Accident management system with vitals monitoring

Polanki Chethan(20BCT0302), Reet Bhatia(20BCT0312), Shreyash Malhotra(20BCT0307)

Abstract

In recent years, there has been a sharp increase in the number of automobiles on the road. This, in turn, is resulting in a huge number of accidents, which are the primary cause of death in the majority of nations. The lack of a proper accident detection system has led to an increase in the number of fatalities. Without effective detection, the response times are delayed. Even if traffic management systems and automotive technology have advanced significantly, accidents continue to rise on a daily basis. Majority of the time, accidents result in fatalities due to a lack of prompt first aid and medical attention. In order to prevent subsequent accidents, timely warn first responders, and optimize traffic for first responders, it is required to design a uniform framework for accident detection. We present a system for accident warning and detection. Various sensors along with Max 30100 are used for vitals monitoring to reduce the chances of false alarms which are usually there in most of the warning systems present now. After the detection, messages will be sent to alert the hospital and family members. Our method enhances the likelihood that the lives of the accident victims will be saved by decreasing the amount of time needed to alert the ambulance, enhancing safety while also improving efficiency and reducing costs associated with accidents. It also takes care of the health of the driver and sends notification to the family members by monitoring his/her heart rate which could be very helpful for drivers with old age and health issues.

1. Introduction

Due to urbanization, the number of cars on the roads are increasing making them more congested. Also, drunk driving cases are very common these days. All of this has led to an increase in the number of road accidents. Due to inadequate facilities for managing traffic and accidents, road accidents are the primary cause of death and injury in the majority of emerging nations.
India has the greatest number of fatalities and mishaps worldwide involving motor vehicles.
There is a growing need for vehicle accident management services as a result of the rise in vehicle accidents across the globe as well as the fast adoption and development of wireless mobile communication technology and wireless networks. Broadband

networks can be used for a variety of purposes, opening the door for the inclusion of useful services. All of the suggested applications are focused on driving and road safety, but none are focused on accident administration, indicating the impending need for new applications and services.
Most of the earlier systems use a couple of sensors and based on the information they get from the sensors, it is determined whether the accident has happened or not. But this method of detection is often inaccurate and not feasible. We often see that sometimes, these systems can give false reports of accidents, which can be seen in paper [9], and that wastes the resources that could be used to help a lot of people that genuinely need them. We aim to improve this situationThe main goal of an accident management system is to have better accuracy, cost-effectiveness, low power consumption, reduce human error, and assure maximum safety.
After conducting a very extensive literature survey, we have identified various problems with the existing systems and we plan on solving one of them-which is reducing false positives-which is very unnecessary and can divert resources from a real accident. It may lead to a waste of money, time and effort which ultimately decreases the effectiveness of the system.
We propose a system with a variety of sensors, but to improve the accuracy of the accident detection and management system, we plan on adding an extra component-vitals monitoring, we will use a Max 30100 sensor to perform heart rate monitoring. A real-time alarm will also be delivered to the Relatives, the nearest ambulance services, hospitals, and police stations. The location of the collision will also be posted online and shared with the nearby ambulance service. The entire system will significantly improve the prompt synchronization of important duties after an accident. An extra layer of protection has also been added, the health of the driver can also be monitored and notifications to family members can be sent using the vitals obtained from the sensors which could be very useful for drivers of old age and those with health conditions also.

The rest of the paper is organized as follows. Section 2 consists of the literary analysis of various accident detection and response methods. Section 3 presents the proposed accident detection and management system. Section 4 presents the analysis of the datasets supporting our proposed solution. Section 5 concludes the work with future scope.

2. Comparative literature analysis of various existing accident detection and response methods

Hesham A. El [1] proposes a system which uses IOT, radio frequency(RF) and LCD technologies to communicate between vehicles. Visible light communication technology is used for communication between vehicles along with various IOT sensors used to take pictures of the incident. RF is used to find suitable paths in case an accident happens. Orlean G. Dela Cruz et al. [2] perform an analysis of various research papers using the LDA algorithm to identify crash severity factors. A. Mohamed Arif Aslam et al. [3] propose a model with GSM and GPS module to send alert messages and NodeMCU, gyroscope and crash sensor to collect the data for the accident. Cloud is used to process and store all the data. Shafin Talukdar et al. [4] uses Wi-Fi Module, Accelerometer, LED, Buzzer, GPS, GSM, Push Button, Ultrasonic Sensor, Vibration Sensor and Arduino to propose a VANET system to detect accidents efficiently and VTS(vessel traffic service) which is a maritime monitoring and management system to resume victims of the accident quickly.

Parthasarathy P et al. [5] gives us an accident detection system for a bike, with the bike and helmet section interconnected to a mobile application which sends notification and accident location via google maps, in case of any accident. The bike has a vibration sensor and the helmet has a pulse sensor. Gaffar G. Momin et al. [6] proposes a vehicle health monitoring system to alert the driver of any major problems with the vehicle and displays these using LCD display interfaced with arduino. Sensors that he uses are flow, gas, temperature and pressure sensors. Abdul Mateen et al. [7] identified a system of Smart Roads which have all the sensors and actuators installed for the detection of accidents, alert system(AALS) is installed on both the sides with a microphone to detect the sound of the accident and alert all the vehicles on the road by blinking lights. The roads have various nodes spaced out equally to measure various parameters. Shavan Askar et al. [8] make use of 5G networks and SDN to improve the functionality of VANET. At all the edge nodes in the system, fog computing is used to process all the data for faster computation. Because of this, a large number of devices with better bandwidth and low latency can be connected to improve the efficiency of the detection system. Bharat Naresh Bansal et al. [9] made a review paper outlining the various advantages and disadvantages of certain accident detection and notification systems which can be used to identify the best and suitable method for us.

Bilal Khadil Dar et al. [10] proposed an emergency response and disaster management system(ERDMS) which can be used to get sensor data from accelerometer, GPS and microphone. Wan Jung Chang et al. [11] implemented a system called DeepCrash which uses in-vehicle infotainment, sensors and cameras to detect head-on collisions using a cloud based deep learning server which also issues notifications. Maid Khaled Almohsen et al. [12] proposed a model which uses a heart Beat sensor and vibration sensor interfaced with an Arduino board to send the information to already saved numbers and verifies the driver with a biometric parameter-fingerprint. Umakant Dinkar Butka et al. [13] uses smartphones to detect accidents and nodeMCU to transmit the notification. Rani Fathima Kamal et al. [14] uses eye blink sensors, acceleration sensor and alcohol sensor interfaced with Arduino. Mithun R et al. [15] uses an arduino based GPS and GSM model to send messages to multiple rescue units if an accident happens. Fizzah Bhatti et al. [16] proposed a system where mobile devices are used for detection and communication. Insan Arafat Jahan et al. [17] implemented a system where various sensors namely accelerometer sensor, GPS sensor, gyroscope sensor and digital compass sensor are interfaced with raspberry pi for sensing the data and all the data collected is pushed onto the cloud.

S. Din [18] paper offers a beaconless traffic-aware spatial routing system for ITS to decrease network overhead and enhance data delivery. It outperforms beacon-based systems with traffic-aware and geographical routing. Simulations show that the proposed protocol improves packet delivery ratio, end-to-end latency, and control overhead. S. Yu's [19] paper proposes a secure message authentication for IOV called IOV-SMAP that uses the cryptographic connection between V2I. This algorithm is tested in simulation over various parameters also and it performed well. W. Yao et al. [20] paper proposes a secure and efficient communication way for decentralizing CR-IOV , this algorithm uses blockchain to increase the security, privacy and optimization of communication efficiency. This paper provides a valuable contribution in CR-IOV.

Khattak. [21] proposes the integration of fog computing with VANET, discusses the opportunities and disadvantages of integrating fog technology with VANET, and also proposes a new architecture to provide efficient communication between the vehicle and the cloud. Zhao [22] proposes a model based on CNN in VANET which predicts Traffic accidents by using image-based features from VANET to predict traffic accidents. Ksouri [23] proposes a data collecting approach for increasing safety in IOV, using a Clustering algorithm to reduce the data transmission between V2I. Suriyapa Boonwattana[24] this paper presents an adaptive alert message broadcasting system for Vehicular Ad Hoc Networks (VANETs) for improving road safety using a method that adapts changing road condition and vehicle speed to optimize the message of alert to stop vehicle accidents. S. Talukder [25] proposes a VANET-based IoT with V2V communication method for detecting and preventing vehicle collision, using different sensors and VANET to avoid and detect collision between vehicles. This paper makes a significant contribution to the field of VANETs and IoT and can be used as a starting point for more studies in this sector.

From the various papers that we have gone through, these are the limitations that we have identified:

Most of the systems proposed to make major use of vibration sensors which is not at all accurate because it causes a lot of false alarms if not calibrated properly.
None of the proposed systems take in the factor of security-hackers can easily hack the data and alter it, which can lead to unnecessary deaths and false alarms.
Proper platform to store and process sensor data is not there, and if it is there, cloud is used, which is fine for storage, but may cause delay in the processing of data which in turn leads to late response by an accident detection system-where time is a very crucial factor.
Most of the systems use not more than two sensors so the accuracy of detection is very low.
Papers provide technological methods to improve IoV and VANET performance, but they do not look at the ethical, legal, or regulatory problems that can occur when these technologies are used in the real world.

We propose a system to reduce all these false alarms. We have identified all the important sensors we need to incorporate along with a heart rate measuring sensor which is our novel approach to reduce all the false alarms and that is discussed in the next section.

3. Proposed system

We propose a system which consists of the following components:

- Arduino Uno Board
- GPS Neo 6M Module
- MPU6050 Gyroscope sensor
- SIM800L Module
- Max 30100 sensor
- MQ3 sensor

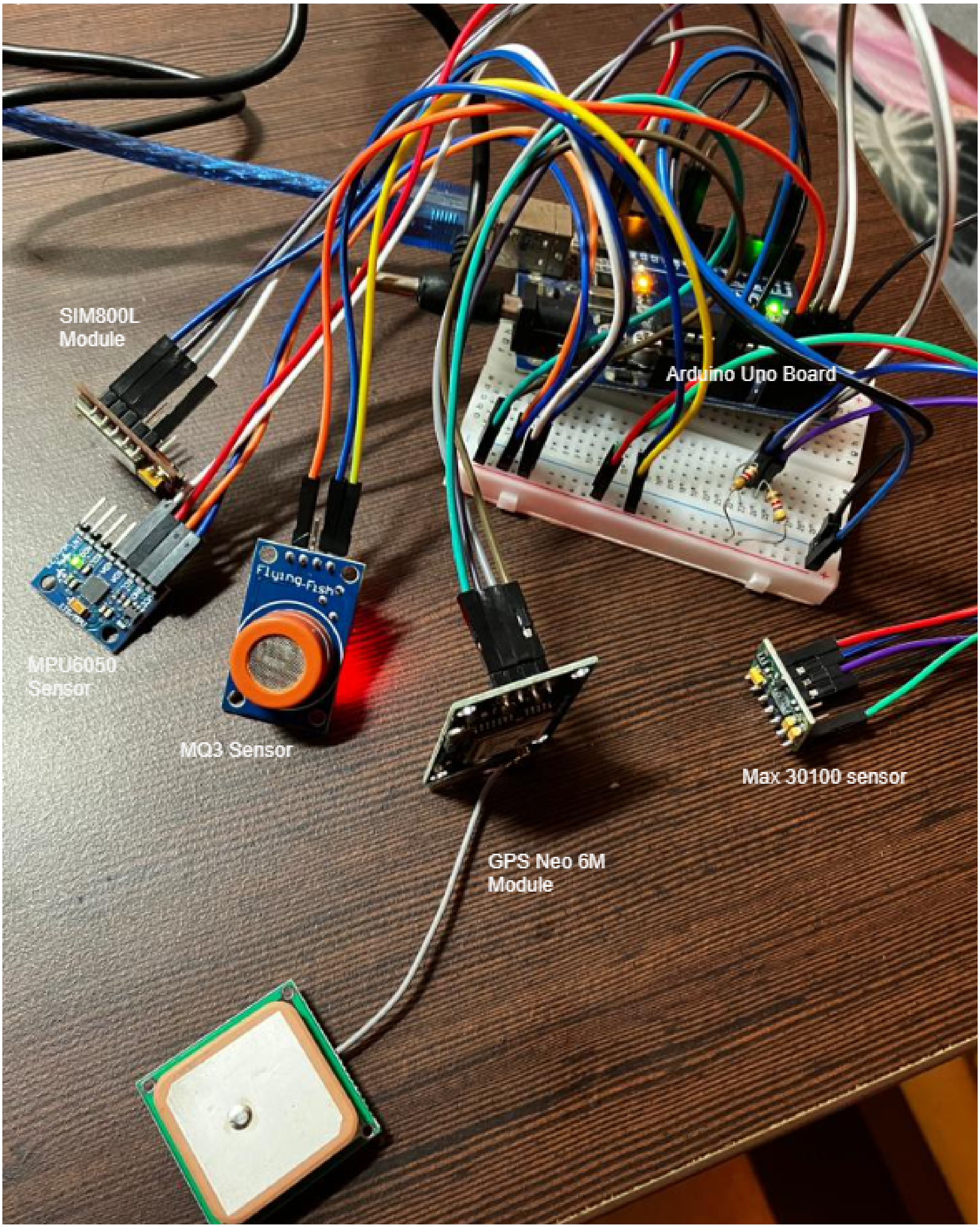
The GPS Neo 6M Module gets the car's current location in geographical coordinates(Latitude, Longitude).

The MPU6050 measures the speed in kmph and if there is any rapid decrease or increase in the speed, we will get a notification for it as well.

SIM 800L gets the required location from the GPS Neo 6M Module and SIM800L module sends an SMS to the nearby hospital and family members with the respondent's contact number.

The Max 30100 sensor measures the heart rate of the driver.

The MQ3 measures the alcohol level of the driver.



CODE:

```
#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_MPU6050.h>
#include <SoftwareSerial.h>
#include <TinyGPS.h>
#include "MAX30100_PulseOximeter.h"

#define SIM800_RX 10
#define SIM800_TX 11

SoftwareSerial sim800(SIM800_RX, SIM800_TX);
TinyGPS gps;

// Initialize MPU6050 sensor
Adafruit_MPU6050 mpu;
float speed = 0;
float last_speed = 0;

// Initialize MQ-3 sensor
int mq3_pin = A0;
float alcohol_value = 0;
```

```
#define REPORTING_PERIOD_MS     1000

// Create a PulseOximeter object
PulseOximeter pox;

// Time at which the last beat occurred
uint32_t tsLastReport = 0;

// Last heart rate and SpO2 levels
uint8_t last_hr = 0;
uint8_t last_spo2 = 0;

// Callback routine is executed when a pulse is detected
void onBeatDetected() {
  Serial.println("Beat!");
}

void setup() {
        // Start serial communication
  Serial.begin(9600);
  sim800.begin(9600);

        // Initialize MPU6050 sensor
        mpu.begin();
```

```
    mpu.setAccelerometerRange(2);
    mpu.setGyroRange(250);

        // Initialize MQ-3 sensor
        pinMode(mq3_pin, INPUT);

    Serial.print("Initializing pulse oximeter..");

        // Initialize sensor
        if (!pox.begin()) {
      Serial.println("FAILED");
        for(;;);
        } else {
      Serial.println("SUCCESS");
        }

        // Configure sensor to use 7.6mA for LED drive
    pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);

        // Register a callback routine
    pox.setOnBeatDetectedCallback(onBeatDetected);
}

void loop() {
```

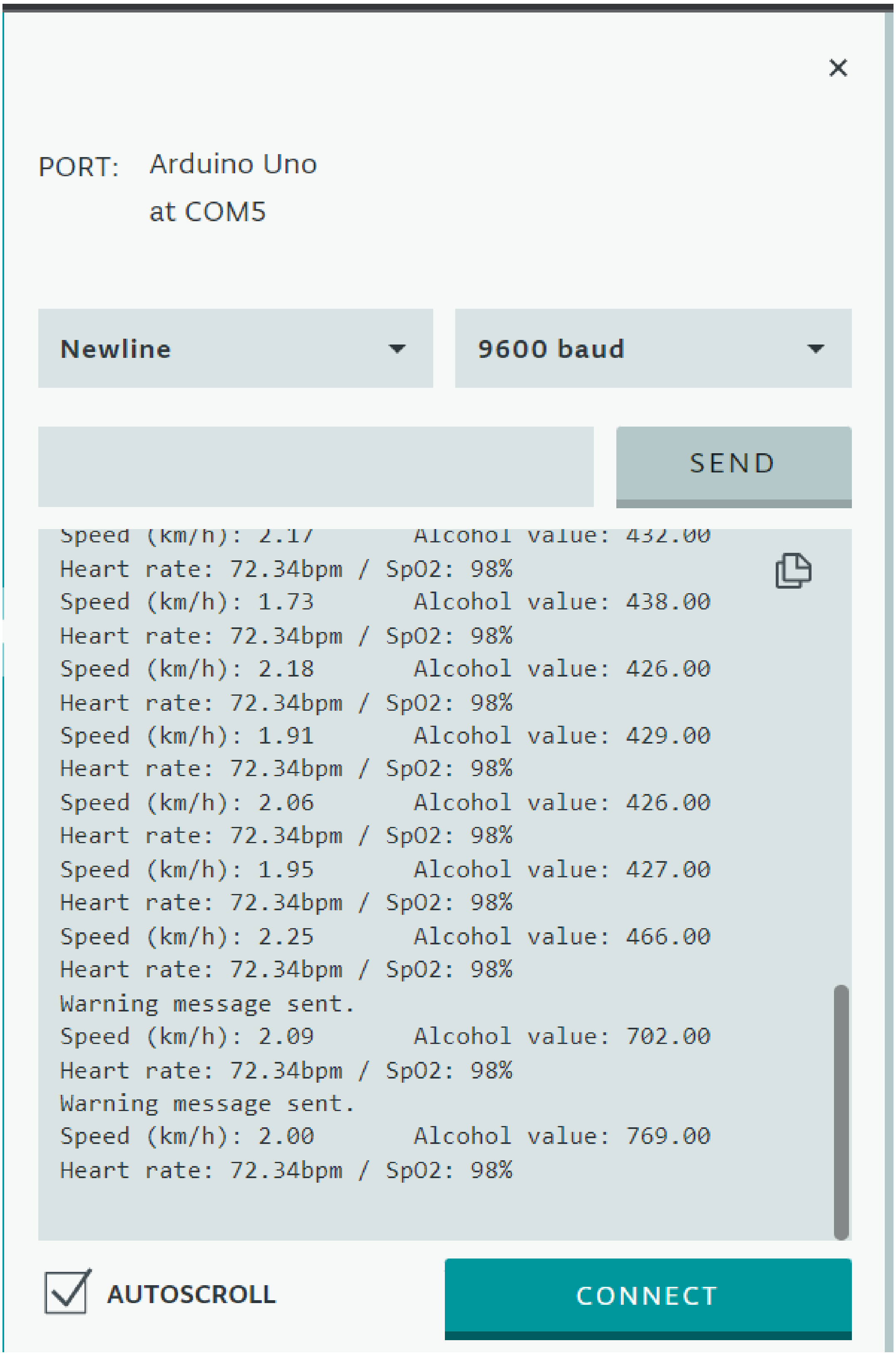
```
    // Read MPU6050 sensor values
    sensors_event_t accel_event, gyro_event, temp_event;
mpu.getEvent(&accel_event, &gyro_event, &temp_event);
    float accel_x = accel_event.acceleration.x;
    float accel_y = accel_event.acceleration.y;
    float accel_z = accel_event.acceleration.z;

    // Calculate speed using MPU6050 sensor
    speed = sqrt(pow(accel_x, 2) + pow(accel_y, 2) + pow(accel_z, 2));
    speed = speed * 3.6; // Convert to km/h

    // Read MQ-3 sensor value
    alcohol_value = analogRead(mq3_pin);

    // Read from the sensor
    pox.update();

    // Grab the updated heart rate and SpO2 levels
    if (millis() - tsLastReport > REPORTING_PERIOD_MS) {
  //Serial.print("Heart rate:");
  //Serial.print(pox.getHeartRate());
  //Serial.print("bpm / SpO2:");
    // Serial.print(pox.getSpO2());
 //Serial.println("%");
```

```
    // Check for sudden abnormalities in heart rate and SpO2

if ((pox.getHeartRate() > 100 && last_hr <= 100) || (pox.getSpO2() < 90 &&
last_spo2 >= 90)) {

// Send SMS message with warning
String message = "WARNING: Sudden abnormality detected in heart rate and/or
SpO2! Please seek medical attention immediately.";
sim800.println("AT+CMGF=1"); // Set SMS mode to text
delay(100);
sim800.println("AT+CMGS=\"+919966127567\""); // Replace with phone number to
send message to
delay(100);
sim800.print(message);
delay(100);
sim800.write(26); // Send message
Serial.println("Warning message sent.");
}

// Check for high alcohol value
if (alcohol_value > 500) {
    // Send SMS message with warning
    String message = "WARNING: High alcohol level detected! Please do not
drive!";
  sim800.println("AT+CMGF=1"); // Set SMS mode to text
```

```
        delay(100);

     sim800.println("AT+CMGS=\"+919966127567\""); // Replace with phone number
to send message to

        delay(100);

     sim800.print(message);

        delay(100);

        sim800.write(26); // Send message

     Serial.println("Warning message sent.");

}


// Update last values

last_hr = pox.getHeartRate();

last_spo2 = pox.getSpO2();


}


// Print sensor values to serial monitor

Serial.print("Speed (km/h): ");

Serial.print(speed);

Serial.print("\t Alcohol value: ");

Serial.println(alcohol_value);

Serial.print("Heart rate: ");

Serial.print(pox.getHeartRate() );

Serial.print("bpm / SpO2: ");
```

```
Serial.print(pox.getSpO2());
Serial.println("%");

// Delay for a certain amount of time
delay(1000);

}
```

OUTPUT SCREENSHOT:

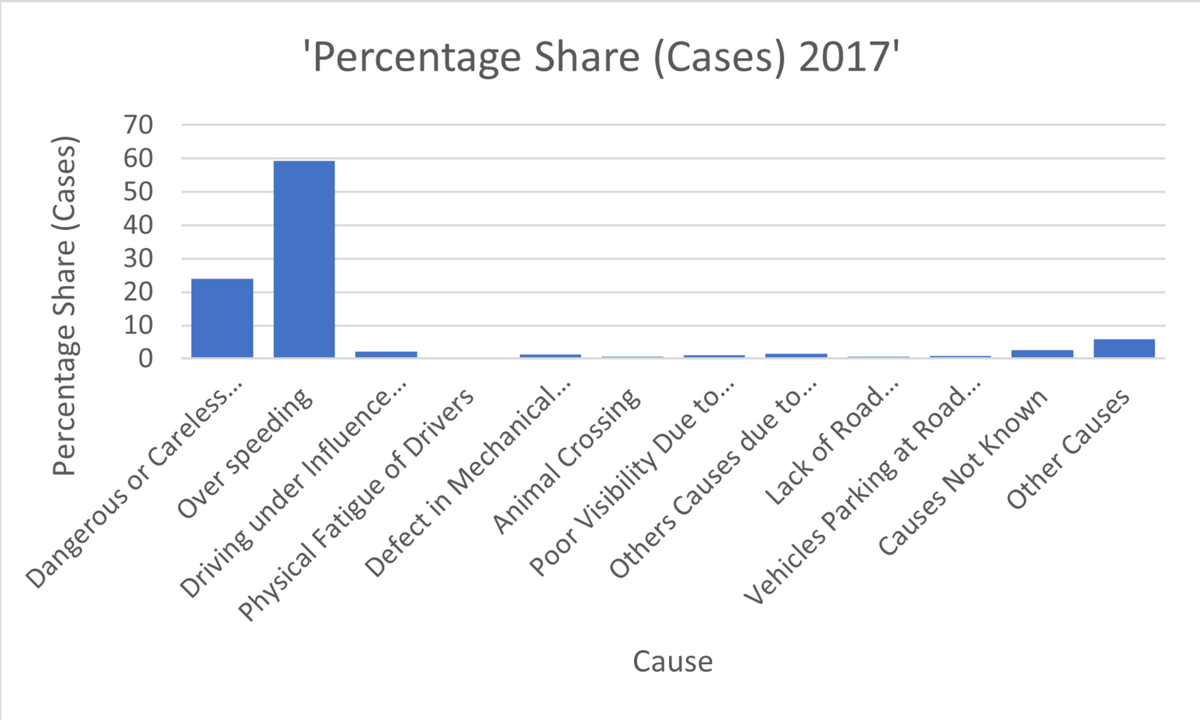


Here is the output of the code what we have provided the vitals of the driver and also the alcohol levels of the driver, when the alcohol is detected then a message will be shown and also when there are any difference in the values of heart rate and spo2 a similar message will also be sent, apart from these things when we find sudden drop in speed then also the message will be sent and location is also included.

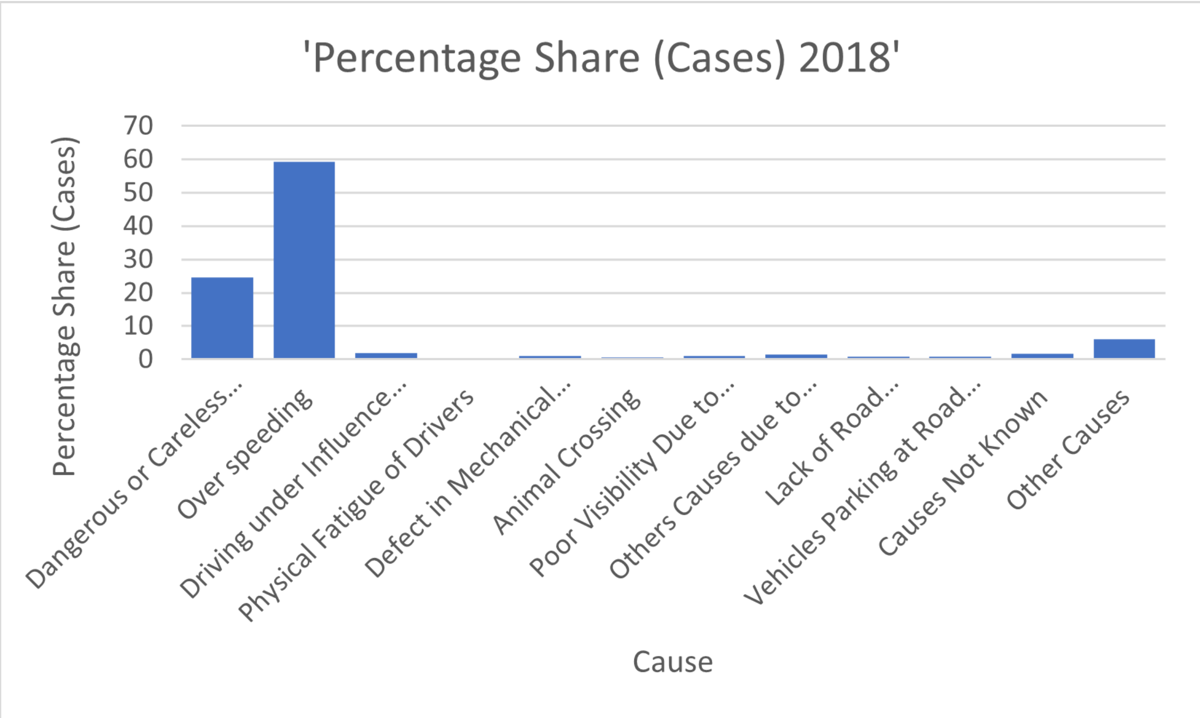
The below screenshot shows how the notification will be sent once the accident is detected.

4. Analysis

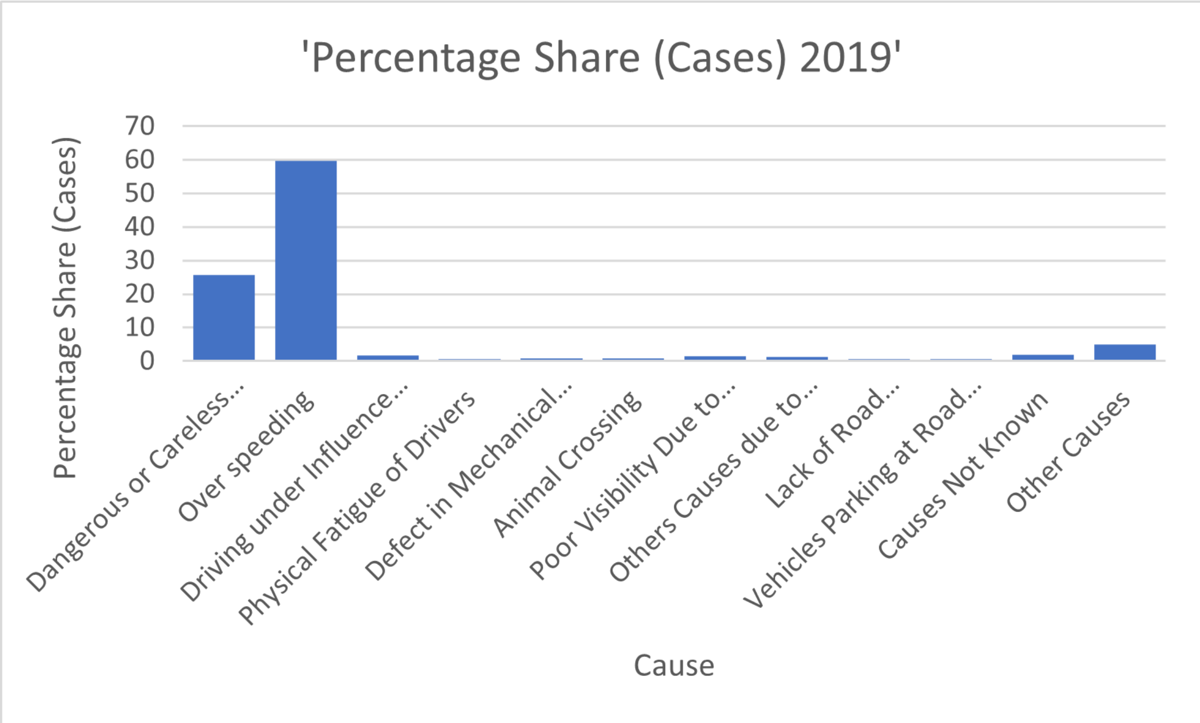
The given hardware model helps in detecting an accident with monitoring vitals like SPO2, temperature, Heart rate. We are analyzing accident data from 2017-19



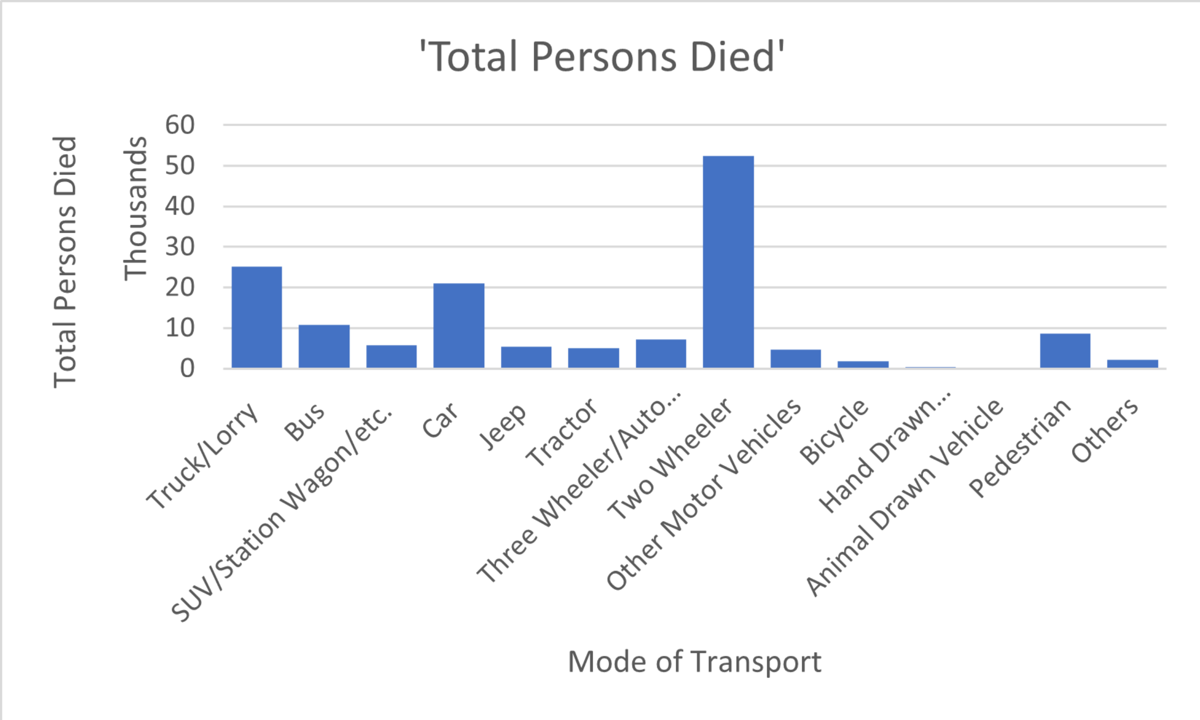
This data belongs to 2017. Here we saw the data of the accidents which occurred in the complete year across the country, here many causes are given but the accidents which are in high number are careless driving and over speeding.



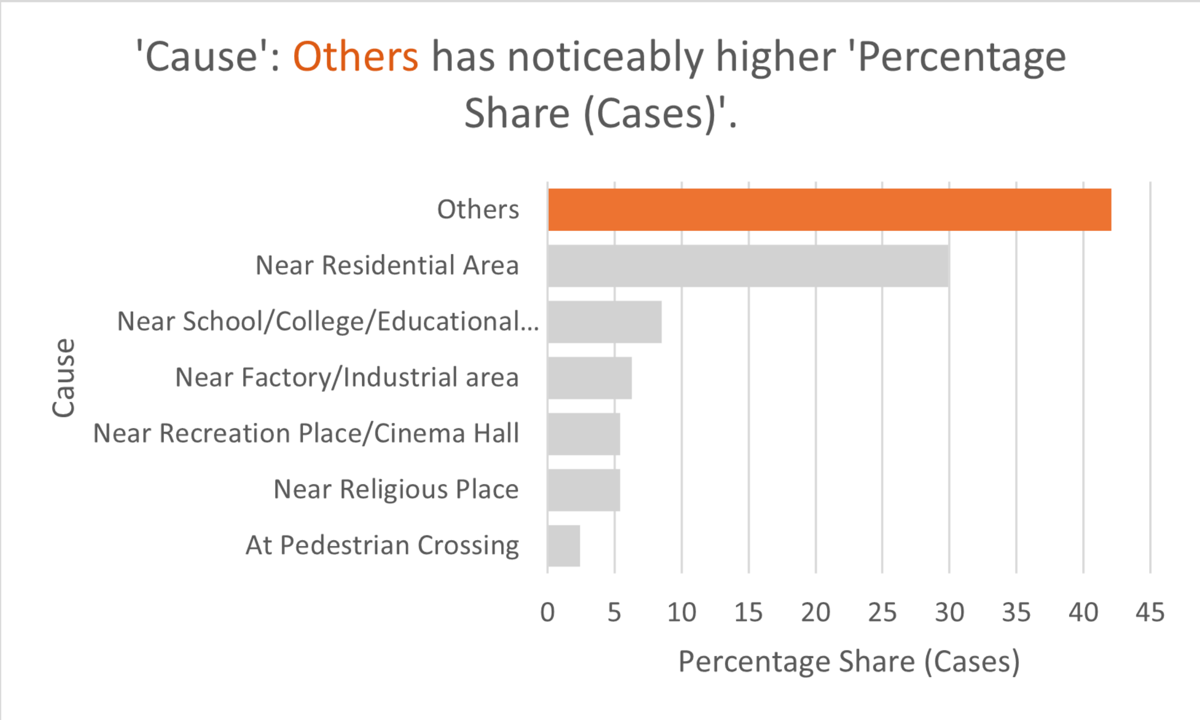
When we see the results of 2018 then the scenario is the same here as well. We are seeing that most accidents are happening because of over speeding, careless and dangerous driving.



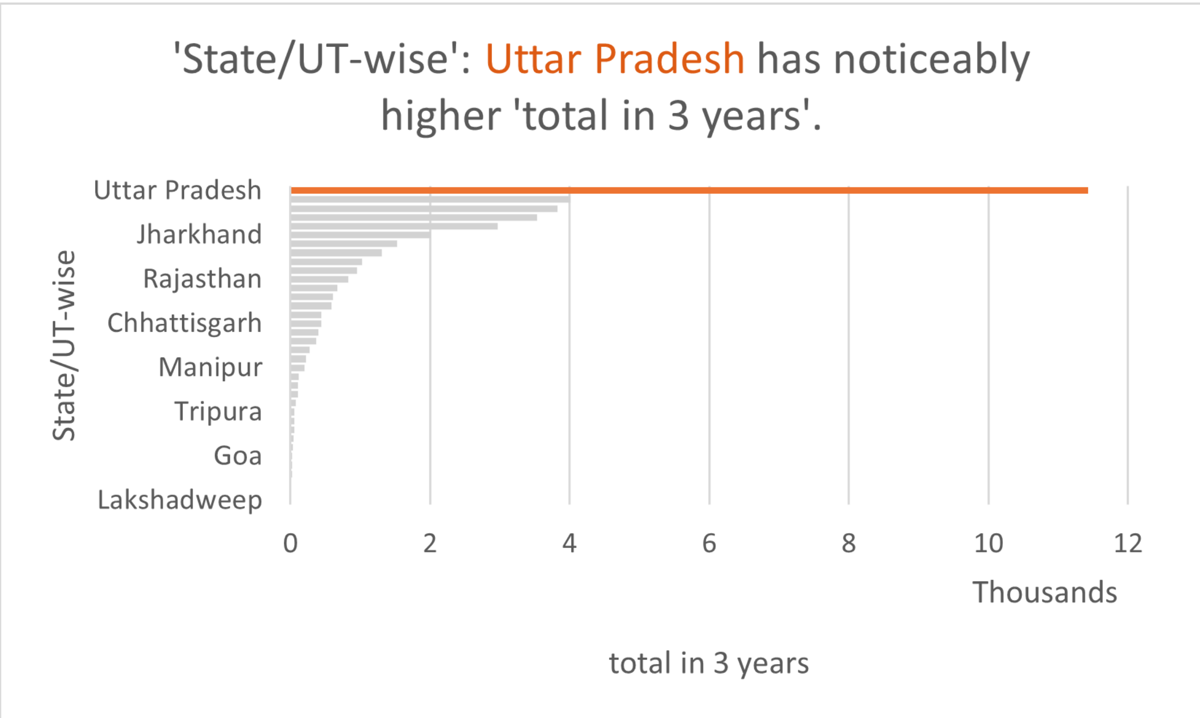
When we see in 2019 the values are almost similar we are seeing noticeably high graphs with cause over speeding and careless driving. if this kind of accidents happened in a remote areas and not so busy highways then it will be a huge problem to save the people inside the car, but using the arduino based accident detection module gives message to the concerned parties such as nearest hospitals and emergency contact numbers and also we can send this message to the family members. This module doesn't only look at accidents which happened at high speed but also monitors vitals which are crucial in today's world. If the module found any abnormalities in the body of the driver it will send a message to concerned parties. This overspeeding can be notified by detecting the speed and these vitals can be shown and can give a warning to keep the driver aware about his vitals, this helps not to cause accidents in very serious health problems like heart attacks.



When it comes to total accidents we can see cars, trucks and two wheelers and buses are in high number. Where this will be the similar statistics in all following 3 years the data given here are the total number of people who died by traveling in which mode of transportation. As the significant accidents are comparatively high when we look at all 4 wheelers and heavy vehicles together when compared with bikes. This module not only goes for cars but also bikes where the MQ 3 sensor has to be placed near the rider when it comes to setting up this module on a bike. But in cars and other mentioned vehicles this can be easily done and with continuous vital monitoring we can decrease accidents happening by health issues as well.



This data shows where we can see more number of accidents most of the accidents are happening in residential areas in the cities this data is combined or urban and rural areas this stats shoes the occurrence is noticeably high in these areas, apart from this module which detects accidents this stats show there has to be speed measure for these areas when the reason will be high speeds.



This data shows the maximum number of accidents which happened in each state, which stands out to be Uttar Pradesh have more accidents which results in conclusion that these kinds of modules have to be made mandatory in these states and also north east states and lakshadweep has noticeably less number of accidents.

5. Conclusion and future work

The proposed system successfully reduces the problem of false detection of all the existing accident management systems while enhancing safety, improving efficiency and reducing costs associated with accidents. It also monitors the driver's health and sends notifications to family members if something is wrong.

While our work shows good results, still room for improvement and future research is there. More sophisticated algorithms can be developed to detect complex accident scenarios like multi-vehicle collisions so that immediate help can be provided. Further, our system can be enhanced by integrating it with emerging technologies like vehicle-to-vehicle (V2V) communication. Finally, artificial intelligence and machine learning can be integrated to take it one step further and improve the effectiveness of the system. Security using various cryptographic algorithms to encrypt data being sent over to the respondents can also be implemented.

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