IoT Based Vehicle Accident And Tracking System Using Raspberry pi and ESP32

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Abstract—**The requirement for vehicles has increased dramatically in recent years, which has resulted in a dramatic increase in traffic fatalities and accidents. Emergency services taking longer to get at accident scenes—often as a result of delayed communication and crowded roads—is a significant contributing cause to this increase. In this study, an anti-sleep alarm for drivers is proposed along with an IoT-based car accident detection and warning system. The technology targets driver weariness and accident detection as two major causes of accidents. The accident detection module measures variables like speed, accelerometer data, and GPS angle changes to identify collisions using a smartphone connected with an external pressure sensor. The device reduces emergency response time by automatically notifying surrounding hospitals upon detection of an accident[1]. In addition, The anti-sleep module tracks the movements of the driver's eyes to identify sleepiness, sounding an alert if the driver keeps their eyes closed for a prolonged amount of time[2]. Road safety is improved by this real-time sleepiness detection technology, which warns drivers before accidents happen. When combined, these devices offer a complete solution for raising traffic safety and lowering fatalities from traffic accidents.**

Keywords— accident, rescue, IoT, anti-sleep alaram , detection, Driver, Road safety, Emergency

INTRODUCTION:

Worldwide, automobile accidents have grown to be a serious public health issue. An alarming surge in traffic accidents has been caused by a number of causes, including the growing number of vehicles, driver conduct, inadequate infrastructure, and the complexity of modern road networks. The Association for Safe International Road Travel (ASIRT) estimates that 1.35 million individuals lose their lives in traffic accidents annually. This comes up to almost 3,700 deaths every day, which puts traffic accidents among the world's leading causes of death[3]. In addition, it is estimated that between 20 and 50 million individuals experience non-fatal injuries each year, many of which lead to permanent impairments and a reduced quality of life.

In low and middle income nations, where emergency response systems may be underdeveloped and road safety regulations may be less strict, the burden of traffic injuries is especially great. The lack of quick medical attention and first aid during accidents is a major factor in road traffic fatalities. Emergency services could save many victims if they arrived at the scene quickly. Regrettably, more fatalities frequently result from delays in reporting accidents, particularly when they occur on highways or in isolated locations[4]. To make matters worse, passing cars frequently fail to notify the authorities of accidents, either out of carelessness or disregard.

Thus, it is crucial that emergency responders have timely access to accident location information so they can start giving care as soon as feasible. Innovative solutions are required to overcome the largest gap in road safety tactics, which is the inability to accurately detect and report accident locations in real-time.

Road accidents are mostly caused by driver faults, such as weariness and intoxicated driving, in addition to delayed accident response. When drivers are fatigued, they lose consciousness while operating a vehicle, which makes it difficult for them to maintain control and steer clear of collisions. Even though the risks of drunk driving are well known, tiredness driving is still not given enough credit. In India, the Ministry of Road Transport and Highways stated in 2015 that there are over 400 fatalities each day from 1,374 accidents, with young adults aged 15 to 34 bearing a disproportionate share of the blame. Studies show that alcohol intake is a contributing factor in between 50 and 60 percent of road accidents worldwide, making drunk driving a severe public safety concern.

A comprehensive system that combines alcohol detection, anti-sleep alarms, and accident detection can be very helpful in addressing these issues and lowering the number of accidents and fatalities. While anti-sleep alarms use track eye blink sent alert emergency message , intelligent accident detection systems are able to monitor driver fatigue. Drunk drivers can't operate a car thanks to alcohol detection devices, which use sensors to assess alcohol levels. With their proactive approach to road safety, these integrated technologies lower the likelihood of accidents and increase the effectiveness of emergency response[5].

RELATED WORK

This section overlooks similar existing solutions and examines their advantages and disadvantages:

IoT-based Vehicle Accident Detection and Prevention System

Developed by R.Kumar,A.Singh The paper proposed an IoT-based solution integrating GPS, accelerometers, and GSM modules to detect accidents and alert emergency services. Real-time tracking of vehicle speed and motion data helps in quick accident detection, sending an alert with the location to emergency contacts. Drawacks of project The system lacks provisions for detecting driver conditions like drowsiness and alcohol consumption. Moreover, it doesn’t cover aspects of preventive measures such as anti-sleep alarms or integrating multiple IoT sensors[1].

An IoT-based Vehicle Monitoring System for Accident Prevention and Sleep Detection developed by ***M. Alam, S. Haider*** This study introduced an IoT system for continuous driver monitoring, which includes fatigue detection algorithm using eye-blink sensors and vehicle data. The system sends a warning to the driver when drowsiness is detected and initiates an automatic stop if the driver does not respond. Gaps are The approach doesn't integrate alcohol detection, which limits the scope of accident prevention. Moreover, environmental factors affecting the accuracy of eye-blink sensors were not deeply studied[2].

IoT-based Driver Safety Enhancement System developed by **P. Sharma, N. Ra** The paper implemented an IoT-based system that detects alcohol levels in the driver's breath using an alcohol sensor. It also monitors the speed of the vehicle and detects abnormal changes that suggest an accident drawbacks This study only focuses on alcohol detection and vehicle speed anomalies. It lacks sleep-detection mechanisms, and the system's reliability in emergency scenarios where the driver needs immediate help was not explored[3].

IoT-Enabled Vehicle Accident Detection with Anti-Sleep Alarm and Alcohol Detection developed by ***S. Gupta, A. Banerjee*** The paper developed a comprehensive IoT system incorporating accident detection, anti-sleep alarms, and alcohol detection. The system uses an accelerometer for accident detection, a heart rate monitor for detecting sleepiness, and an alcohol sensor for breath analysis. Drawbacks The system's integration with emergency services was only tested in simulated environments. Real-world testing for system accuracy, especially for anti-sleep alarms, was limited, and the paper lacks discussion on how external factors like noise or driving conditions affect system performance.[4]

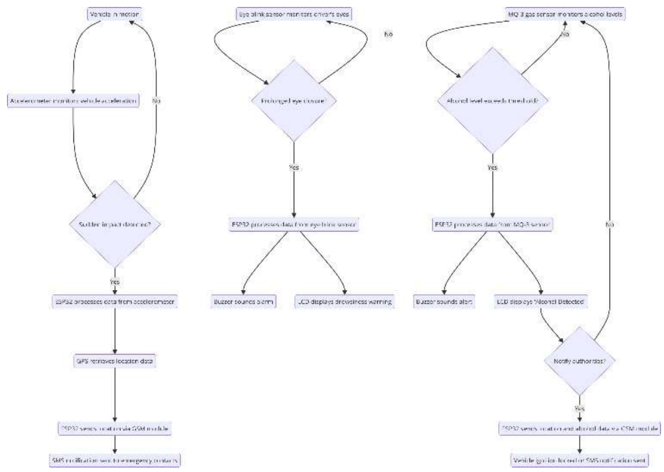


Fig. 1 – System Flowchart

I. METHOD

Accelerometer : The accelerometer tracks the movement of the car continually and picks up on any abrupt changes in acceleration, like a sudden stop or accident. An accident alert is sent by the system when the sensor records an unusual acceleration or collision that exceeds a certain threshold, signifying a possible mishap.

ESP32 (Microcontroller)*:* The system's central processing unit is the ESP32. It analyzes the information received from the GPS, accelerometer, and other sensors. When the ESP32 detects an accident, it uses the GPS location information to transmit a notification over the GSM module.

GPS Module: The GPS module gives location data in real time. The technology obtains the exact latitude and longitude coordinates of the car in the event of an accident.

GSM Module: Contact with pre-configured contact numbers or emergency services is made possible by the GSM module. Upon accident detection, the ESP32 sends an SMS providing the accident location (GPS coordinates) to emergency services or designated contacts, allowing them to respond immediately.

LCD Display (16x2 with I2C): The LCD shows current system status information in real time. For instance, it can display the amount of alcohol the MQ-3 sensor detected, whether the driver appears sleepy, or whether an accident has been reported. The wiring is made simpler by the I2C interface, which makes sure the LCD runs on fewer pins.

Eye Blink Sensor: The eye blink sensor tracks the blink frequency and eye movement of the driver. The device detects tiredness if the driver's blink rate drastically drops or if their eyes stay closed for an extended period of time.

Buzzer: The alarm mechanism is the buzzer. The buzzer alerts the driver to potential mishaps by making a loud noise when the eye blink sensor detects tiredness. This helps to avoid accidents caused by drivers falling asleep behind the wheel.

Monitoring Movement: Using an accelerometer, the system continuously keeps track of the vehicle's movements. The accelerometer detects acceleration along the X, Y, and Z axes in order to identify any abrupt changes that would point to a collision.

Collision Detection: The accelerometer recognizes a sudden impact or deceleration that surpasses a predetermined threshold when the vehicle is involved in an accident. Based on the kind of vehicle and anticipated impact forces in the event of a collision, the threshold is carefully calibrated.

Processing and Decision-Making: The ESP32 receives data from the accelerometer and uses it to assess and decide if the detected event meets the criteria for an accident. The ESP32 detects an accident and moves on to the next stage if there is a noticeable change in acceleration.

Accident Notification: The ESP32 uses the GPS module's real-time data to locate the precise location of the vehicle when it detects an accident. The position of the vehicle and a notification that an accident has occurred are sent by SMS to pre-designated emergency contacts via the ESP32 via the GSM module. This guarantees that loved ones or emergency agencies can act swiftly.

Displaying Warnings: The driver receives further information at the same time as a visual alert such as "Drowsiness Detected" appears on the LCD display. Visual and aural alerts work together to make sure the driver is aware of the issue right away.

II. DESIGN AND ARCHITECTURE

The below system architecture is the conceptual model that defines the structure, behavior, and more views of our proposed system.

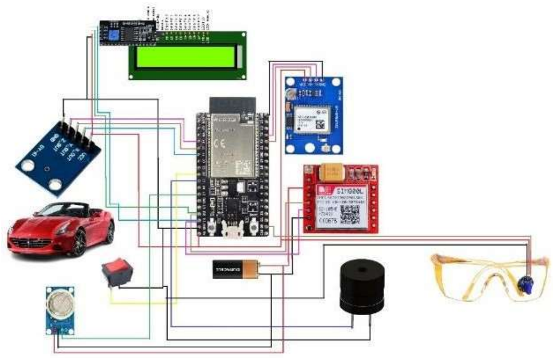


Fig. 2 – Diagram

Three main levels comprise the architectural design: the Sensing Layer, Processing Layer, and Communication & Output Layer.

Sensing Layer :

The data collection from the driver and environment falls under the purview of this layer. It is made up of the following sensors:
Accelerometer**:** Tracks acceleration and deceleration continuously, identifying crashes or unexpected hits.
Eye Blink Sensor: Tracks the path and duration of the driver's blinks to determine whether or not they are sleepy.
MQ-3 Gas Sensor :measures the amount of alcohol in the driver's breath and determines if it surpasses a safe limit[6].

Processing Layer :

The ESP32 microcontroller, which is part of the processing layer, is responsible for the following tasks:

Data Acquisition: Real-time data collection from the sensors is done through data acquisition.

Data Analysis: determines the operational state by processing the data that has been obtained. For instance, the system presumes an accident has happened if it senses a sudden hit.The system sounds an anti-sleep alarm if the eye blink sensor records extended eye closure.The system stops the car from starting if it detects alcohol levels above the permitted limit using the MQ-3 sensor[7].

Decision Making: The ESP32 carries out preset actions, including sending alerts or setting off alarms, based on the data it has processed.

Communication & Output Layer:

The user interface and notifications are the main topics of this layer:
GPS Module: When an accident is detected, it transmits location information to the ESP32.
GSM Module: Provides information about location and accident status together with SMS alerts to emergency contacts.
LCD Display: Gives the driver visual feedback by displaying current statuses and warnings (such as "Accident Detected," "Drowsiness Detected," or "Alcohol Detected").
Buzzer**:** Makes noise to alert the driver to possible hazards, such fatigue or intoxication[8].

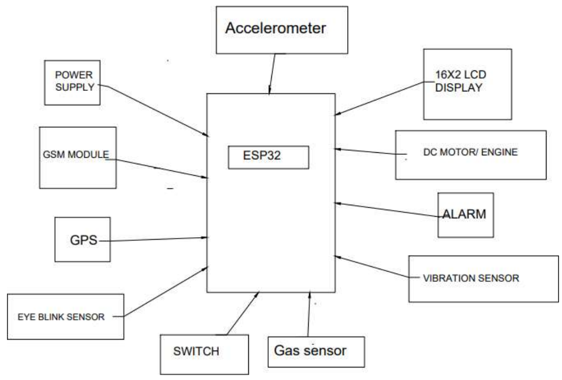


Fig.3

Hardware Components

In our implementation we have used an IoT device containing different components and modules as well as communications capability. The main components of this device are:

1. Accelerometer :

A sensor called a accelerometer monitors the acceleration forces applied to an object, assisting in the detection of vibration, motion, and direction.

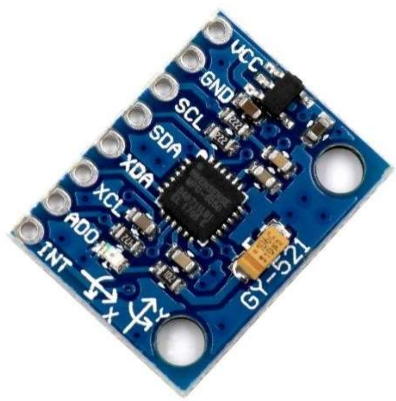


Fig.4

It is essential to a vehicle's ability to detect rapid changes in direction or speed, such as those that occur during stops or crashes. Safety features like stability control, airbags, and accident detection systems frequently use this data. An accelerometer can detect sudden deceleration and use that information to initiate warnings or alerts, such as sending emergency messages in the event of an accident[9].

2. Global Positioning System (GPS)

GPS navigation is a component that accurately calculates geographical location by receiving information from GPS satellites. [7] The SKM53 GPS module device is used to send to server the exact vehicle location.

Fig. 5 – IoT Device Components

3. GSM Module

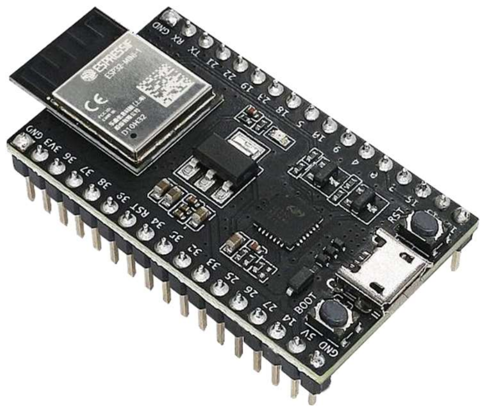
A GSM module is a gadget that makes it possible for systems to send and receive voice calls or SMS messages over a cellular network. It is utilized in car safety systems to notify emergency contacts or authorities in real time of alerts or location data[10]. In the event of an accident or other important occurrence, the GSM module guarantees prompt notification through its integration with a microcontroller.

4. Gas Sensor

A gas sensor measures the amount and presence of particular gases, like methane, carbon monoxide, and alcohol, in the surrounding air. It is frequently used in car safety systems to check the driver's breath for alcohol content in an effort to stop drunk driving.

Esp32:

With integrated Wi-Fi and Bluetooth, the **ESP32** microcontroller is a potent and adaptable device that is perfect for Internet of Things applications and wireless communication. It has low power consumption, dual-core processing, and a variety of ports for attaching sensors and modules, including GPIO, ADC, and I2C[11]. The ESP32 functions as the primary processor in car safety systems, handling sensor data and carrying out operations like alarm triggering and notification sending. It is a strong option for smart systems due to its wireless connectivity and real-time capabilities.



Eye Blink Sensor :

An eye blink sensor is a tool used to track the number and length of eye blinks, usually in order to identify weariness or indicators of drowsiness. It measures how long the eyes stay closed or open by tracking the movements of the eyelids using infrared light. The eye blink sensor in car safety systems warns drivers when extended eye closure suggests fatigue, which helps avert collisions. The technology has the ability to sound alarms or cautions to keep the driver informed when it detects aberrant trends.

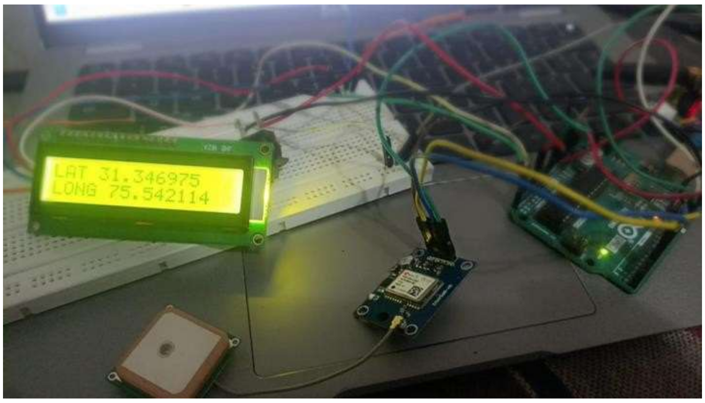
LCD :

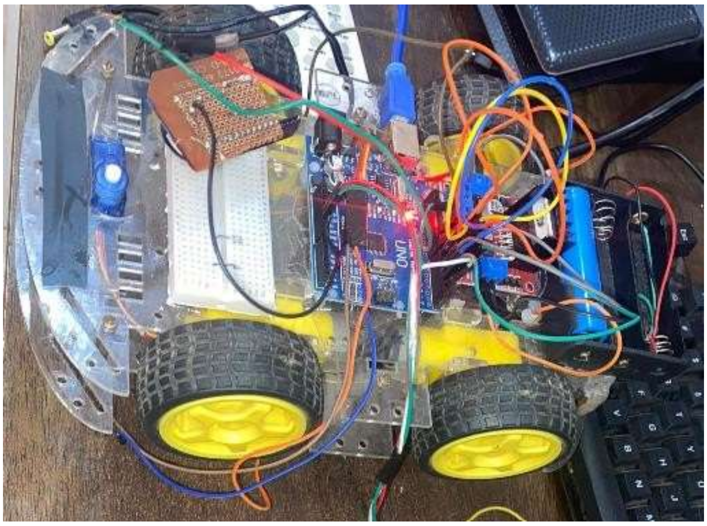
A flat-panel display technology called an LCD (Liquid Crystal Display) is frequently employed in a variety of devices to visually portray information. A 16x2 LCD display in car safety systems offers real-time updates on things like accident status, drowsiness warnings, and alcohol detection alerts. It efficiently and simply displays messages, giving drivers quick access to important information. The LCD is perfect for embedded systems, such as those used in cars, because of its small size and low power consumption.

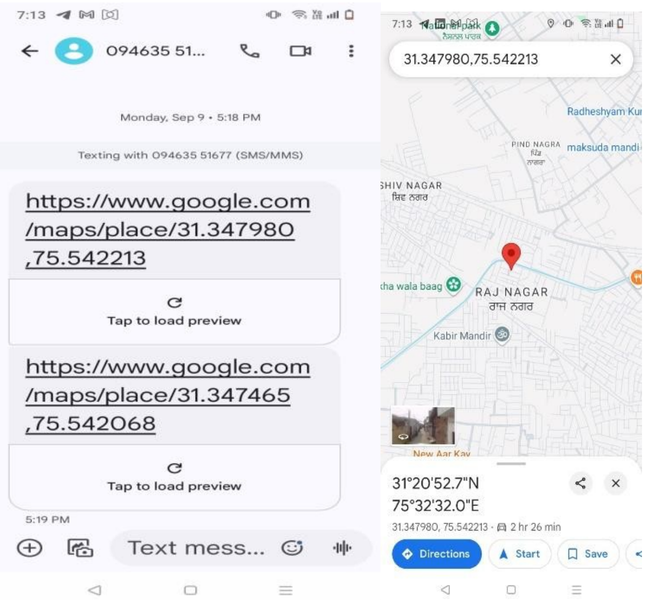
III. Results

This section shows a simulation of some important features implemented in our system.

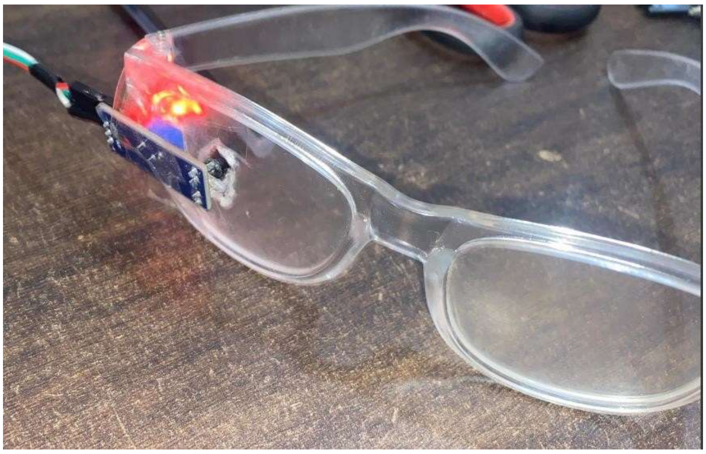
Notification system:







Anti sleep alarm with Alcohol detection:



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