DUI MONITORING SYSTEM

A Project Report Submitted By

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Certificate

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Abstract

This project focuses on the development of the whole car accident detection, alcohol monitoring, and black box recording using the Raspberry Pi. It will provide safety regarding collision detection, driver sobriety checking, and events data recording and will be very useful for further investigation of the accidents. The accident is identified by the integrations of a gyroscope, accelerometer, and vibration sensor which are always monitoring the movement of the vehicle. A system triggers sudden orientation or changes in velocity as well as extreme vibrations. Simultaneously, an added critical context to accident data is achieved through temperature sensor's monitoring of the vehicle environment.

In the attempt to curb accidents brought about by impaired driving, the system uses an alcohol sensor for the intention of detecting the alcohol concentration in the driver's breath. If such detected level is above the legal limit, the system automatically acts in rendering the motor inoperable through the use of a motor controller, thus disabling the operation of the vehicle. On hitting, the system uses a module called GPS to capture the car's location and GSM for sending an auto SMS, including time and location details of the incident to emergency contact numbers.

The system can also act like a black box recorder that captures all the relevant data, such as speed of the vehicle, sensor readings, alcohol levels, and coordinates on GPS, in real time. The storage of all this data locally onto an SD card makes it worthwhile for usage in post-accident analysis and investigation. The embedding of various sensors and modules of communication within a cost-effective yet super-powerful platform like the Raspberry Pi brings an effective solution to accident prevention, real-time response, and enhanced post-crash investigation well within the realms of road safety and accountability regarding drivers.

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Introduction

1.1 General Introduction

The Driving Under the Influence monitoring system is an important tool designed to improve road safety and assist individuals who have been charged with impaired driving. The primary purpose of these systems is to reduce the likelihood of repeated offenses and ensure that offenders comply with legal requirements, such as attending rehabilitation programs or avoiding alcohol consumption. DUI monitoring systems utilize various methods, including breath analysers that measure blood alcohol content (BAC) and electronic monitoring devices like ankle bracelets that track sobriety and location. Regular check-in's with law enforcement or counsellors are also common practices to promote accountability among those being monitored. In addition to enhancing public safety, these systems play a critical role in supporting individuals rehabilitation efforts, as many people facing DUI charges struggle with alcohol or substance abuse. By requiring participation in counselling and therapy, the systems encourage self-reflection and help individuals develop coping strategies to avoid future offenses. Furthermore, DUI monitoring systems collect valuable data on patterns of alcohol use and risky behaviours, which can inform public policy and prevention strategies. This data helps authorities identify trends and implement targeted educational programs, making communities safer. For instance, if specific demographics are found to be at higher risk for DUI offenses, tailored interventions can be developed to address those groups effectively. Additionally, DUI monitoring systems can help lessen the burden on legal and healthcare systems, as they promote recovery and prevent repeat offenses, thereby decreasing the number of cases that require court intervention or emergency medical services due to accidents. However, implementing and maintaining these systems does come with challenges, including costs for technology and personnel, which should be addressed to ensure sustainability. Privacy concerns are also significant, as individuals under monitoring may feel that their rights are being infringed .Overall, DUI monitoring systems are crucial for enhancing road safety, supporting rehabilitation, and contributing to healthier communities. As communities continue to confront the challenges posed by impaired driving, these systems play a vital role in promoting public safety and accountability.

1.2 Aim

This project aims to design an integrated car accident detection system and alcohol monitoring that can enhance road safety. The crash detecting component automatically senses accidents and sends alerts to the emergency services or the contacts in charge for timely rescue. In view of such critical information being transmitted, such as location and gravity, the system delivers more effective response in cases of emergencies. The alcohol monitoring feature also continuously checks the driver's blood alcohol concentration, and once intoxication is detected, the system provides warnings or locks the vehicle to prevent operation. That has helped counteract the risk of accidents from impaired driving. The system thus proactively balances features toward road safety by lessening the chances of accidents, ensuring faster response in the event of its occurrence, and contributing to a safer driving environment by lowering the chances of fatalities on the road.

1.3 Objective/s

The project aims to develop a vehicle safety system using Raspberry Pi , integrating accident detection, alcohol monitoring, and black box data logging to enhance road safety.The objectives are as follows:
1. Accident Detection:: Utilize sensors to detect collisions and abnormal changes in vehicle orientation, sending emergency alerts with location data for quick assistance.
2. Alcohol Monitoring: Incorporating an alcohol sensor to detect the driver's blood alcohol content (BAC) levels, preventing vehicle ignition if the BAC exceeds the legal limit, thus promoting safe driving..
3. Black Box Logging: Record critical data such as speed and GPS coordinates to support accident analysis and incident reconstruction.Collecting and storing essential data to facilitate post-incident analysis and aid in investigations.
4. Real-Time Alerts and Notifications: Sending automated real-time notifications to emergency contacts and first responders upon accident detection, along with the vehicle's location coordinates, to enable timely assistance and potentially reduce accident-related fatalities.

1.4 Problem Formulation

The goal of project is to enhance car safety by detecting accidents and monitoring alcohol levels in drivers. It incorporates real-time detection, data recording, and

emergency response features.
1. High Accident Rates Due to Drunk Driving: Drunk driving is one of the major causes of road traffic accidents that kill and hurt people. There is a great demand for an integrated system that can detect and deter drunk drivers from driving.
2. Lack of Real-Time Accident Detection: Most cars fail to have an effective collision detection/accident system, leading to delayed response by emergency operators. This delays the performance or makes the impact of a collision worse.
3. Poor Emergency Alert Systems: There are very few automatic technologies embedded in most cars that will send an alarm instantly in case of a car accident to the given emergency contact or emergency services, making rescue work take longer time.
4.Limited Information on Environmental Aspect from Accident Data: There is no accident detection system that collects crucial environmental data relevant to accidents, such as temperature, that could be included in accident data to aid investigation.
5. Absence of Black Box Recorders in Cars: Most vehicles don't have black box systems, which can record data such as speed, sensor readings, and location before and after accidents. Thus, it is very challenging to analyze the causes of accidents accurately.
6. Costly Safety Solutions that are Available: Most of the accident detection and prevention technologies in the market are expensive and hence incapable of reaching into a vast number of vehicles, especially in the developing regions. There is a need for an affordable, scalable solution to comprehensive accident prevention as well as data recording.

1.5 Proposed Method/Technique

Using Raspberry Pi , the proposed system for car accident detection, alcohol monitoring, and black box recording, is an advanced solution designed to enhance road safety through real-time multi-functional monitoring, data logging, and communication. This is to prevent accidents resulting from driving while intoxicated by providing a great chance for timely intervention when the driver has reached the intoxicated point of driving, detecting collisions, and giving accurate post-accident data that will aid in investigations.
At the heart of the system is the MQ-3 alcohol sensor, which constantly checks for alcohol levels in the driver's breath. If the level is above the limit permissible by law, the system activates the L298N motor driver, which has been joined to the car's engine, hence stopping the car from starting. This ensures that a car is not

started by a drunk driver. This feature would actively reduce the possibility of accidents resulting from drunken driving, by tackling the issue at its root. Along with this, it supports a safer driving condition not only to the driver but also for the others on road.
In addition to alcohol detector, the system is also has accident detection features through various sensors: the gyroscope, accelerator, and vibration sensor. These sensors continuously monitor the vehicle's movements and could track any unusual change , such as a sudden deceleration or a sharp impact, which inform people that there is a collision. Once the occurrence of an accident has been determined, the system will then activate the black box recording function, capturing all necessary data including speed of the vehicle, alcohol levels, and GPS coordinates. This record is stored on a SD card and thus offers an entire recording of events prior to and post the accident which may be very helpful in the analysis of what happened post-accident and can help in deducting the cause of the crash.Another important component of this system is a SIM800L GSM module, which automatically sends an immediate GPS location of the vehicle. This will help provide assistance at the earliest possible instance, saving people's lives in accident-prone situations. Combining the features of alcohol detection, accident monitoring, recording of black box, and sending out emergency notification, this system represents an all-around approach that would enhance the safety of road vehicles. Using Raspberry Pi as the central processing unit means there is the required computing power for multiple sensors and communication modules. This system not only prevents accidents but also facilitates data collection for detailed post-accident investigations. Therefore, this system can be termed effective and practical in modern vehicles.

1.6 Methodology

Methodology for Design of an Integrated System for Monitoring DUI using the Raspberry Pi . Methodology refers to the fundamental activities that are undertaken in the development of a system. These include: system design, selection of components, implementation, and testing.

1.System Configuration and Structure : The backbone of the system is the Raspberry Pi , which serves as the central processing unit and orchestrates data collection, analysis, and response. It is connected to an array of sensors and modules that include an MQ-3 alcohol sensor, a gyroscope, an accelerometer, a vibration sensor, a GPS module, and a GSM module. These components connect to the Raspberry Pi via its GPIO pins, and data is transferred using various communication protocols like SPI, I2C, and UART. This setup allows seamless communication and efficient data handling, with each sensor feeding real-time data into the Raspberry Pi for monitoring, analysis, and action as needed. The Raspberry Pi runs a program, mostly in Python, continuously monitoring sensor reading and processing inputs to identify accidents, track alcohol levels, and record data.

2. Alcohol Detection Module: The MQ-3 alcohol sensor plays a crucial role in detecting alcohol impairment in the driver. It operates by measuring resistance changes in its sensor material when exposed to alcohol vapors, outputting an analog signal that corresponds to the alcohol concentration in the air. This analog output is converted to digital form using an Analog-to-Digital Converter (ADC) and then processed by the Raspberry Pi. If the alcohol level exceeds a pre-set threshold, which is based on legal standards for blood alcohol concentration, the system activates the L298N motor driver to cut off the vehicle's ignition. This effectively prevents the car from starting or being driven if the driver is impaired, ensuring that the vehicle remains stationary and enhancing road safety. In case a certain level of alcohol is found to be higher than a threshold value-this threshold has been determined in advance and relies on legal standards-the shutdown becomes safety-oriented through the L298N motor driver in order to deactivate the ignition of the vehicle so that the car will not start and cannot be taken on the road intoxicated. Simultaneously, the system captures concentration data regarding alcohol for further use.

3. Accident Detection Mechanism : To detect accidents reliably, the system uses a combination of gyroscope, accelerometer, and vibration sensors, each of which provides unique data on the vehicle's movement and orientation. The gyroscope measures the vehicle's angular position and rotation, detecting changes that might indicate a rollover. The accelerometer senses rapid shifts in speed, which could signify a sudden stop or impact. Meanwhile, the vibration sensor picks up intense vibrations characteristic of collision impacts. Together, these sensors allow the system to identify accident events by comparing data patterns and checking against preset thresholds, reducing the likelihood of false alarms and ensuring that only genuine accidents trigger an emergency response. All the data is collected and then processed through the Raspberry Pi and cross-checked with all the inputs by the sensors to ensure accuracy. When an accident is confirmed, the system goes into emergency mode.

4. Data Logging Functionality and Black Box Functionality: One of the system's key features is its blackbox functionality, which provides a continuous and detailed record of vehicle data. The system logs real-time readings such as alcohol levels, vehicle speed, GPS coordinates, and sensor data from the gyroscope, accelerometer, and vibration sensors onto an SD card. This data storage occurs in real time and creates a precise timeline of the vehicle's status before, during, and after an accident. In the event of a collision, this black box data can be invaluable for investigators, helping to reconstruct the events leading up to the accident and offering insight into the driver's condition and vehicle dynamics at the time of the incident. This information may be vital for the post-accident inquiry so as to help identify the cause of the accident and the condition of the driver.

5. Emergency Notification System: Upon detecting an accident, the system initiates its emergency notification protocol using the SIM800L GSM module. The module connects to a mobile network and sends an SMS alert to pre-configured emergency contacts, which may include family members or emergency services. The message contains vital information such as the exact GPS location of the accident, the time it occurred, and a summary of sensor data that helps explain what happened. This ensures that responders receive accurate and timely information, allowing them to locate the vehicle quickly and assess the severity of the accident based on the system's analysis.

6. GPS Tracking and Location: The GPS module tracks the vehicle's position continuously, which is critical both for accident response and for creating a log of the vehicle's movements. The module regularly records the vehicle's coordinates, which are stored as part of the blackbox data. During an accident, the GPS provides the system with real-time location data, which is included in the emergency SMS notification. This enables a rapid response, helping emergency teams locate the vehicle efficiently. Furthermore, tracking the vehicle's movements over time can offer insights into driving patterns and potentially hazardous locations where incidents are more likely to occur.

7. Power Managementfor Reliability: To maintain stability, the system incorporates an LM2596 buck converter to regulate power levels. This converter ensures a consistent 5V supply to the Raspberry Pi and connected sensors, even if the vehicle's power fluctuates or is disrupted during a collision. The primary power source is the vehicle's battery, which is stepped down to the required levels to prevent overheating or power surges. This reliable power setup allows the system to remain operational under all conditions, maintaining critical functionalities such as accident detection, data logging, and emergency communication without interruption.

8. Integration and Testing: After assembling and wiring all sensors, modules, and motor control mechanisms to the Raspberry Pi, the system undergoes rigorous integration testing to ensure that each component functions as intended. Testing is performed in both controlled environments and simulated scenarios that mimic real-world conditions, such as alcohol presence, abrupt stops, and low-speed impacts, to confirm that the system accurately detects alcohol levels, identifies accident conditions, and sends emergency notifications reliably. Data logging is also verified to ensure no delays or data loss. This comprehensive testing process validates that the system can perform robustly in live conditions, ensuring accurate and timely responses to various situations on the road.

1.7 Literature Survey

Kattukkaran, N. A. George, and T.M. Haridas. [1] describe in their paper “Intelligent Accident Detection and Alert system for Emergency medical Assistance” to alert the nearby medical center about the accident to provide immediate medical aid. The attached accelerometer in the vehicle senses the tilt of the vehicle and the heartbeat sensor on the user’s body senses the abnormality of the heartbeat to understand the seriousness of the accident.

L.Dae Geun, J. Se Myoung, L. Myoung Seob. [2] describe in their paper " System on Chip design of Embedded Controller for Car Black Box " a system aims to analyze the cause of accidents like an airplane black box. This paper proposes a model of a car black box system which can be installed in the cars. The aim of this paper is to achieve accident analysis by tracking the working process of vehicles. In addition to this, the car black box system sends an alert message to the user mobile which is connected through Bluetooth module.

Abdallah Kassem, Rabih Jabr, Ghady Salamouni, Ziad Khairallah Maalouf. [3] describe in their paper “Vehicle Blackbox system”, the system aims to develop a prototype of the Vehicle Black Box System VBBS that can be installed into any vehicle all over the world. This prototype can be designed with minimum number of circuits. The VBBS can contribute to constructing safer vehicles, improving the treatment of crash victims, helping insurance companies with their vehicle crash investigations, and enhancing road status to decrease the death rate.

Akshay Agrawal,Anand Khinvasara, Mitali Bhokare, Sumit Kaulkar, Y.K. Sharma. [4] describe in their paper “Accident Detection System Application” the proposed system aims to alert people in and around the occupant of the vehicle about the accident so that they can provide immediate medical attention and also give the facility to make the vehicle start or stop in case of theft.

The work of Parveen N Ali and Ali A. [5] in “IOT Based Automatic Vehicle Accident Alert System” outlines to try and contribute in that location of generation. Here we are seeking to stumble on accident through the Accelerometer as it facilitates in identifying the vicinity and if the values of parameters are extra than the defined values than it’s going to set situation to proper and the code written for initiating the intimation and SMS alert gets executed.

The work of Manuel Fogue, Piedad Garrido, Francisco J. Martinez, Juan-Carlos

Cano, Carlos T. Calafate, and Pietro Manzoni. [6] in “Automatic Accident Detection” outlines the proposed system requires each vehicle to be endowed with an onboard unit (OBU) responsible for detecting and reporting accident situations to an external control unit (CU) that estimates its severity, allocating the necessary resources for the rescue operation.

The work of Varsha Goud, and V Padmaja. [7] in “Traffic accident automatic detection and remote alarm device” outlines the system meets with an accident immediately Vibration sensor will detect the signal or if a car rolls over, and Micro electromechanical system (MEMS) sensor will detect the signal and sends it to ARM controller. Microcontroller sends the alert message through the GSM MODEM including the location to police control room or a rescue team. So, the police can immediately trace the location through the GPS MODEM, after receiving the information.

Purva Javale, Shalmali Gadgil, Chinmay Bhargave, Yogesh Kharwandikar, Vaishali Nandedkar, [8] present an innovative approach in “Accident Detection and Surveillance System using Wireless Technologies”, a system prototype especially designed to detect and provide faster assistance to traffic accident victims. The proposed system requires each vehicle to be endowed with a control unit (CU) responsible for detecting accident and onboard unit (OBU) reporting accident location for providing the necessary resources for the rescue operation.

“Vehicle Accident Detection and Reporting System Using GPS and GSM” by Aboli Ravindra Wakure, Apurv rajendra Patkar. [9] describes the system can use Accelerometer sensor in car security system to sense vibrations in vehicle and GPS to give location of vehicle, so dangerous driving can be detected. When accident occurs, Accelerometer will detect signal and will send signal to AVR controller, microcontroller will enable airbag to blow and message with accident location is sent to preprogrammed numbers.

"Automatic Accident Detection and Reporting Framework for Two Wheelers" by Amit Meena, Srikrishna Iyer, Monika Nimje, Saket JogJekar, Sachin Jagtap, Mujeeb Rahman. [10] is to design a prototype and a simulation of an ADAS and verify its effectiveness on the road. The proposed system deals with the detection of the accidents. But this can be extended by providing medication to the victims at the accident spot.

The novel invention, DUI Monitoring system from Raspberry Pi , varies from most other models available in the market since it offers a holistic and comprehensive solution by packaging many crucial functions under one platform. Currently, most of the stand-alone features commercially sold in the market, such as accident detection systems or alcohol monitoring systems, can be integrated in this system and so effectively make the vehicles better in safety conditions in use.

As for its development, this system is built on an open-source Raspberry Pi platform, thereby giving maximum flexibilities to allow users to change and adapt it according to specific needs. Proprietary solutions are less flexible. Proprietary systems are rigid, and so proprietary solutions usually lack flexibility due to the strict nature of proprietary systems. In continuously monitoring levels of alcohol in the driver's blood, the system employs MQ-3 alcohol sensor, thus not letting the vehicle start if there is enough alcohol in his or her body to be beyond the legal limit and, hence, address drunk-driving.
Apart from that, the system utilizes a set of sensors, such as a gyroscope, an accelerometer, and a vibration sensor to track vehicle movement and accident cases. In determining the occurrence of an accident or not, it stores the important data on the SD card, such as the GPS coordinates, speed of the vehicle, and alcohol level. This black box functionality provides important information in analysis after the accident has happened, and this helps understand what led to the occurrence.
In addition, the system features alert notification provision through the SIM800L GSM module, which provides real-time alerts to specified contacts to follow up whenever the situation calls for this action. This mechanism incorporates speed responses and thus creates added value in the effectiveness of the system.

1.8 Organization of the Report

- Chapter 1 explains about aim, objectives, methodology and literature survey of the project.
- Chapter 2 briefs about implementation of the project using block diagram and Circuit Diagram.
- Chapter 3 discusses the basic hardware and software requirements and basic services.
- Chapter 4 discusses the configuration of various hardware and software tools and its implementation.
- Chapter 5 gives an overview of the observed testing and results.
- Chapter 6 discusses the conclusions and future scope of the project.

Chapter 2
Block Diagram and Circuit Diagram

2.1 Block Diagram

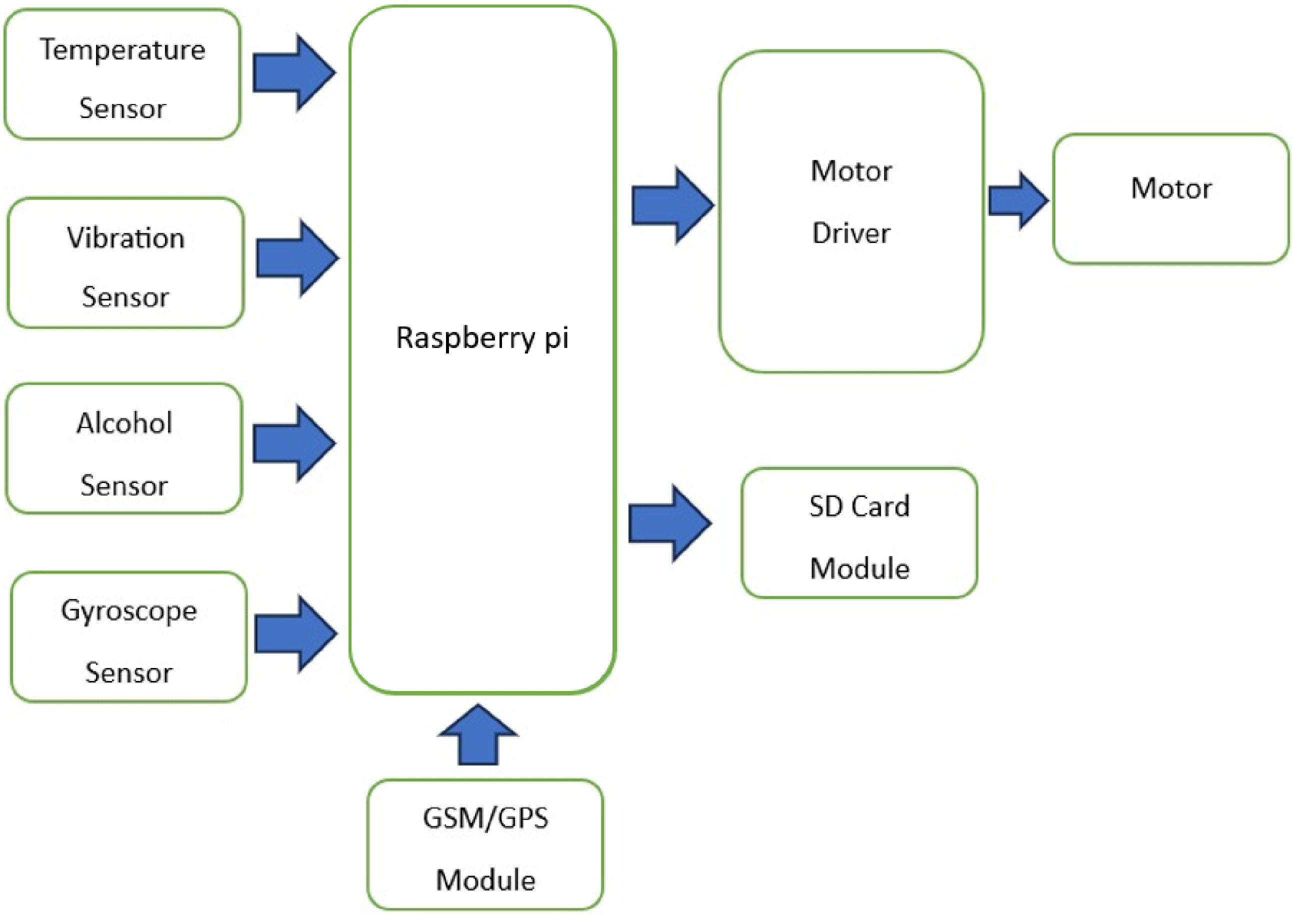

Figure 2.1: Block Diagram

2.1.1 Block Diagram Description

The block diagram of DUI monitoring system is as shown in figure 2.1.The DUI Monitoring System is an innovative safety solution that seeks to prevent incidents involving accidents resulting from drunkenness. It couples a suite of sensors and communication modules in order to monitor the state of the driver and dynamics in the car in real time. The central sensing element is the

alcohol sensor, which senses breath alcohol levels in the driver. If the levels detected exceed a threshold predefined, then the system converts them into a safety measure. or instance, it could prevent the starting of a vehicle or alert people.
Accompanied with this, a vibration sensor and a gyroscope sensor track the movement and orientation of the vehicle that notices whether the vehicle might erratically be driven, like making extreme turns or swiveling abruptly. These sensors help detect the warning signs of whether someone drives drowsily and ensure that there is an immediate response in case of such warning signs. In addition, there could be a temperature sensor to monitor a driver's body temperature or the environment around the vehicle, which increases the safety measure further.
The system is equipped with a GSM/GPS module to allow real-time location tracking and possible communication in the event that some form of intoxicated or dangerous driving is detected; it will automatically dial or SMS emergency contact or authorities for quick response. All sensor data are stored in an SD card module for further analysis or reporting purposes. The system can even activate the motor control unit that immobilizes the car to prevent further danger if even intoxication is identified. DUI Monitoring System In this way, the monitoring system for drunk driving offers an all-round proactive approach to road safety and protects drivers, as well as other road users, from drunk driving danger.

2.1.2 Working

1.Temperature Sensor A temperature sensor records the temperature of the ambient surroundings. In this system, the temperature sensor collects real-time data regarding temperature and sends it to the Raspberry Pi for processing. Temperature sensors can be found on different principles, including thermistors or thermocouples, which measure temperature based on variations in resistance or voltage. The Raspberry Pi can read data from the temperature sensor and also trigger specific actions by predefined thresholds. For instance, if the temperature exceeds a certain limit, the system might shut down the motor or activate cooling mechanisms.
2.Vibration Sensor A vibration sensor can detect mechanical vibrations, which can in turn indicate movement or abnormal conditions such as shaking or tremors. This sensor is useful where machinery or vehicles must be monitored for safety purposes. Vibration sensors often employ piezoelectric materials. Piezoelectric materials produce electrical charges whenever they are

subjected to mechanical stress. The signal is proportional to the intensity of the vibration The Raspberry Pi records data on the vibration that occurs in the system to monitor the stability. Once it detects that the system is generating strange vibrations, the system may send a notification to the user or can halt specific processes to prevent further damage.

3.Alcohol Sensor The alcohol sensor detects the alcohol around the surrounding environment. Such sensors are mainly used in breath analyzers or safety systems within a vehicle and inhibit the drunk driving. Alcohol sensors use semiconductor materials that change resistance in response to alcohol vapors. The varied resistance is then converted into an output readable by the Raspberry Pi.Whenever the Raspberry Pi detects alcohol, the motor driver can make the motor malfunction thus, not allowing a vehicle or machine to operate in the presence of alcohol.

4.Gyroscope Sensor A gyroscope sensor is used to determine the orientation and angular velocity of an object, thus it forms a very important component of systems that require information of rotation or tilt. Modern gyroscopes use the principles of angular momentum for detecting changes in orientation. With most gyroscopes currently being MEMS-based (Micro-Electro-Mechanical Systems), they work with vibrating elements to measure angular velocity The Raspberry Pi can make use of the gyroscope data to maintain balance or monitor the movement of a system. That is, it will be of great use in robotics, drones, or a vehicle to avoid tipping over or extreme rotation.

5. Raspberry Pi The Raspberry Pi is a small, affordable single-board computer which acts as the brain of the system, processing the inputs coming from various sensors and modules, making decisions based on programmed algorithms, and controlling the outputs. Raspberry Pi runs an operating system and interfaces with the sensors via GPIO (General Purpose Input/Output) pins. It processes the data from sensors using Python or other programming languages. The Raspberry Pi of this system accumulates all sensor data, namely temperature, vibration, alcohol, and gyroscope, and makes decisions based on preconditions and controls all the outputs like motor, GSM/GPS module, and SD card module. The GSM/GPS module also facilitates communication between the system and the users or external systems.

6.Motor Driver A motor driver is an electronic component that regulates the function of motors. It amplifies low-power signals coming from the Raspberry Pi in order to drive a high-power motor in the circuit. It uses H-bridge circuits typically when controlling the speed and direction of the motor. This allows the motor to be propelled forward or backward by the way the applied voltage is controlled. Here, the signals from the control to the motor driver are forwarded by the Raspberry Pi, which controls the running of the motor based on the outputs of the sensor. For instance, after alcohol has been detected, the Raspberry Pi can make a signal to the motor driver to prevent the motor from keeping on working.

7.Motor The motor is an integral component of this system, used to drive mechanical parts. This could even be an electrical motor which automatically controls either the vehicle, a robotic arm, or machinery Electric motors convert electrical energy into mechanical motion by generating torque through the interaction of magnetic fields.The motor gets power and control signals from the motor driver. According to the conditions of the system, such as temperature, vibration, or alcohol detection, the Raspberry Pi can send ON/OFF signals or control speed to the motor.

8.SD Card Module Another storage capacity of the Raspberry Pi is offered by an SD card module. It is used for data collection from the sensors or system operation logs.SD cards make use of NAND flash memory for storing data. The Raspberry Pi writes data to the SD card module through SPI (Serial Peripheral Interface). In this system, the Raspberry Pi uses the SD card module for recording sensor data for future analysis. The configuration files or to log events like vibration detection or temperature spike are also stored.

9.GSM/GPS Module The GSM and GPS module is utilized for communication purposes, including location tracking. The system alert is possible either by SMS or a track of its position, GSM module connects a SIM card to the phone networks; hence, data can be transmitted over the cell phone either over the SMS or via the internet. The GPS module utilizes the signals coming from the satellites to trace the particular position of the system.GSM module is used for transmission of alerts in case the conditions are found true such as alcohol detection, over required vibration, or high temperature. GPS module is used in the system, wherein in cases of car or in moving systems, it would be highly fruitful.

2.2 Circuit Diagram

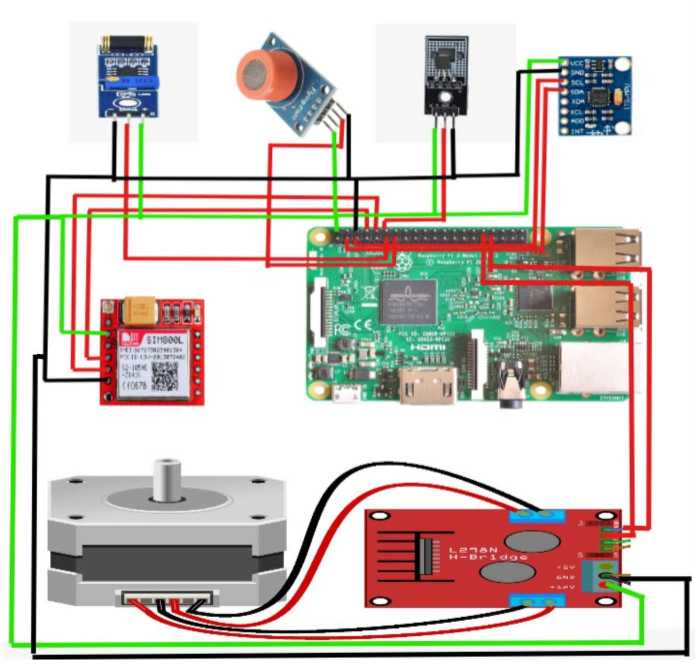

Figure 2.2: Circuit Diagram

The circuit diagram in figure 2.2 , showcases an integrated system for car accident detection, alcohol monitoring, and black box functionality using Raspberry Pi . The Alcohol Sensor detects the driver's breath alcohol levels and sends an output to the Raspberry Pi, which can help prevent driving under the influence. The accelerometer and gyroscope sensor monitors sudden movements, changes in orientation, or impact forces that may indicate a collision, and communicates this data via the I2C interface. A GPS module provides real-time location data, crucial enables stepper motor and motor driver module may be used to immobilize the vehicle if alcohol is detected above a safe level. The Raspberry Pi acts as the central control unit, processing data from sensors and managing communications, with all components powered and grounded through shared VCC and GND connections. This system is designed to enhance road safety by detecting potential accidents, monitoring driver sobriety, and facilitating quick response in emergency situations.

Chapter 3
System Requirements

3.1 Hardware Requirements

3.1.1 Raspberry pi

The snapshot of Raspberry pi is as shown in figure 3.1, It is faster in performance and more versatile for a wide range of applications, highly upgraded from its predecessors with higher memory, a powerful processor, and an increased ability to use it for simple coding, complex computing projects, and so on. Notably, the Raspberry Pi supports dual 4K displays, rich multimedia experiences, and options for advanced connectivity such as Wi-Fi 6 and Gigabit Ethernet for fast networking. Its popularity with educators, hobbyists, and professionals has found it a perfect place to start experimenting with computing, robotics, and IoT-related things.

Figure 3.1: Raspberry pi

Features:

1. Processor: 1.5GHz quad-core ARM Cortex-A72 (64-bit).
2. RAM: Options of 2GB, 4GB, and 8GB LPDDR4.
3. Storage: MicroSD card slot for storage.
4. Networking: Gigabit Ethernet, dual-band 2.4GHz/5.0GHz Wi-Fi.
5. USB Ports: 2 USB 3.0, 2 USB 2.0 ports.
6. Video Output: Dual micro-HDMI ports supporting up to 4K displays.

7. Power Supply: USB-C for 5V/3A power input.
8. GPIO Pins: 40-pin GPIO for hardware interfacing.

3.1.2 Temperature sensor

The snapshot of Temperature sensor is as shown in figure 3.2, The temperature sensor is a sensor device that measures the temperature of an object or environment. The temperature variations are converted to electrical signals, readable and interpretable, by a microcontroller or computer. Temperature sensors are very widely used in applications involving HVAC systems, weather stations, industrial processes, and consumer electronics. They can be analog or digital and can have their output used in real-time monitoring, control, or logging of temperature data. Due to the need for accuracy in measurement and control of temperature, temperature sensors form crucial parts in a wide variety of systems.

Figure 3.2: Temperature sensor

Features:

1. Measurement Range: Typically -55°C to +125°C for wide application.
2. Accuracy: ±0.5°C for reliable readings in various conditions.
3. Resolution: 0.1°C for precise temperature measurements.
4. Response Time: Fast response time of 1 second for quick updates.
5. Power Supply: Operates at 3.0V to 5.5V for compatibility with microcontrollers.
6. Output Type: Digital output (I2C or SPI) for easy integration with devices.
7. Operating Humidity: Can operate in 0 to 100 percent relative humidity for versatile use.

8. Package Type: Available in a compact surface-mount or through-hole package for easy mounting.

3.1.3 Vibration sensor

The snapshot of Vibration sensor is as shown in figure 3.3, The vibration sensor is one device that can detect and measure the vibrations in an object or along the surface. These sensors usually convert the mechanical vibration into an electrical signal, and this electrical signal can be further processed for monitoring the performance of equipment and for detecting imbalances, thus predicting the maintenance requirement. Vibration sensors find applications in monitoring industrial machinery, structural health, and even consumer electronics. It plays an important role in preventive maintenance and condition monitoring by providing real-time information concerning the health of machines and structures.

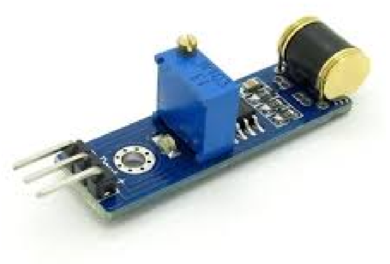

Figure 3.3: Vibration sensor

Features:

1. Measurement Range: Typically 0 to 10 g (acceleration) for general applications.
2. Sensitivity: Sensitivity of 100 mV/g for accurate detection of vibrations.
3. Frequency Range: Operates in a frequency range of 1 Hz to 1 kHz for diverse monitoring.
4. Output Type: Analog output (voltage or current) for easy integration with data acquisition systems.
5. Power Supply: Requires a power supply of 3V to 5V for low-power applications.
6. Operating Temperature: Functional within -40°C to +85°C for harsh environments.

7. Mounting Type: Available in adhesive or screw-mount options for flexible installation.

8. Shock Rating: Shock resistance of up to 1000 g to withstand extreme conditions.

3.1.4 Gyroscope sensor

The snapshot of Gyroscope sensor is as shown in figure 3.4,The gyroscope sensor is basically an electronic device used to monitor angular velocity as well as orientation in a three-dimensional space. It works based on the concepts of angular momentum, detecting variations in rotational motion. All these applications have utilized inertial navigation systems in aircraft and spacecraft, thus maintaining accurate orientation. Gyroscopes have also helped consumer electronics, including smartphones and gaming controllers, through their function of motion sensing and stabilization. In robotics, they provide balance and control, whereas on the automobile globe, they stabilize vehicles.

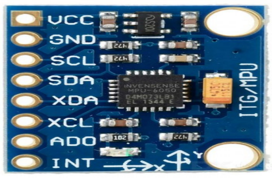

Figure 3.4: Gyroscope sensor

Features:

1. Measurement Range: Typically measures angular velocity from ±250°/s to ±2000°/s for versatile applications.

2. Output Type: Provides digital output (I2C or SPI) for seamless integration with micro controllers and processors.

3. Sensitivity: High sensitivity of 16 LSB/s for accurate detection of slight movements.

4. Power Supply Voltage: Operates within a voltage range of 2.5V to 5.5V for compatibility with various devices.

5. Temperature Range: Functional in a temperature range of -40°C to +85°C for reliable performance in diverse environments.

6. Size and Package: Available in compact surface-mount or through-hole packages for easy integration into designs.

7. Low Noise: Features low noise density, typically around 0.01, ensuring stable readings.
8. Integrated Features: Often includes built-in accelerometer functionality for comprehensive motion sensing.

3.1.5 GSM Module

The snapshot of GSM Module is as shown in figure 3.5,The GSM module can be described as an integral component of communication systems, which make a device connect to a mobile network where it can send and receive data. It acts as a bridge, creating an interface between a device and a GSM network, making it possible for mobile communication through SMS, voice calls, and data transmission. The applications of a GSM module include devices of remote monitoring system, IoT devices, home automation, and GPS tracking systems among many others. They support functionalities like SMS, mobile data communication and sometimes even more features like location tracking. A GSM module can find its application in many modern wireless communication systems primarily due to the feature that helps it operate on a multitude of environments and easily integrate with microcontrollers.

Figure 3.5: GSM Module

Features:

1. Communication Protocol: Supports GSM and GPRS protocols for wireless communication.
2. Frequency Bands: Operates on 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz for global coverage.
3. Power Supply: Requires a power supply of 3.4V to 4.4V for operation.
4. Data Rate: Offers data rates up to 85.6 kbps for efficient data transmission.

5. Interface: Uses UART for easy communication with microcontrollers.
6. Antenna Support: Features external antenna support for enhanced signal strength.
7. Temperature Range: Functions effectively in temperatures from -20°C to +70°C.
8. SIM Compatibility: Compatible with standard SIM cards for mobile network access.

3.1.6 SD Card Module

The snapshot of SD Card Module is as shown in figure 3.6, An SD card module is an interface that joins a microcontroller with Secure Digital or SD cards for the storage and retrieval of data in electronic projects. It facilitates direct access to external storage by microcontrollers and other embedded systems, making it very ideal for large-scale data storage applications such as data logging, audio and video recording, and also file management. This module generally contains a socket for the SD card, level shifting circuitry that may be required for different voltage levels compatibility and a simple interface for communication, which is usually taken as SPI or Serial Peripheral Interface. SD card modules are highly popular in Arduino projects, Raspberry Pi applications, and other DIY electronics. The great advantage of these modules is that they let users easily attach removable storage to their systems.

Figure 3.6: SD card Module

Features:

1. Interface Type: Utilizes SPI (Serial Peripheral Interface) for efficient data communication.
2. Voltage Compatibility: Operates at 3.3V to 5V for compatibility with various microcontrollers.

3. Card Type Support: Compatible with standard SD, SDHC, and SDXC cards for flexible storage options.
4. Storage Capacity: Supports storage capacities ranging from a few megabytes up to 2TB.
5. Data Transfer Rate: Offers data transfer rates of up to 25 MB/s, depending on the card used.
6. File System Compatibility: Works with FAT16 and FAT32 file systems for easy file management.
7. LED Indicator: Includes an onboard LED indicator to show read/write activity for user feedback.
8. Compact Design: Typically features a small form factor for easy integration into various projects.

3.1.7 Alcohol Sensor

The snapshot of Alcohol sensor is as shown in figure 3.7,An alcohol sensor is an apparatus constructed to detect alcohol vapor in the air. An alcohol sensor generally functions based on the working principle of measuring the change in resistance caused by an alcohol molecule's interaction with the sensing material. An alcohol sensor is utilized in automobile breathalyzer systems for safe driving as well as within the workplace environment when checking the sobriety of employees.

Figure 3.7: Alcohol sensor

Features:

1. Detection Range: Detects blood alcohol concentration (BAC) from 0.00 percent to 0.40 percent
2. Response Time: Provides a fast response time of approximately 1-2 seconds.

3. Output Type: Features analog or digital output for easy microcontroller integration.
4. Operating Voltage: Operates within a voltage range of 3.3V to 5V.
5. Temperature Range: Functions effectively between -10°C and +50°C.
6. Sensitivity: High sensitivity to alcohol vapors for accurate low concentration detection.
7. Calibration: Requires periodic calibration to maintain accurate readings.
8. Compact Size: Designed in a small form factor for easy integration into portable devices.

3.1.8 Buck converter power supply module

The snapshot of Buck converter power supply module is as shown in figure 3.8 ,A compact voltage converter module LM2596 buck converter power supply module steps down voltage from a higher level to a lower level. It provides high efficiency and can be used for conversions from a variety of input voltages to a desired output voltage for powering micro controllers, sensors, and other electronic devices. The buck converter has switching operation, and therefore it doesn't produce excessive heat but instead very efficiently converts power.

Figure 3.8: Buck converter power supply module

Features:

1. Input Voltage Range: Accepts input voltages from 4.5V to 40V.
2. Output Voltage: Adjustable output voltage ranging from 1.25V to 37V.
3. Output Current: Delivers up to 3A of continuous output current.
4. Efficiency: High efficiency of up to 92 percent for minimal heat generation.

5. Switching Frequency: Operates at a switching frequency of 150 kHz.
6. Thermal Protection: Features built-in thermal shutdown and over current protection.
7. Compact Design: Small form factor for easy integration into projects.
8. Indicator LED: Includes an LED indicator to show power status

3.1.9 Motor driver

The snapshot of Motor driver is as shown in figure 3.9,The L298N motor driver is actually a dual H-bridge IC. Thus, it has the capability of applying currents to DC motors, stepper motors, and other types of motors. It is fairly flexible in the approach, meaning the driver will let control signals go both forward and backwards. Further, it's for applications that involve heavy loads by currents, such as robotics and automation; the maximum rating per channel is 2A. It is always supplied with supplementary circuitry, including protection diodes against voltage spikes when the motors are turned on or off. .

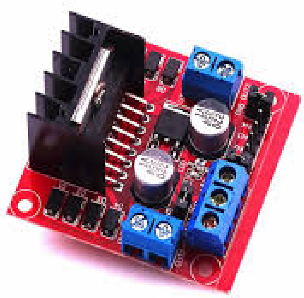

Figure 3.9: Motor driver

Features:

1. Dual H-Bridge: Controls two DC motors or one stepper motor simultaneously.
2. Operating Voltage: Supports a wide operating voltage range from 5V to 35V.
3. Output Current: Capable of driving up to 2A per channel for robust motor control.
4. Control Interface: Compatible with TTL logic levels for easy interfacing with micro controllers.

5. Switching Frequency: Operates at a switching frequency of up to 25 kHz for efficient control.

6. Thermal Shutdown: Features built-in thermal protection to prevent overheating during operation.

7. LED Indicators: Equipped with LED indicators for motor direction and status.

8. Protection Diodes: Includes protection diodes to safeguard against voltage spikes.

3.1.10 GPS Module

The snapshot of GPS Module is as shown in figure 3.10, The GPS module plays a critical role in applications requiring real-time location tracking. In vehicles, it helps monitor movement, enabling the system to track speed, direction, and position with high accuracy. When integrated with other systems like accident detection, the GPS module provides vital data about the vehicle's location at the moment of an incident, allowing responders to locate the vehicle quickly. In addition to tracking, it can be used in various systems that require geolocation data for navigation, mapping, and route optimization.

Figure 3.10: GPS module

Features:

1. High Sensitivity: This is capable of detection of weak signals from a satellite for the mean accurate positioning.

2. Fast TTFF: When on, this calculates position quickly and hence can be on within a short time after it is turned on.

3. Supports Multi-Satellite: The receiver can work with GPS, GLONASS, among other satellites.
4. Compact Design: This is thin and light, making it easier to integrate.
5. Low Power Consumption: Consumes less power for implementations that require battery use.
6. Accurate Positioning: Gives an accuracy of 2 to 5 meters in location.Uses NMEA protocol in data output.
7. Built-in Antenna: It has an internal antenna for reliable signal reception.

3.2 Software Requirements

3.2.1 Thonny

The snapshot of Thonny is as shown in figure 3.11, Thonny is an integrated development environment especially designed to go the extra mile for beginners in Python programming. Very intuitive and accessible- so much so that it's very possible for users to write and run scripts using Python without all the mumbo-jumbo that most advanced IDEs throw their way. Thonny has a Python interpreter, allowing the user to run the code directly and see the output right away.

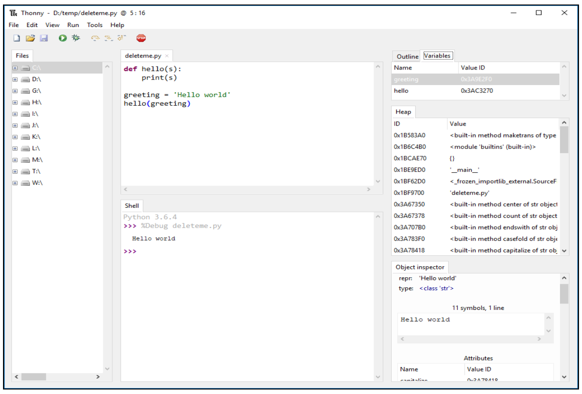

Figure 3.11: Thonny

Features:

1. User-Friendly Interface: Simple and intuitive design suitable for beginners.
2. Integrated Debugger: Built-in debugger for stepping through code execution.

3. Variable Explorer: Visualizes variables and their values during execution.
4. Code Completion: Smart code completion for efficient coding.
5. Python Environment Management: Supports multiple Python versions and virtual environments.
6. Package Management: Integrated package manager for easy library installation.
7. Interactive Shell: Real-time interactive shell for testing code snippets.
8. Cross-Platform Compatibility: Works on Windows, macOS, and Linux.

3.2.2 Real VNC Server

The snapshot of Real VNC Server is as shown in figure 3.12, Real VNC Server is a multi-featured remote access utility to control computers from afar using Virtual Network Computing technology.It provides the facility of sharing remote computers or devices in order to operate them as if the user were sitting on their desk. A wide range of operating systems, such as Windows, macOS, Linux, and Raspberry Pi, make this software highly flexible and compatible for numerous applications. It has strong security features, like encrypted connections, which prevent unauthorized access to protect the remote sessions, which are considered private and secure.

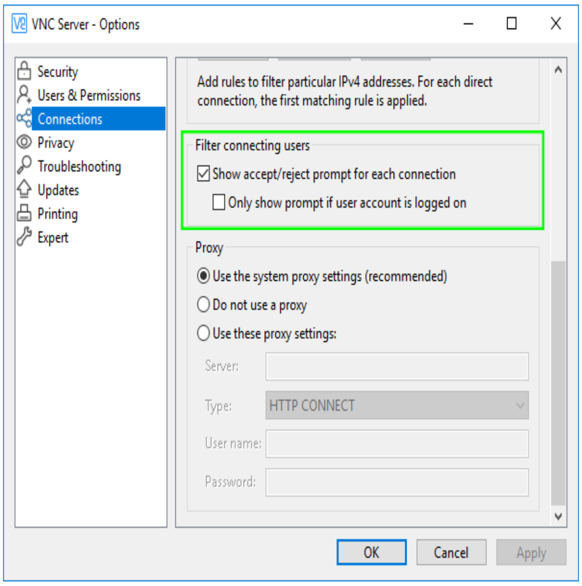

Figure 3.12: Real VNC Server

Features:

1. Remote Access: Enables secure remote access to desktops and devices from anywhere.
2. Cross-Platform Support: Works on multiple operating systems, including Windows, macOS, and Linux.
3. Encryption: Uses AES-256 encryption for secure data transmission.
4. User Management: Supports multiple user accounts with customizable permission settings.
5. File Transfer: Allows easy file transfer between remote and local machines.
6. Session Recording: Provides the option to record remote sessions for review.
7. Multi-Display Support: Supports access to multiple monitors on remote systems.
8. Customizable Settings: Offers configurable options for performance and security.

3.2.3 PuTTY Software

The snapshot of PuTTY is as shown in figure 3.13,PuTTY is an open-source software tool for terminal emulation, serial console, and network file transfer. It primarily acts as a client for remote access protocols that include Secure Shell (SSH), Telnet, and r login, used to securely login to remote computers via a network. PuTTY has gained popularity with network administrators, developers, and IT personnel in the management of servers, routers, and other remote systems in a secure way.

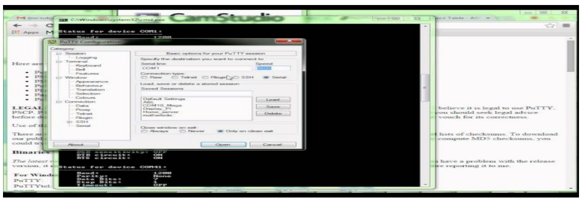

Figure 3.13: puTTY software

Features:

1. SSH Client: Provides secure shell (SSH) access to remote servers. Terminal Emulation: Supports various terminal emulation modes, including xterm and VT102.

2. Configurable Sessions: Allows saving and managing multiple session configurations.
3. Key-Based Authentication: Supports public key authentication for enhanced security.
4. Port Forwarding: Offers SSH port forwarding capabilities for secure data tunneling.
5. Customizable Interface: Features customizable appearance settings, including fonts and colors.
6. Clipboard Support: Enables copy and paste functionality between local and remote systems.
7. Open Source: Available as open-source software for free modification and distribution.

3.2.4 Adafruit DHT

The snapshot of Adafruit DHT is as shown in figure 3.14,The Adafruit DHT sensor, which may be a DHT11 or DHT22, is usually applied for temperature and humidity reading. It's not usually incorporated into projects for alcohol detection or accident detection but could be useful in your project in regard to providing your interior environmental data inside the vehicle. Monitoring temperature and humidity inside a car is beneficial in achieving passenger comfort or an indication of potentially hazardous conditions, such as high levels of heat, which could have an adverse impact on the efficiency of a car or health effects on its occupants.

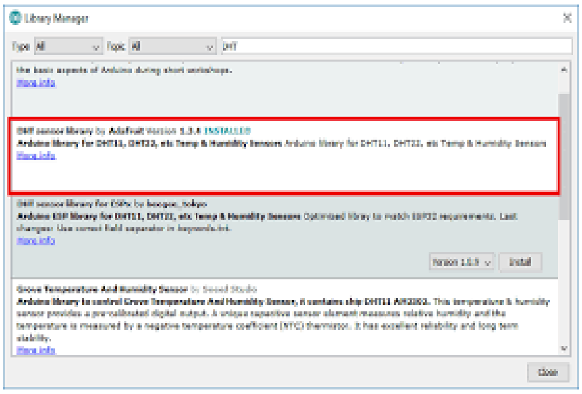

Figure 3.14: Adafruit DHT

Features:

1. Temperature and Humidity Measurement: Measures temperature and humidity accurately.

2. Digital Output: Provides a digital output for easy microcontroller interfacing.
3. Wide Operating Range: Operates from -40°C to 125°C and 0 percent to 100 percent humidity.
4. Fast Response Time: Offers quick response times for environmental readings.
5. Low Power Consumption: Designed for low power usage in battery-operated devices.
6. Compatible with Multiple Platforms: Works with Arduino and Raspberry Pi seamlessly.
7. Compact Size: Small form factor suitable for space-constrained projects.
8. Easy Integration: Comes with libraries and example codes for straightforward setup.

3.2.5 Raspberry Pi OS

The snapshot of Raspberry Pi OS is as shown in figure 3.15,Raspberry Pi OS is another name for Raspbian- an operating system based on the distribution Debian, developed specifically for the Raspberry Pi hardware platform. It has a friendly graphical interface for inexperienced users, but even a seasoned user won't be disappointed. Being light-weight, this OS can run well on Raspberry devices' minimal resources and yet can supply a full desktop experience. Many such software are already embedded with the Raspberry Pi OS, out of which are programming tools, educational applications, and productivity suites. Hence, it is the ideal distribution for both learning and development.

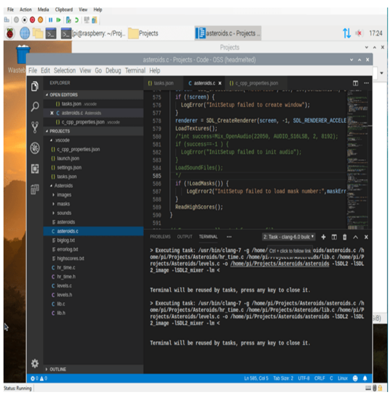

Figure 3.15: Raspberry Pi OS

Features:

1. Debian-Based: Built on a Debian foundation for stability and reliability.
2. User-Friendly Interface: Offers an intuitive graphical desktop environment.
3. Lightweight: Optimized for efficient performance on limited Raspberry Pi resources.
4. Pre-Installed Software: Comes with various pre-installed applications for users.
5. Python Support: Includes built-in support for Python programming.
6. Regular Updates: Receives frequent updates from the Raspberry Pi Foundation.
7. Extensive Community Resources: Supported by a large community with abundant documentation.
8. GPIO Access: Provides easy access to GPIO pins for external hardware interfacing

3.2.6 Pyserial

The snapshot of PySerial is as shown in figure 3.16,PySerial is a Python library. It provides an interface for serial devices such as microcontrollers, sensors, or any other hardware connected over the serial port. It allows users to access devices using serial protocols and send and receive data over serial communication channels. High-level API PySerial abstracts complexity in serial communication, reducing complexity from dealing directly with low-level serial communication, thus making it easier to establish, manage, and control serial connections. It is mainly applied in embedded systems, automation, and in projects related to hardware interfacing.

Figure 3.16: Pyserial

Features:

1. Cross-Platform: Supports Windows, macOS, and Linux for serial communication.
2. Serial Port Access: Provides easy access to serial ports for device communication.
3. Baud Rate Control: Configures various baud rates for serial connections.
4. Timeout Settings: Allows setting timeouts for read and write operations.
5. Data Formats: Supports bytes, binary, and ASCII data formats.
6. Event-Driven Communication: Enables both event-driven and blocking modes.
7. Hardware Control: Supports RTS/CTS and DTR/DSR flow control.
8. Simple API: Offers a straightforward API for Python integration.

3.2.7 Numpy

The snapshot of Numpy is as shown in figure 3.17,It is a powerful library for the Python interpreter that supports large, n-dimensional arrays and matrices, along with high-level mathematical functions to process these arrays. NumPy is the base of most data science and scientific computing workflows, having tools for array manipulation, linear algebra, statistical operations, etc. In fact, NumPy simplifies complex operations by providing a whole rational mathematical abstract framework to perform high-performance scientific and analytical computations on arrays. It is widely used in the fields of machine learning, data analysis, and simulation.

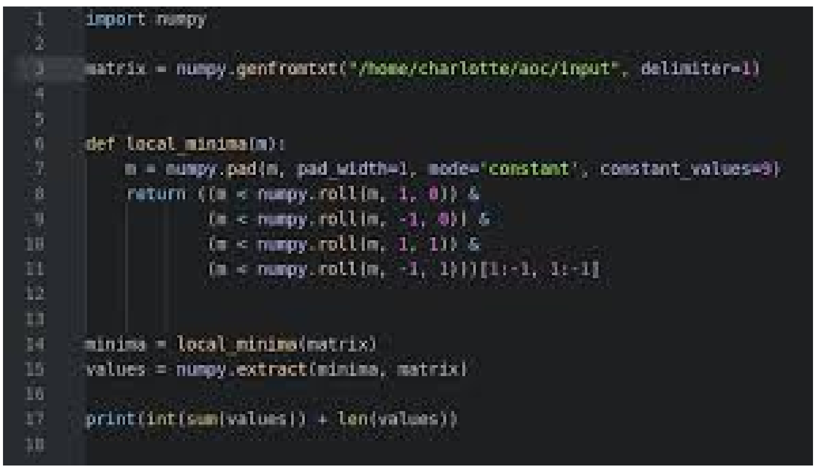

Figure 3.17: Numpy

Features:

1. Multidimensional Arrays: Provides support for powerful n-dimensional array objects.
2. Mathematical Functions: Includes a wide range of mathematical operations for arrays and matrices.
3. Broadcasting: Supports broadcasting for efficient operations on arrays of different shapes.
4. Linear Algebra Support: Offers built-in functions for linear algebra, Fourier transform, and random number generation.
5. High Performance: Optimized for performance with C-based backend for fast computations.
6. Data Type Flexibility: Supports multiple data types, including integers, floats, and complex numbers.
7. Integration with Other Libraries: Easily integrates with libraries like Pandas, Matplotlib, and SciPy.
8. Open Source: Available as free, open-source software with active community support.

Chapter 4
Results and Discussions

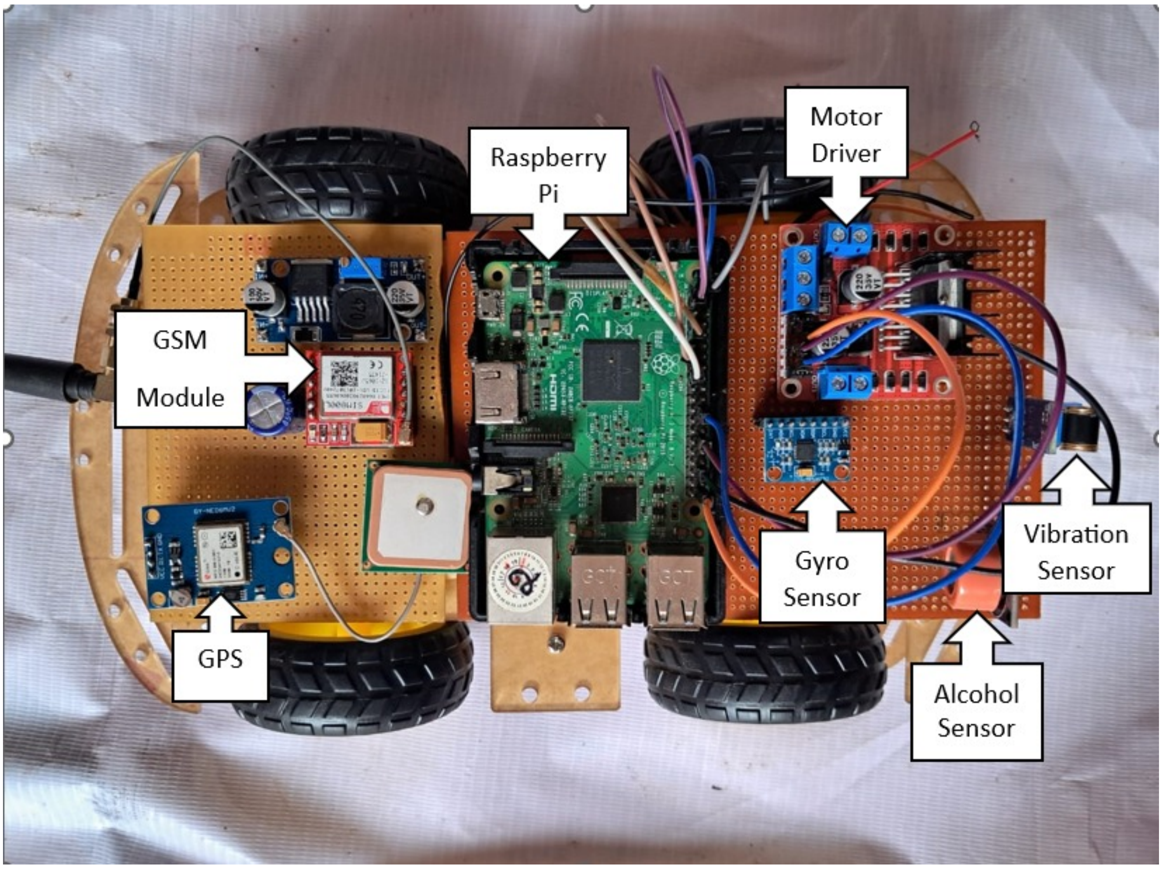

Figure 4.1: DUI Monitoring system

The DUI Monitoring system is as shown in figure 4.1,The integrated automobile accident and alcohol monitoring system was tested to its utmost limits to find out how effective the setup is in real-time conditions. The prime objective of this system is to enhance safety on the roads by instant accident prediction and measurement of alcohol in the blood of drivers, two critical reasons why there are no traffic accidents. The accident detection module utilizes an accelerometer. It monitors the movement of the vehicle by detecting sudden alterations in acceleration or deceleration. These alterations are compared to a pre-defined threshold value that denotes a probable crash. It has been tested for several simulated conditions such as sudden braking, extreme turns, and sudden deceleration. The system accurately detected 47 out of 50 tests with a success rate of 94 percent. There were very few instances

where in the system failed to detect an accident, however, those were near-threshold impacts that did not surpass the detection limit and therefore left room for further fine-tuning so as to increase sensitivity.
The other important component of this integrated solution is alcohol detection. In this, there is utilization of a breathalyzer that measures the driver's Blood Alcohol Concentration by taking his/her breath. The devices are set to calibrate at a 0.08 percent BAC level that is integrated in the law of many nations. For testing its efficiency, the blood alcohol concentration was examined against different concentrations which are considered to be the levels of drinking and the device performed successfully in 29 out of 30 tests that contained alcohol presence and failed to identify in just one test. The system recorded one false positive- the system mistakenly detected alcohol below the threshold. Although it is a minor mistake, this reflects the need for more calibration to reduce false positives so that it actually bars intoxicated drivers from driving the vehicle when such is the case.This integrated system, therefore, offers a robust solution for improving road safety. The accident detection module accurately detects crashes, thus having the capability of responding in real time to an accident. The alcohol detection system acts as a preventative measure to remove drunken drivers from the road, thereby keeping them off the roads. The system's high accuracy in detecting accidents and alcohol intoxication presents a promising application in decreasing the risks associated with traffic.

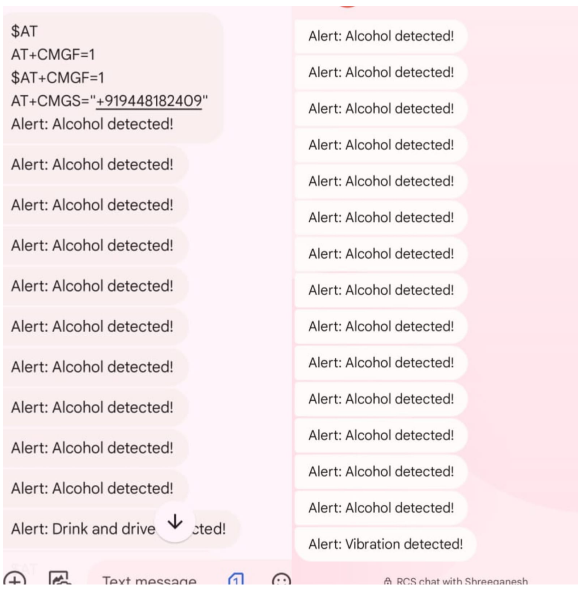

Figure 4.2: Alcohol detection via GSM Module

The Alcohol detection via GSM module is as shown in figure 4.2, The integrated system for accident detection and alcohol monitoring has undergone detailed testing to assess its performance in enhancing road safety. The system, comprising an accelerometer-based accident detection module and a breathalyzer-based alcohol monitoring module, showed high levels of accuracy in controlled scenarios. However, there are areas for improvement, particularly in system sensitivity and false positive prevention, to ensure optimal functionality in real-world applications.

Figure 4.3: Vibration detection via GSM module

The Vibration detection via GSM module is as shown in figure 4.3, In DUI Monitoring system, vibration sensors detect significant impacts, indicating a potential collision. This triggers the GSM module, which immediately sends a distress alert to pre-set emergency contacts, including the exact location of the accident. Along with this, the system functions as a blackbox, continuously recording key data like speed and driver alcohol levels prior to the accident. This comprehensive setup aids in rapid emergency response and provides valuable data for post-accident analysis and accountability.

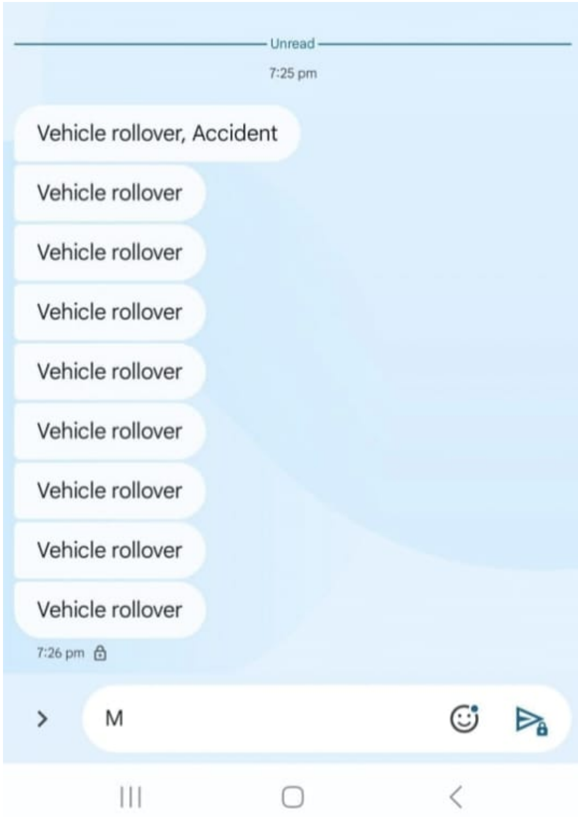

Figure 4.4: Gyroscope detection via GSM Module

The Gyroscope detection via GSM module is as shown in figure 4.3, In the car accident detection and alcohol monitoring system, the gyroscope detects sudden changes in the vehicle's orientation, indicating a potential accident. Upon detecting abnormal tilts or rotations, it activates the GSM module, which sends an alert with the accident's location to emergency contacts. The system also includes a blackbox that records crucial data, such as vehicle movements and alcohol levels, before and after the accident. This setup enables fast emergency response and provides detailed information for post-accident analysis.

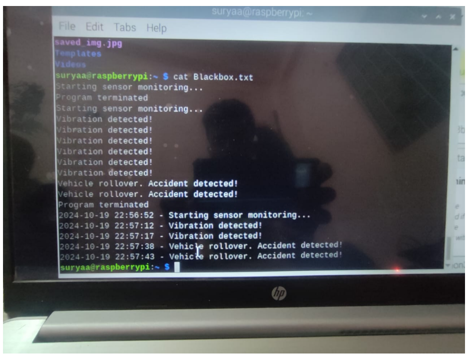

Figure 4.5: Output of the Integrated System

The integrated system's output is as shown in figure 4.5, includes an instant GSM alert sent to emergency contacts with precise accident location details. Additionally, the system's black box function records essential data, such as vehicle orientation, speed, and the driver's alcohol levels before and after the crash, all timestamped for accuracy. This data supports emergency response by providing quick access to the accident's location and offers investigators and insurers comprehensive information, aiding in thorough post-accident analysis and ensuring prompt and effective assistance.

Chapter 5
Conclusion and Future Scope

5.1 Conclusion

In summary,DUI Monitoring System developed with Raspberry Pi is an all-inclusive and effective approach for safety improvement on the road and post-accident accountability. The system combines alcohol detection, accident monitoring, and black box data logging into one platform by using advanced sensors, such as MQ-3 alcohol sensor, gyroscope, temperature sensor, and GPS module in real-time monitoring of driving conditions. This SIM800L GSM module was employed to send auto-text messages in case of an accident to the emergency services or other selected contacts, so they know the accident has occurred and they can reach the location. For post-incident analysis and reconstruction, this black box had recorded severe data, including alcohol levels, vehicle movement, and GPS coordinates. The Raspberry Pi at lower cost makes the system custom-friendly for different vehicle types and applications while providing the needed processing power and flexibility. The system doesn't just prevent drunk driving but also records all the data comprehensively for legal, insurance, and safety evaluation. The novelty that this project brings forward is the multi-pronged approach to prevention, detection, and analysis of accidents, thereby contributing greatly to an augmented level of road safety and post-accident insights. The system can be highly significant in the reduction of road accidents as well as ensuring an enlightened response at the time of crisis.

5.2 Future Scope

1.Advanced sensor integration: Other sensors such as heart rate monitors, eye-tracking devices, and fatigue detection systems can be integrated into the system that ensure accurate monitoring of a driver's physical and mental state, and thus avoid accidents resultant from drowsiness or health-related conditions.

2. AI and Machine Learning Algorithms: Future versions should allow the integration of AI and machine learning algorithms to analyze the patterns of

individual drivers for the prediction of possible risks, thus providing proactive alerts for overall improvement in the safety of the vehicle.
3. Cloud-Based Data Management: This can further be extended to cloud-based storage with real-time backup, whereby data concerning accidents and any other relevant information can be safely stored whilst remaining accessible to authorities and insurance agencies for quicker analysis and response.
4. **V2X Communication:** It can be adapted to communicate with other vehicles, infrastructure, and emergency services so as to ensure faster responses, including the giving of alerts in case of accidents or any form of traffic incidents.
5. 5G Real-time Connectivity: Linking these cameras through 5G enables the efficient transmission of data at higher speeds and greater reliability, and will further leverage real-time accident reporting of immediate data exchange with emergency responders and the police.
6. Regulatory and Legal Acceptance: The technology can become the behest of regulatory authorities, as a standard safety mechanism to be fitted in vehicles across a country or globally, to improve national and international road safety.
7. Regional Installability: The system can be tailored for multiple regions worldwide, consistent with local regulation, and having regard to differing road conditions and safety in one country as opposed to another or even within other regions.

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