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IoT Based Vehicle Accident Detection, Prevention and Parking System

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Abstract: ***Transportation systems play an important role in our daily lives and we can't consider a day without vehicle. Therefore, when we go outside, we observe and watch news on media that road accident occurs every day not only in Bangladesh but also around the world with the increasing of population. People can't understand this phenomenon as it can't be predicted. There are situations where most of the accidents cannot be informed properly to nearby hospital, rescue time and police station on time. And many lives and losses would have saved if ambulance and rescue team had reached the accident spot early. Hence, we have felt that there is a need of developing a system which can enhance road safety management system and mitigate accidents. We do propose this vehicle accident detection, prevention and parking system. A driver can seek emergency help manually with the using of push switch. The broadscale benefit of this module if the vehicle is thrust by any object then the system will notify the driver. And this system can provide all the information of vehicle status, location to the driver and the authority timely.***

Keywords: Temperature sensor, GPS, GSM, Microcontroller, Accelerometer, Ultrasonic sensor, Motor driver, Vehicle parking.

I. INTRODUCTION

Maximum roads in Bangladesh are narrow, have many curves,turns and very tight. These are the major causes of the accident. Vehicle accident prevention and detection system can play a crucial step in taking actions of accident safety and management in transportation system. Such accidents have not only dreadful effects on human life but also causes major loss financially to the victims and government. Some latest researches launched by Bangladesh Road Transport Authority(BRTA) which was published in The Business Standard Newspaper that the country witnessed 50,495 road accidents in 2023 ,5,024 died and 7,495 sustained injuriesand by the Bangladesh Jatri Kalyan Samity (BJKS) which was published recently in Dhaka tribune newspaper that in 2022 at least 6,749 road accidents happened, 9,951 people died and 12,356 others were injured in Bangladesh [1]. These data are just numbers and day by day it is increasing rapidly at an alarming rate. In 2023 from January to June 2023 Dhaka Metropolitan Police (DMP), a renowned police department of Bangladesh recovered 126 vehicle which were hijacked previous year but the litigation number was higher than that [2]. Then many robbers had changed the outer structure, and sold the engine parts before seizing. So, if the vehicle's exact location can be traced on that time then there will be less possibility of hijacking. Therefore, in order to detect accident place, avoid accident and eliminate hijacking and for parking vehicle we used certain sensors to function the mechanism effectively.

II. LITERATURE SURVEY

Various public and private organizations around the world have taken many steps to detect, localize, report and analyze road accidents that happens everyday on road. Many authors have worked on Internet of things (IoT) based technology to mitigate this situation recently. Here we discuss the most related works and highlight our model.

Swetha,Shruti,Sushmita found many shortcomings while working with the IoT based Vehicle Accident Detection And Tracking System using GPS Modem such as high cost, sending data are not secure and the systems is not applicable for poor network connection places[3]

Ali and Alwan [4] proposed a system by following some steps to detect low speed and high-speed car accidents. If the vehicle runs at high speed and the smartphone's acceleration is > 4G, then there is an accident that is identified by the mobile application. It may provide false alert in few cases because it works only on mobile networks.

Authors Raut and Sachdev [5] proposed a call notification system which was comprised of XBee WiFi Module, XBee Shield, Module and Seeeduino. They implemented crash sensors only. Hence the accuracy of the system may not be standard.

Sandeep discussed a solution for the accidents that are mainly occurred by drinking alcohol and drive issues. For this model, they integrated few sensors like touch sensor, heartbeat sensor, alcohol sensor attached with Raspberry Pi. In their system, they were only able to know the situation of the car when the driver is drunk [6].

Yadav [7] suggested a way for detecting accident and determining the reason to the registered number. In their work, they are able to report an accident to a fixed number but by following this they couldn't obtain an emergency service. However, the work was not satisfactory because of the lack of resources and components which they suggested to present in implementation section.

kusum , Sampada, Ramakanth discussed a detection system of driver drowsiness using IR sensor .The head movements of the driver are monitored by the vibration sensor which is fixed onto the fore head of the driver .If the driver falls sleep the eye blink sensor vibrates and LCD displays the warning message. The wheel is then be slowed or stopped depending on the situation. This system is uncomfortable as the driver has to attach an accelerometer to the forehead every time. Here, driver behavior is the only factor for identifying accident [12].

Table 1: A summary of Comparison among Accident detection, prevention system

Authors& Year	**Detection accuracy**	**Accident classification**	**Control system**	**Emergency center help service**	**Communication technology**	**Car parking system**	**Temperature detection**
Swetha,s..,et al 2017[3]	low	Accident type	Mobile phone Based	Automatic	Wi-Fi	No	No
Koneti ,p..et al 2017[6]	low	Drunken drive	Smartphone based	No	Wi-Fi	No	No
Kusum,s.et al [12],2021	High	Drive issue	Smartphone based	Automatic	Wi-Fi	No	No
Sharma.s..et al[8],2019	Low	Injury's existence	No	Automatic	4G/LTE	No	No
Praveen,S.et, al[9],2022	High	Accident type	No	Automatic	4G/LTE	No	No
Proposed method	High	Accident type	Smartphone based	Automatic & Manually	Wi-Fi, GPRS	yes	Yes

We have studied many research and project paper related on IoT based vehicle accident and detection system. We found that these projects have tradeoffs and lack of some material and resources.

III. PROPOSED METHOD

This project proposes innovative approaches to enhance road safety management of vehicle accident detection, prevention and car parking system with the proper use of advance Internet of Things (IoT). This study aims to explore the system architecture, implementation and potential benefits of an IoT based Accident Detection and prevention system for smart vehicles. This system sends data of vehicle's location, internal parameters, condition to the server in real time. Thus, the authority can easily monitor vehicle movement through server if it is stolen or damaged. If the car tilts by any accident or collision occurs it will send short message of longitude and latitude value of that spot to the hospital, police station and authority promptly via Global Positioning System (GSM) over the internet at the same time. The overarching goal of this project is the driver can get emergency help service by pressing push switch manually staying inside of the car at crisis moment. Ultrasonic sensor is used here for maintaining short distance at the time of car parking. Moreover, if the car gets thrusted by any object then limit switch will give signal to the driver. This will help the driver to anticipate and mitigate potential accidents before they occur. By leveraging this IoT technology and intelligent algorithm this proposed system aims to reduce accidents, vehicle hijacking and save lives and losses of property at a greater rate.

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IV. SYSTEM IMPLEMENTATION

The proposed system is consist of temperature Sensor (DS18B20), GPS (Neo6m), Accelerometer (ADXL335), Ultrasonic Sensor (HC-SR04), Motor Driver (L293D), Motor, switch, Buzzer, LED. These components are integrated following the block diagram below

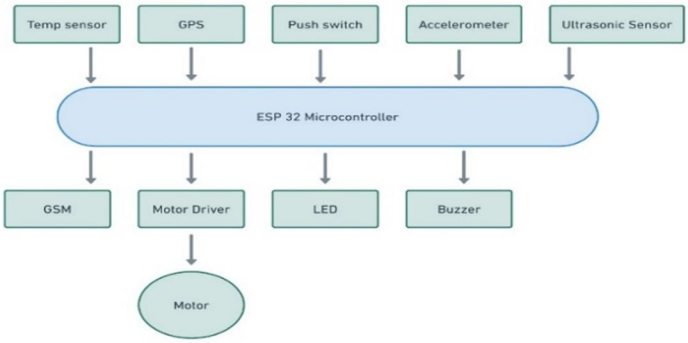

Figure 1. Block diagram of IoT based Accident detection, prevention and Car parking system

V. HARDWARE COMPONENT

A. ESP32 Microcontroller

ESP32 serves as the brain of the system which has high processing data speed with built in Bluetooth and Wi-Fi. It is energy efficient as it consumes low power in sleeping mood. It features dual core processor, multiple general input/output pins(GPIO),Analog to digital converters(ADCs),Digital to analog converters(DACs),Pulse width modulation(PWM) and various communication interfaces like Serial peripheral interface(SPI),Inter-integrated circuit(I2C),Universal asynchronous receiver transmitter (UART),reset button, micro Universal serial Bus (USB) port and boot button etc.

B. Temperature sensor (DS18B20)

Temperature sensor (DS18B20) has high accuracy as it is waterproofed. And being long wired, the information of temperature of system can easily be measured from a distance. Sensor output is digital so ADC is not necessary here and it is consist of three pins; voltage collector VCC, ground (GND) and Output.

C. GPS (NEO6M) and GSM

The Global Positioning System (GPS) is a satellite-based radio navigation system. It is used in this system to know the location of altitude, latitude value of vehicle in real time. It communicates via UART that makes easy to interface with ESP32. Then Global System for Mobile Communication (GSM) communicates with microcontroller via UART and delivers the data to the server and in emergency case it can send SMS in specific number

D. Accelerometer (ADXL335)

ADXL335 is a 3 axis (x, y and z) analog accelerometer used to measure the acceleration of x, y and z axis of an object. We used this sensor to measure the rapid changes of acceleration of vehicle caused by vibration and tilt motion. Accelerometer sensor senses the change of Gravitational forces (g force) in the object. The value of the g force tells about the type of the accident collision or tilt. When the particular value of any axis (x, y or z) increases above the threshold value and it remains above the threshold value at particular time then it will detect accident at tilt position. On the other hand, if there is a collision of face to face then there will be a shock wave and, on that time, if all the three axis (x, y and z) value increases above the threshold value then the sensor detects accident.

E. Push switch and limit switch

If the system doesn't function automatically then for seeking emergency help the driver can manually send message by pressing the push switch to the police station and hospital and authority. Almost every vehicle attach bumper to the front side of the car for protection and sometimes the driver can't realize if anything hits the bumper. In that case if we set up limit switch with bumper then the limit switch will notify the driver with a signal.

F. Ultrasonic Sensor (HC SR04)

It uses ultrasonic waves to measure the distance of an object and it is widely used in robotics, automation. Here, In this system We used this device for car parking system to avoid collision.Using the trig pin, we send the ultrasound wave of 10µs duration then it will travel through the air. If there is any object or obstacle it will bounce back to the module and with the echo pin reflected sound is listened. Considering the travel time duration and the speed of the sound we can calculate distance of the opposite or adjacent object.

We know the speed of sound in air is 343m/s(approximately) or .343cm/s. The time duration is the amount of time the echo pin is HIGH and we calculate it as10 µs. The distance travelled by the wave =time duration*.343/2. So, our system will determine the distance of the adjacent or opposite object and notify the driver. Then the driver will be able to stop the car maintaining safe distance and thus collision can be avoided eventually.

The program we use to determine the time is given by

```
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = (duration*.0343)/2;
Serial.print("Distance: ");
Serial.println(distance);
```

G. Motor driver (L293D)

Motor can't be operated with low current signal; it needs high current signal. To produce high current signal, we used this motor driver.

H. Motor

It is used as a sample if the system works or not.

I. Power Supply

In our system we used 3.7v ,1200mAh capacity battery. And at the time of real application the power system parameter's value may vary. We develop a power bank circuit which is combination of Battery Management System (BMS) and 3.7v – 5v boost converter to perform the mechanism effectively. The BMS saves the battery from being overcharged and over discharged. SIM800L, push switch & limit switch are operated with 3.3v power supply and ESP32 microcontroller, Neo 6m,HC-SR04 and all other components are operated with 5V power Supply.

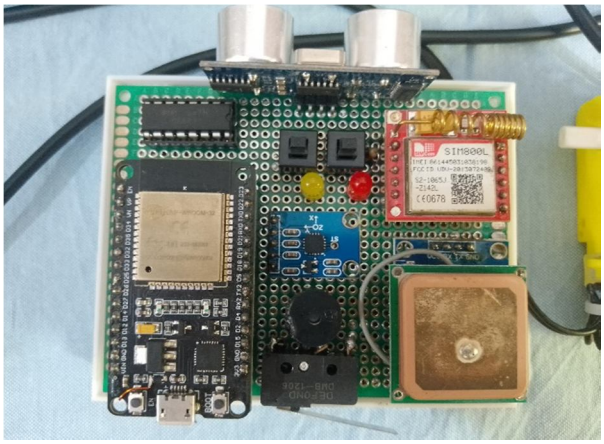

Figure 2. Hardware set up of accident detection, prevention and Car parking system

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VI. REQUIRED SOFTWARE

A. Arduino IDE: Arduino is the brain of the entire mechanism as it controls the flow of information between sensors. The Arduino Integrated Development Environment (IDE) software tool serves as a platform for uploading program in Arduino microcontroller.
B. Blynk Cloud: Blynk cloud is a web application which helps the authority to visualize data, manage system and IOT devices from anywhere.

VII. SYSTEM ARCHITECTURE AND WORKING PRINCIPLE

This system is developed with the using of Arduino IDE and Blynk. The programming language C++ with other variants were uploaded to microcontroller (ESP32). The mechanism is divided into some subsystems and these subsystems are interconnected. The following figure represents the system architecture. The sensors will detect the respective parameters and pass the signals to microcontroller.

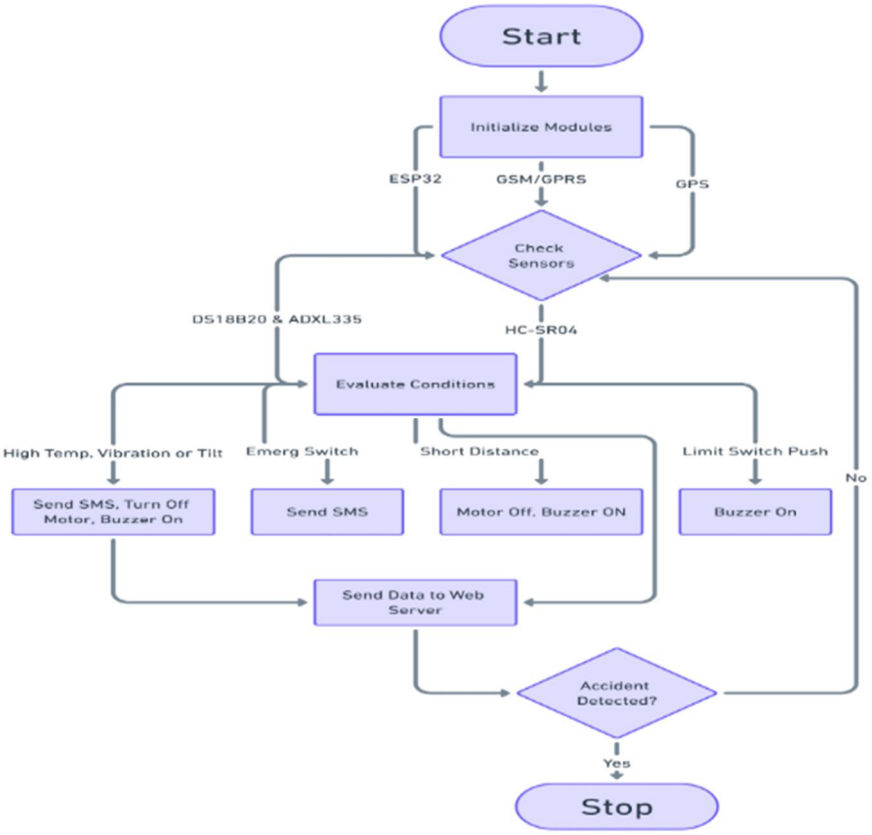

Figure 3. Flow Chart for working principle of the Accident detection, prevention mechanism

When the driver touches the power button, the detection system will be activated. Then GSM/GPRS, GPS module will be initialized and temperature sensor (DS18B20) will check the engine temperature continuously. Accelerometer (ADXL335) monitors vibration frequency and acceleration value. If the vibration frequency, engine temperature and acceleration value increase above the specified threshold value then microcontroller count it as an accident. Then GSM will send emergency SMS and the location will be traced by the GPS system and turn off the motor and turn on buzzer. If none of the sensor's parameter value increases above the specified value it will evaluate the condition again. Ultrasonic sensor (HCSR04) is attached to the system for maintaining short distance at car parking. If any car approaches closely to this attached device car it will give alert to the driver. If emergency push switch is pressed then it will send emergency message. Here, in our system Limit switch is affixed at every side of the vehicle. If limit switch is thrust by unwanted object then the system will turn on buzzer. This will help to avoid forthcoming damage. Then the driver will be able to take the car in safe mode and place. Our proposed system will always update data on web server using open-source application. Here motor is symbolized as a vehicle engine.

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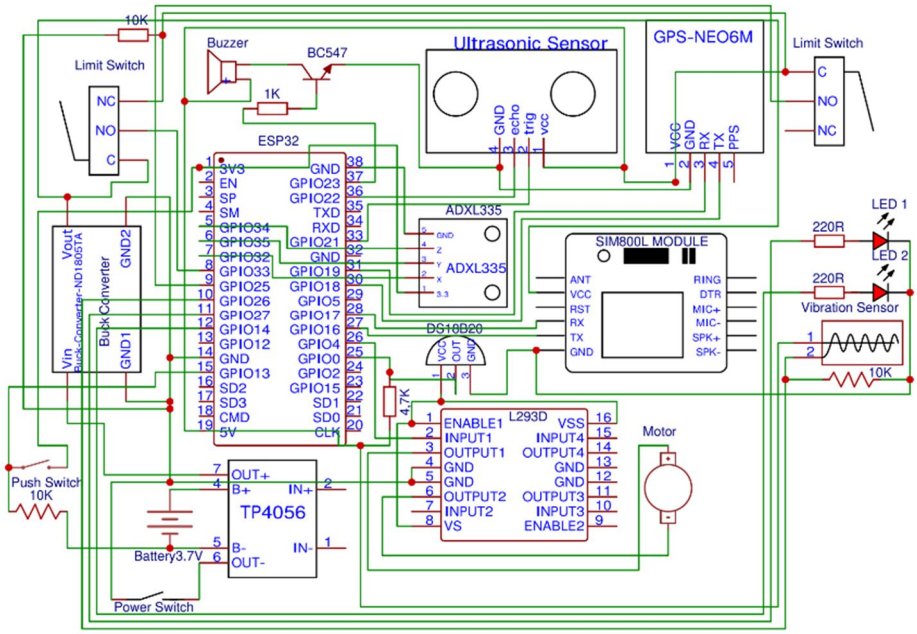

Figure 4. Schematic circuit diagram of accident detection, prevention and vehicle parking system.

VIII. CODE IMPLEMENTATION

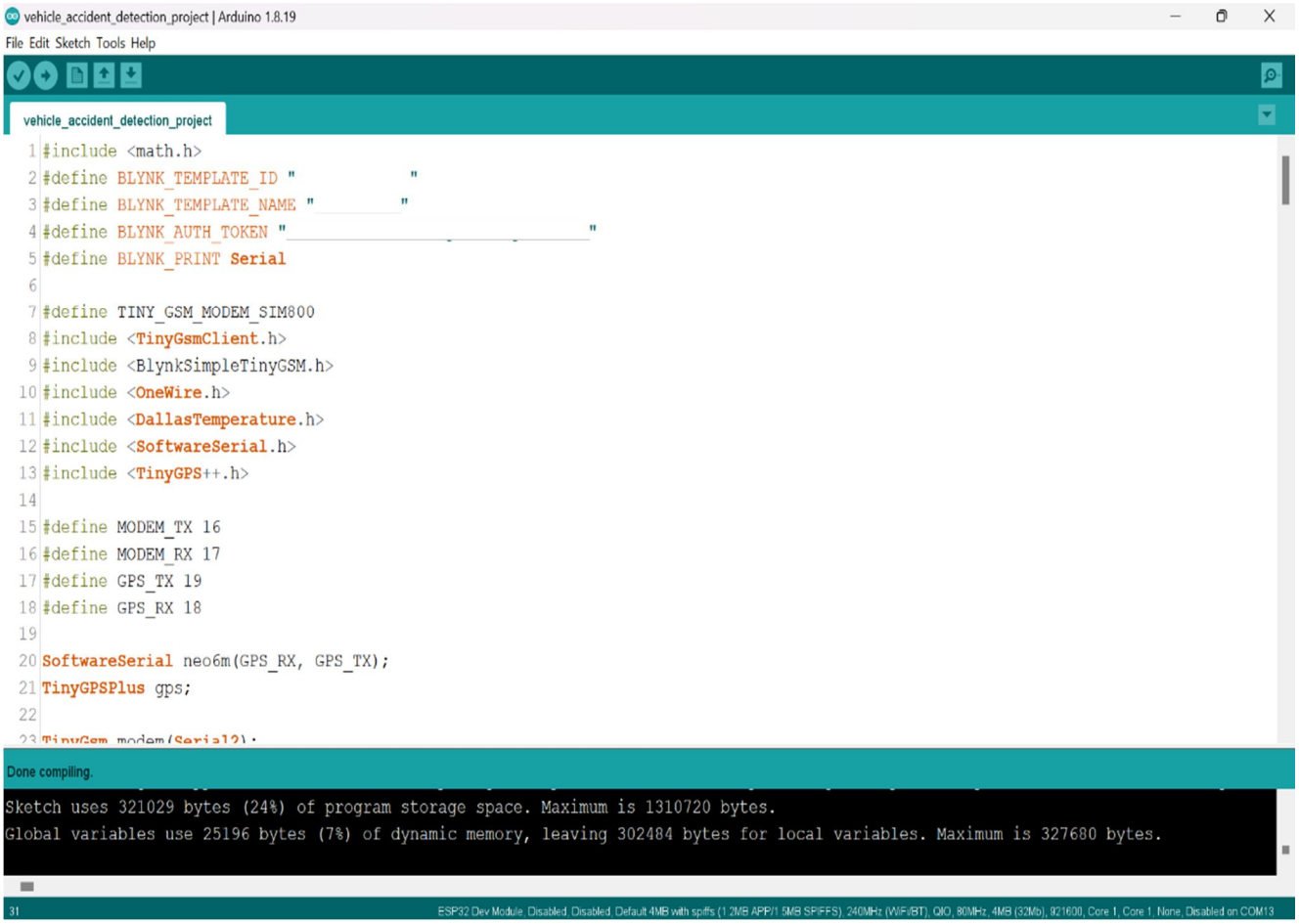

Figure 5. Compiling was done successfully with the use of Arduino IDE

IX. HARDWARE IMPLEMENTATION

A. *Application of Accelerometer*

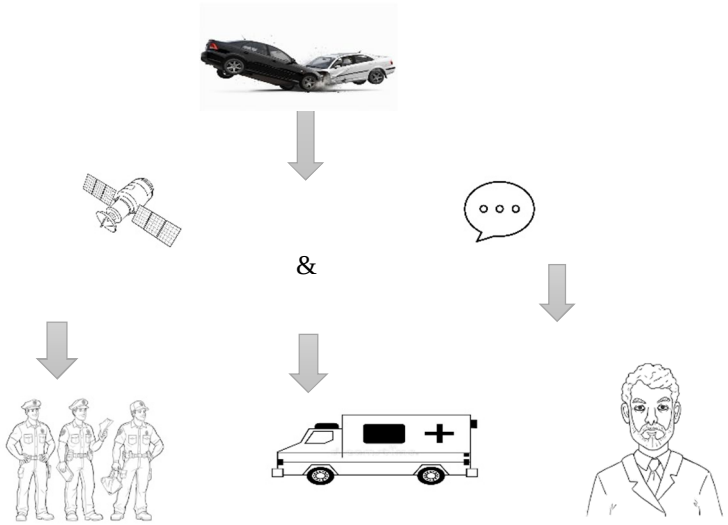

Figure 6. An overview of IoT based Accident detection and alerting system

B. *Application of Ultrasonic sensor*

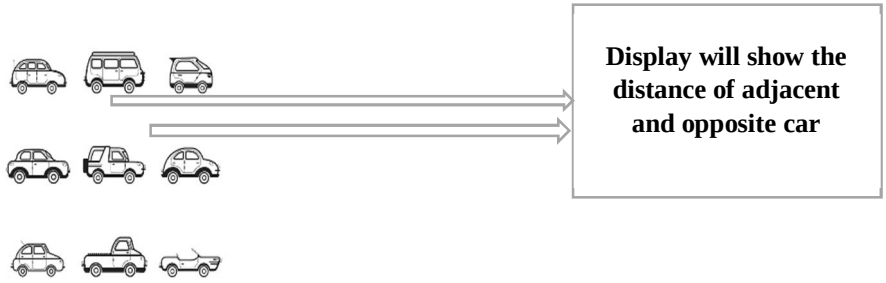

Figure 7. An overview of IoT based vehicle parking system

C. *Application of Push Switch*

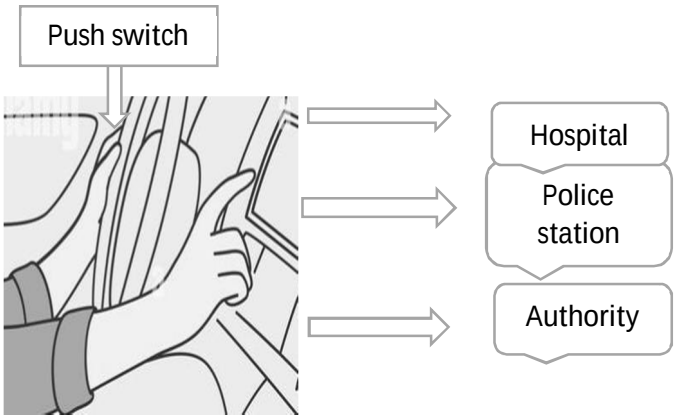

Figure 8. An overview of IoT based emergency help system

D. Application of limit switch

Figure 9. An overview of IoT based vehicle observing system

X. ADVANTAGES

1) Can detect the severity of accident at static and tilt condition
2) GPS location can be traced during accident and moving time
3) Less Vehicle hijacking possibility
4) Unwanted damage can be avoided
5) Vehicle parking feature
6) Engine temperature can be monitored
7) Emergency SMS can be sent manually.

The system is highly profitable and it has multiple applications. Our proposed system is approximately precise making it useful for shortening reactions times and providing services in crisis moment.

Future work-In this project we used Ultrasonic sensor and limit switch to avoid unwanted damage. Hereafter, LiDAR can be used to perform these tasks and it will be also able to do a scan of 360-degree angle. In addition, if a camera can be set up with the proposed device rugged roads and hazardous dent can be early detected as an warning with the use of image processing system.

XI. CONCLUSION

In our mechanical life we have started to depend on automobiles for our daily works. For the lack of immediate medical services and rescue team the road accident leads to fatal deaths. Internet of things (IoT) helps many a system to control and monitor remotely.

Our proposed system helps providing with faster communication to three routes for delivering emergency message manually and automatically. And this system asks for help in crucial time. If we implement this model with appropriate planning and resources, this framework can serve the worldwide society at a great extent in transportation system.

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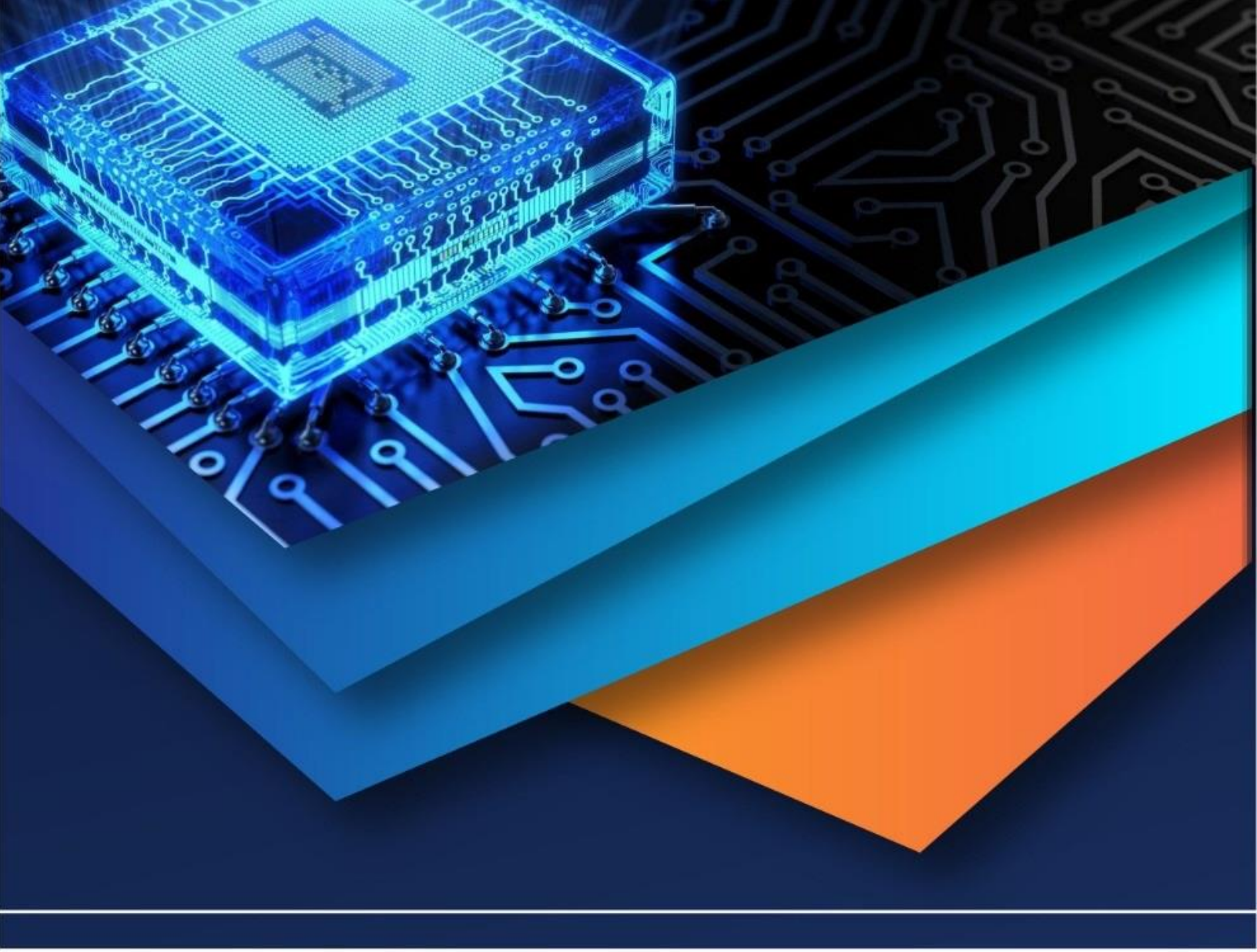

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