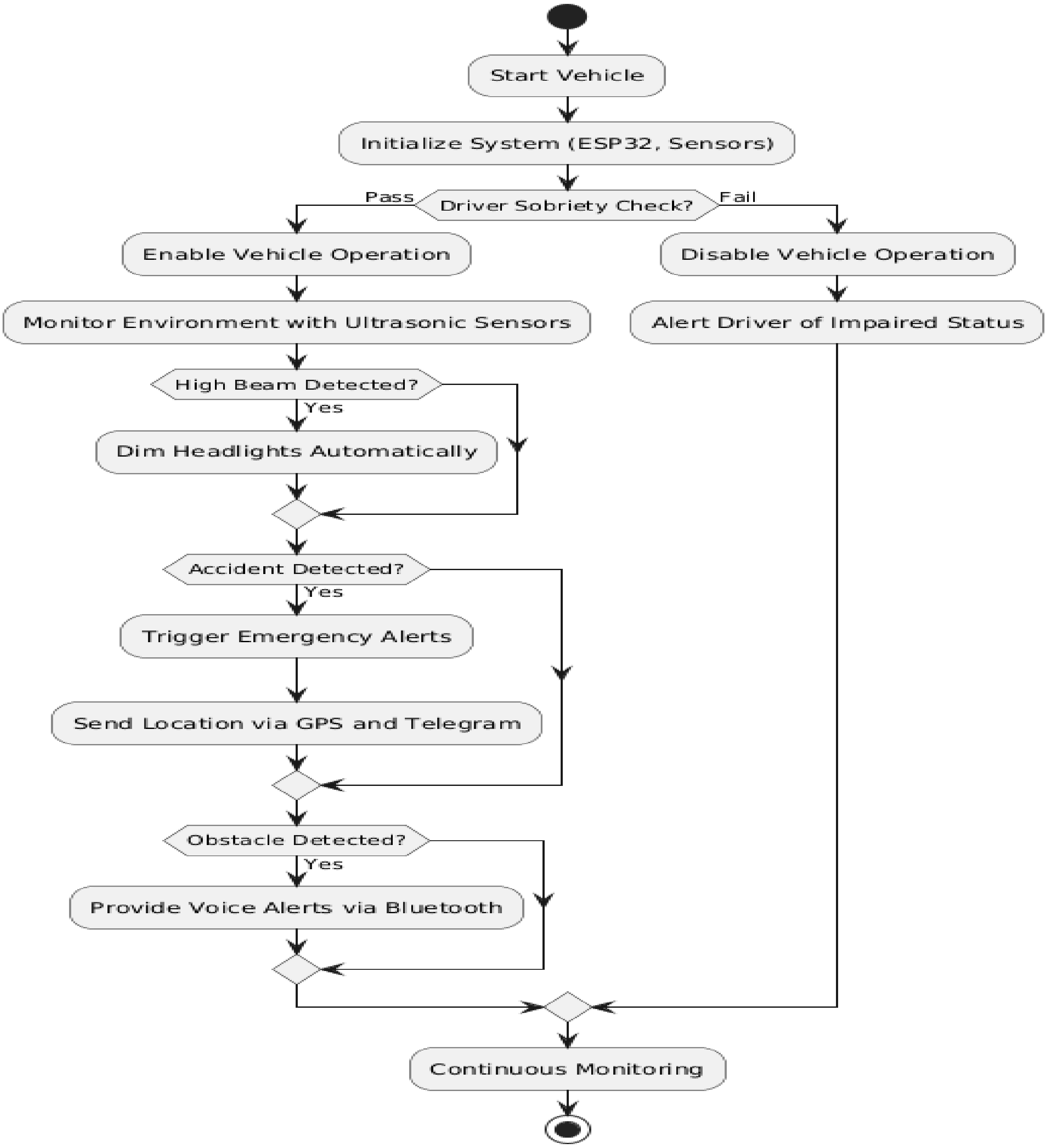


Fig 5.4 Flow Chart

The Multifunctional Vehicle Security System uses an ESP32 to manage sensors for high beam detection, accident detection, object monitoring, and alcohol testing. It adjusts headlights, provides voice alerts via Bluetooth, and tracks location with GPS. In emergencies, it sends alerts via Telegram, ensuring enhanced safety and security for both the vehicle and driver.

5.5 SEQUENCE DIAGRAM

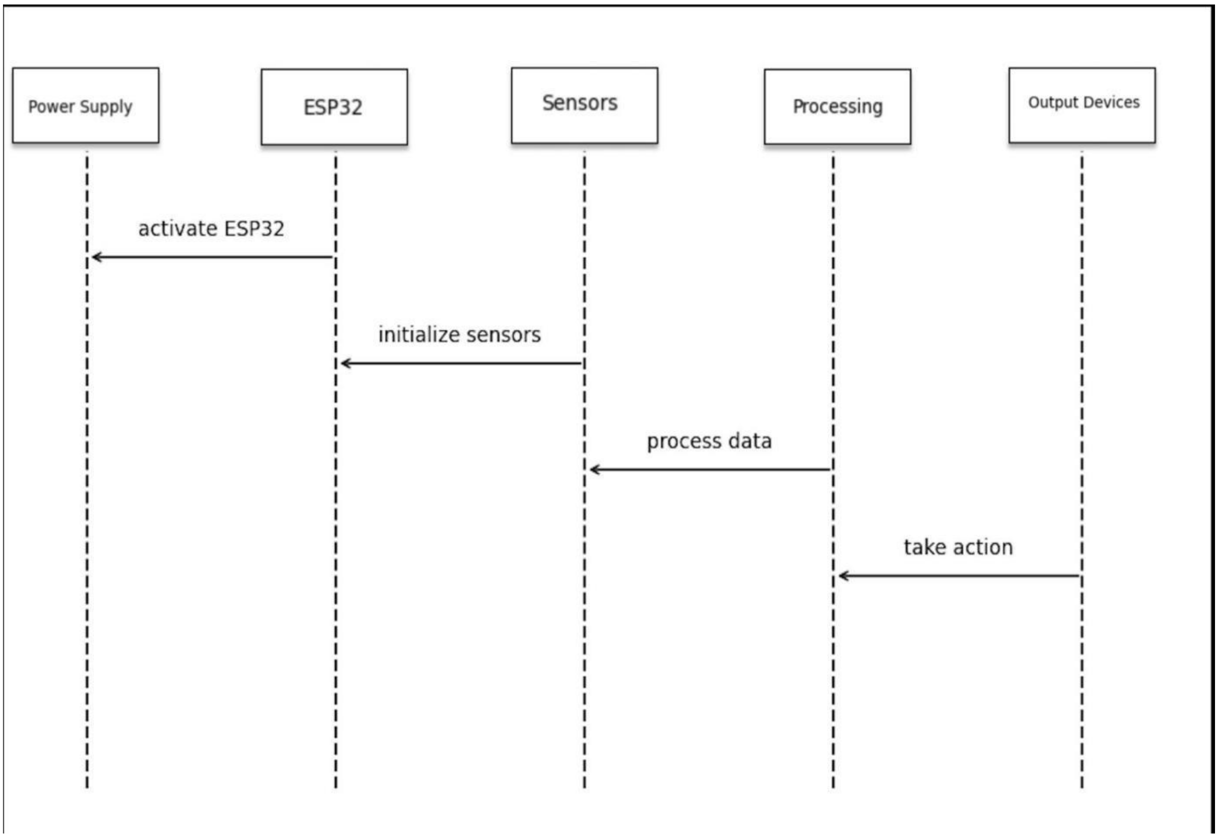


Fig 5.5 Sequence Diagram

During the testing phase, we express the connections between data objects to realize a scenario using sequence diagrams. In the analysis phase, sequence diagrams can make it simpler to identify the subclasses that a system must perform as well as what quality features do inside interaction. To show how successfully the user can engage, flow charts are utilized during the design phase.

In the testing phase, sequence diagrams are utilized to represent the connections and interactions between data objects, helping to illustrate the sequential flow of actions within the Vehicle Safety System using ESP32.In the analysis phase, sequence diagrams simplify the process of identifying key system subclasses and their responsibilities. By analyzing the interactions between the Power Supply, ESP32, Sensors, Output Devices, and Emergency Contacts, developers can better understand the quality features provided by the system, such as real-time tracking, obstacle alerts, and ignition control. This phase ensures all essential functionalities are captured during system development.

A sequence diagram is a type of interaction diagram that shows the step-by-step flow of actions and how components interact with each other in sequential order. For the Vehicle Safety System, the process begins with the activation of the power supply, followed by data capture from sensors.

This chapter focuses on the architecture and systems that depict the Vehicle Safety System using ESP32. It includes visual representations such as flow diagrams, use case diagrams, and sequence diagrams to provide a detailed understanding of the system's functionality. By illustrating how the system components interact and process data, this chapter ensures a comprehensive explanation of the proposed model.

SUMMARY

This chapter focus on the architecture and systems that are used to depict the proposed models.it also has the flow diagrams, use case diagrams, sequence diagram etc.

SYSTEM REQUIREMENTS

CHAPTER 6

SYSTEM REQUIREMENTS

To be used efficiently, all computer software needs certain hardware components or other software resources to be present on a computer. These prerequisites are known as (computer) system requirements and are often used as a guideline as opposed to an absolute rule. Most software defines two sets of system requirements: minimum and recommended. With increasing demand for higher processing power and resources in newer versions of software, system requirements tend to increase over time. Industry analysts suggest that this trend plays a bigger part in driving upgrades to existing computer systems than technological advancements.

6.1 ARDUINO SOFTWARE

6.1.1 INTRODUCTION TO THE ARDUINO IDE

- The Arduino is a single-board microcontroller solution for many DIY projects, we will look at the Integrated Development Environment, or IDE, that is used to program it. Once the installer has downloaded, go ahead and install the IDE. Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module.
- It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process.

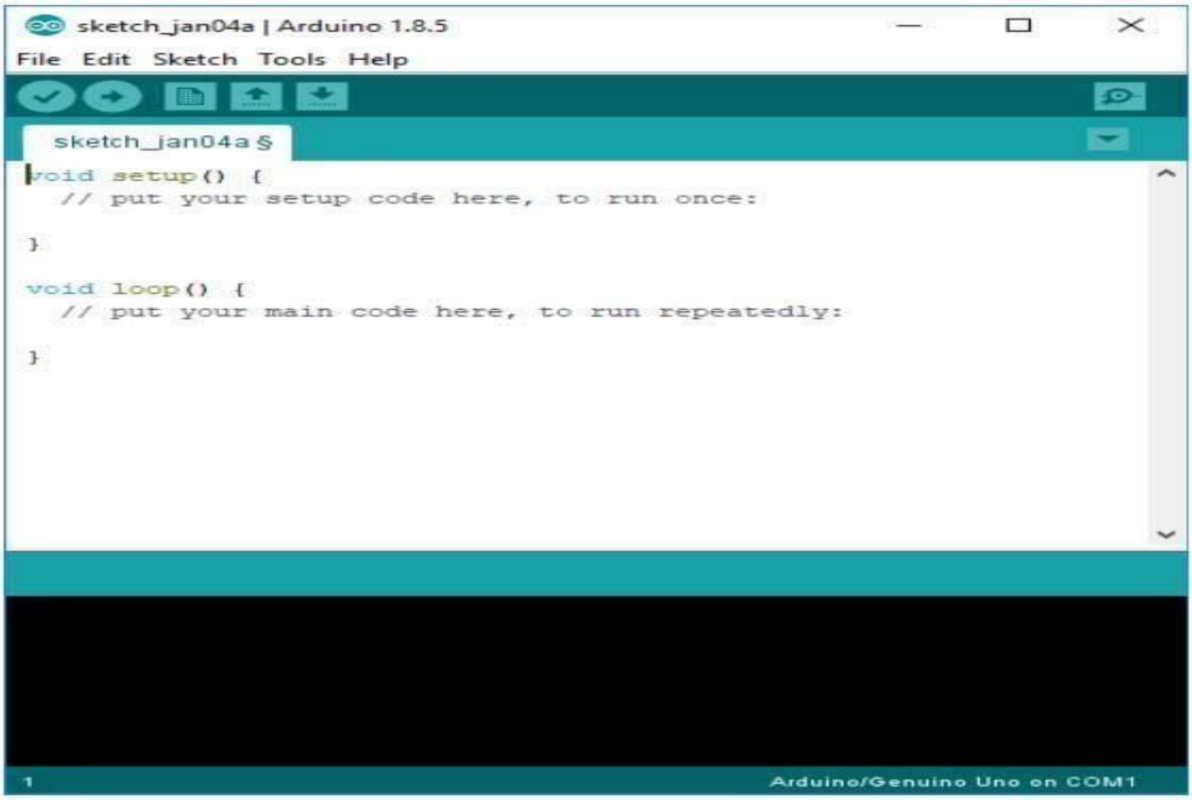
6.1.2 DOWNLOAD THE IDE

First, you must download the IDE and install it. Start by visiting Arduino‘s software page. The IDE is available for most common operating systems, including Windows, Mac OS X, and Linux, so be sure to download the correct version for your OS. If you are using Windows 7 or older, do not download the Windows app version, as this requires Windows 8.1 or Windows 10.

6.2 THE ARDUINO IDE

The Arduino IDE is incredibly minimalistic, yet it provides a near-complete environment for most Arduino-based projects. The middle section of the IDE is a simple text editor that where you can enter the program code. The bottom section of the IDE is dedicated to an output window that is used to see the status of the compilation, how much memory has been used, any errors that were found in the program, and various other useful messages.

Fig. 6.1. Arduino program dumping window



Projects made using the Arduino are called sketches, and such sketches are usually written in a cut-down version of C++ (a number of C++ features are not included). Because programming a microcontroller is somewhat different from programming a computer, there are a number of device-specific libraries (e.g., changing pin modes, output data on pins, reading analog values, and timers).

This sometimes confuses users who think Arduino is programmed in an ―Arduino language.‖ However, the Arduino is, in fact, programmed in C++. It just uses unique libraries for the device.

6.2.1 THE 6 BUTTONS

While more advanced projects will take advantage of the built-in tools in the IDE, most projects will rely on the six buttons found below the menu bar.

Fig 6.2.The button bar

- The check mark is used to verify your code. Click this once you have written your code.
- The arrow uploads your code to the Arduino to run.
- The dotted paper will create a new file.
- The upward arrow is used to open an existing Arduino project.
- The downward arrow is used to save the current file.
- The far right button is a serial monitor, which is useful for sending data from the Arduino to the PC for debugging purposes.

6.3 ARDUINO HARDWARE

Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available. The boards use single or double-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple and possibly stacked shields may be individually addressable via an I^2C serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator or ceramic resonator. Some designs, such as the Lily Pad, run at 8 MHz and dispense with the onboard voltage regulator due to specific form-factor restrictions. Most Arduino boards consist of an Atmel 8-bit AVR microcontroller (ATmega8, ATmega168, ATmega328, ATmega1280, ATmega2560) with varying amounts of flash memory, pins, and features.

Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default bootloader of the Arduino UNO is the optibootbootloader. Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic levels and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to- serial adapter board or cable, Bluetooth or other methods. When used with traditional microcontroller tools, instead of the Arduino IDE, standard AVR in-system programming (ISP) programming is used.

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. Uno provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1-inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano, and Arduino-compatible Bare Bones Board and Boarduino boards may provide male header pins on the underside of the board that can plug into solderless breadboards.

There are several I/O digital and analog pins placed on the board which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pullup resistors are used in the board that limits the current exceeding from the given operating conditions. However, too much increase in current makes these resisters useless and damages the device.

SUMMARY

This chapter focus on the system requirements that are used to develop the proposed model. It has both hardware and software requirements that are used by the model.

IMPLEMENTATION

CHAPTER 7

IMPLEMENTATION

THERE ARE THREE MAIN MODULES IN OUR PROJECT

- Input Module: ESP32 is used with Light Dependent Resistor (LDR), tilt sensors, ultrasonic sensors, alcohol sensors, and GPS
- Processing Module:Utilizes the ESP32 microcontroller
- Output Module: Real-time voice alerts via Bluetooth, relays, or emergency messages sent through Telegram with GPS location data.

7.1 INPUT MODULE

- Various sensors are integrated to detect obstacles, motion, and environmental factors.
- **ESP32**: Functions as the core microcontroller for receiving and managing data.

- **ESP32 MICROCONTROLLER**

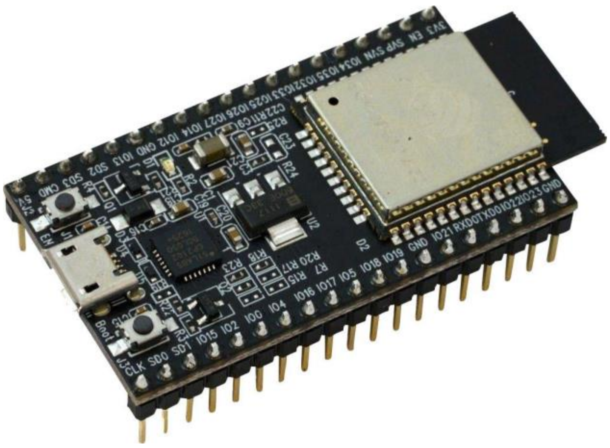


Fig 7.1 ESP32 Microcontroller

- The ESP32 is a compact microcontroller with Wi-Fi and Bluetooth capabilities.Equipped with dual-core processors running at 160–240 MHz, providing high performance for IoT applications.

- **Sensors**

Fig 7.2 Tilt sensors **Fig 7.3 Ultrasonic sensors**

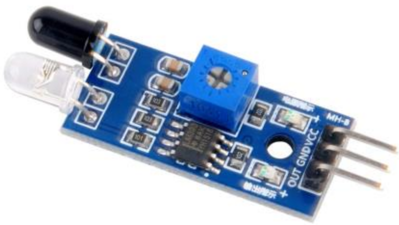


Fig 7.4 alcohol sensors **Fig 7.5 IR sensors**

- Resistor (IR): Detects ambient light levels to control headlights or other lighting systems.
- Tilt Sensors: Monitors changes in orientation to detect rollovers or accidents.
- Ultrasonic Sensors: Measures the distance to obstacles, enabling collision prevention.
- Alcohol Sensors: Detects alcohol concentration to prevent drunk driving.

7.2 PROCESSING MODULE

- The data collected by the sensors is processed by the **ESP32 microcontroller**.
- **Algorithms and Logic**:Obstacle detection and collision prevention algorithms.Anomaly detection based on accelerometer or gyroscope data.Environmental monitoring (e.g., analyzing temperature or humidity readings for

vehicle conditions).

- **Communication Protocols**: Data from sensors is processed using I2C, UART, or SPI communication protocols. The ESP32 ensures efficient processing with its dual-core architecture and low latency.
- **Software/Frameworks Used**:**Arduino IDE**: For programming the ESP32 with safety-specific algorithms.**Embedded Machine Learning** (optional): Lightweight ML models deployed on ESP32 to analyze sensor data more intelligently.

7.3 OUTPUT MODULE

- The **Output Module** integrates various mechanisms to ensure the driver and relevant stakeholders are alerted effectively about safety concerns. Output Mechanisms:
- **Real-Time Voice Alerts**: Delivered through Bluetooth-connected devices, providing immediate audio warnings for detected hazards.
- **Buzzer Alerts**: Emits distinct sound patterns to indicate: Proximity to obstacles, Alcohol detection, Vehicle tilt or rollover risk. Ensures the driver is alerted even in noisy environments.
- **Emergency Notifications:** Messages sent via Telegram including GPS location data for rapid communication with emergency contacts.
- **Relay-Based Actions:** Triggers specific vehicle responses, such as: Disabling the engine if alcohol is detected. Activating hazard lights in emergency situations.
- **Visual Alerts via LCD:**Displays real-time data such as: Distance to obstacles. Alcohol detection alerts. Tilt or orientation warnings. System status, including GPS and Bluetooth connectivity.
- **Communication and Interfaces:** Bluetooth and Buzzer: Provide both audio alerts for immediate attention.LCD:Complements audio alerts with detailed visual feedback. Telegram Integration: Ensures timely emergency messaging and location sharing.

7.4 CODE

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_ADXL345_U.h>
#include <WiFi.h>
#include <WiFiClientSecure.h>
#include <UniversalTelegramBot.h>
#include <ArduinoJson.h>

// LCD Configuration
LiquidCrystal_I2C lcd(0x27, 16, 2);

// Accelerometer Configuration
Adafruit_ADXL345_Unified accel = Adafruit_ADXL345_Unified();

// Motor Pins
int IN1 = 27;
int IN2 = 25;
int IN3 = 33;
int IN4 = 26;

// IR Sensor Pins
int IR1 = 4;
int IR2 = 5;
int IR3 = 14;

// Relay and Buzzer
int Relay1 = 15;
nt Buzzer = 32;

// Ultrasonic Sensor Pins
#define trigPin 18
```

```
#define echoPin 19

// Variables for Ultrasonic Sensor
long duration;
int distance;

// Wi-Fi and Telegram Configuration
const char* ssid = "Robot123";
onst char* password = "123456789";
#define BOTtoken "7763040771:AAE2kS6a0k2Fn1Vy4EjEKMjiMaIC0dNiejg"
#define CHAT_ID "6804694758"
WiFiClientSecure client;
UniversalTelegramBot bot(BOTtoken, client);

// Setup
void setup() {
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
pinMode(IR1, INPUT);
pinMode(IR2, INPUT);
pinMode(IR3, INPUT);
pinMode(IN1, OUTPUT);
pinMode(IN2, OUTPUT);
pinMode(IN3, OUTPUT);
pinMode(IN4, OUTPUT);
inMode(Relay1, OUTPUT);
pinMode(Buzzer, OUTPUT);
digitalWrite(Relay1, LOW);
digitalWrite(Buzzer, LOW);
digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
Serial.begin(9600);
```

```
Serial2.begin(9600);
lcd.init();
lcd.backlight();
lcd.clear();
lcd.print("Multifunctional");
lcd.setCursor(0, 1);
 lcd.print("    Robot...");
delay(1000);
if (!accel.begin()) {
Serial.println("No valid sensor found");
while (1);
}
WiFi.mode(WIFI_STA);
WiFi.begin(ssid, password);
client.setCACert(TELEGRAM_CERTIFICATE_ROOT);
while (WiFi.status() != WL_CONNECTED) {
Serial.print(".");
 delay(500);
}
bot.sendMessage(CHAT_ID, "Multi Functional Robot..");
delay(1000);
}

// Main Loop
void loop() {
FORWARD();
One_Handed();
Alcohol_Check();
LDR_Check();
Distance();
TILT_CHECK();
}

// Functions for Different Features
```

```
void One_Handed() {
if ((digitalRead(IR1) == HIGH && digitalRead(IR2) == LOW) ||
(digitalRead(IR1) == LOW && digitalRead(IR2) == HIGH)) {
lcd.clear();
lcd.print("One Handed");
lcd.setCursor(0, 1);
lcd.print("Detected");
bot.sendMessage(CHAT_ID, "One Handed Detected");

 BuzzerAlert();
}
 if (digitalRead(IR3) == LOW) {
lcd.clear();
lcd.print("Blind Spot");
lcd.setCursor(0, 1);
lcd.print("Detected");
 bot.sendMessage(CHAT_ID, "Blind Spot Detected");
 STOP();
BuzzerAlert();
}
}
void TILT_CHECK() {
sensors_event_t event;
accel.getEvent(&event);
float X_val = event.acceleration.x;
float Y_val = event.acceleration.y;
lcd.clear();
lcd.print("X:");
lcd.print(X_val);
lcd.setCursor(0, 1);
lcd.print("Y:");
lcd.print(Y_val);
delay(1000);
if (abs(X_val) > 3.5 || abs(Y_val) > 7.5) {
```

```
String message = (abs(X_val) > 3.5) ? "Tilt Detected" : "Accident Detected";
bot.sendMessage(CHAT_ID, message);
 BuzzerAlert();
STOP();
}
}
void Alcohol_Check() {
 int S_val = analogRead(36);
lcd.clear();
lcd.print("Alcohol:");
lcd.print(S_val);
delay(1000);
if (S_val > 2000) {
lcd.clear();
lcd.print("Alcohol Detected");
bot.sendMessage(CHAT_ID, "Alcohol Detected");
BuzzerAlert();
STOP();
}
}
void LDR_Check() {
int L_val = 4096 - analogRead(39);
lcd.clear();
lcd.print("LDR:");
lcd.print(L_val);
delay(1000);

if (L_val > 1000) {
lcd.clear();
lcd.print("High Beam");
lcd.setCursor(0, 1);
lcd.print("Detected");
bot.sendMessage(CHAT_ID, "High Beam Detected");
STOP();
```

```
digitalWrite(Relay1, HIGH);
delay(1000);
}
}
void Distance() {
digitalWrite(trigPin, LOW);
delayMicroseconds(5);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = duration * 0.034 / 2;
lcd.clear();
lcd.print("Distance:");
lcd.print(distance);
delay(500);
if (distance < 50) {
lcd.clear();
lcd.print("Object Detected");
bot.sendMessage(CHAT_ID, "Object Detected");
STOP();
 BuzzerAlert();
}
}
// Motor Control
void FORWARD() {
digitalWrite(IN1, HIGH);
digitalWrite(IN2, LOW);
digitalWrite(IN3, HIGH);
digitalWrite(IN4, LOW);
}
void STOP() {
 digitalWrite(IN1, LOW);
digitalWrite(IN2, LOW);
```

```
digitalWrite(IN3, LOW);
digitalWrite(IN4, LOW);
}
// Buzzer Alert
void BuzzerAlert() {
digitalWrite(Buzzer, HIGH);
delay(1000);
digitalWrite(Buzzer, LOW);
}
```

SUMMARY: This Chapter contains the implementation part. It also has the content related to implementation and analysis par

RESULTS

CHAPTER 8

RESULTS

As far as we know, ensuring vehicle safety is a critical challenge, especially for drivers in hazardous conditions. Many individuals must regularly travel on unpredictable terrains without advanced safety features, putting their lives at risk. Situations like impaired driving, proximity to obstacles, or unexpected mechanical issues can lead to accidents. We aimed to develop a device capable of addressing these concerns by integrating advanced sensing and alerting mechanisms.

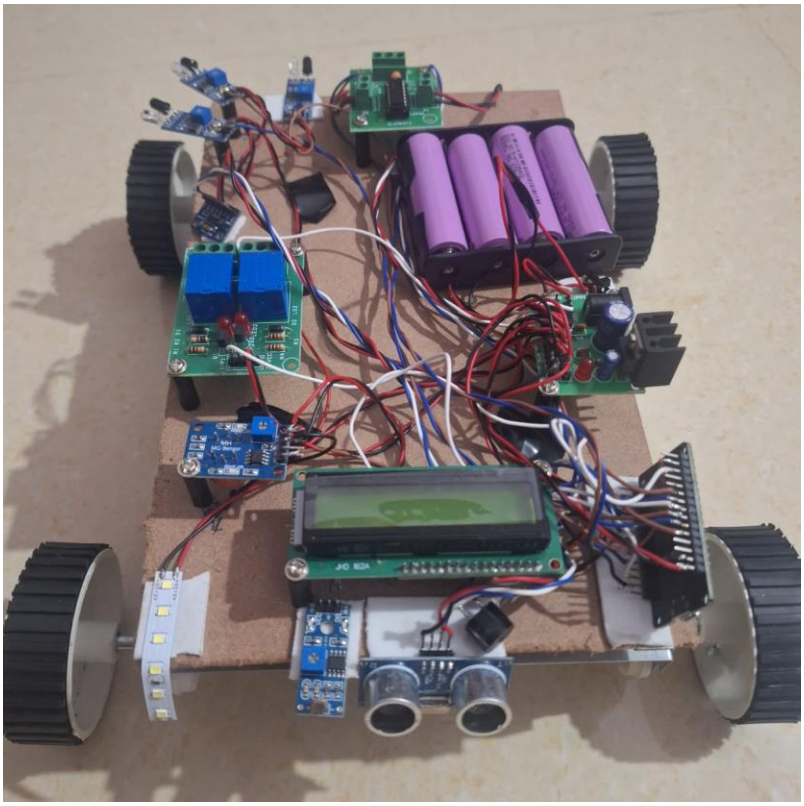


Fig 8.1 Representation of our Prototype Model

This model connects the hardware components with software written specifically for ESP32. The cooling system ensures operational efficiency, while the outputs provide real-time alerts to the driver and emergency contacts, if necessary. Preventing accidents and enhancing response time during critical situations were the primary motivations behind this design. The hardware setup includes:**ESP32 Microcontroller**: Serves as the core of the system, integrating multiple sensors.**Sensors**: Ultrasonic, alcohol, tilt, and IR sensors detect potential risks like obstacles, driver impairment, or vehicle tilt.**Outputs**: Alerts through buzzer, LCD display, Bluetooth voice prompts, and Telegram notifications with GPS data.

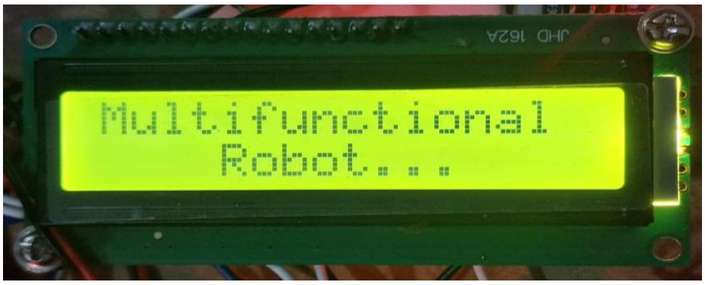


Fig 8.2. Setup Function

Fig 8.3. One-Handed Detection

Fig 8.4. Alcohol Detection

Fig 8.5. High-Beam Detection

Fig 8.6. Object Detection

Fig 8.7. Accident Detection

Fig 8.8. Tilt Detection

CONCLUSION

CONCLUSION

The designed model focuses on enhancing vehicle safety by utilizing ESP32 as the central control unit. The ESP32, a versatile microcontroller, integrates various sensors to monitor the environment and the driver's condition. Data collected from sensors, such as ultrasonic for obstacle detection, alcohol sensors for driver impairment, and accelerometers for tilt or accident detection, ensures comprehensive vehicle safety monitoring.The system processes this data to trigger appropriate actions. Alerts are displayed on an LCD, transmitted via Bluetooth voice prompts, and sent as real-time messages through Telegram, including GPS location data in emergencies. Relays and buzzers ensure immediate response mechanisms, enhancing the overall effectiveness of the system.Future improvements may include incorporating machine learning models for predictive analysis, night vision cameras for better visibility, and optimizing power consumption for extended operational reliability. The ultimate goal is to create a safer driving environment, reducing the risk of accidents and providing real-time support in critical scenarios

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