International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST229689

Active Safety System in Vehicles using Sensor Network Model

Ishan Kharat, Atharva Kulkarni, Dhaval Mahajan, Kartik Avhad, Sumit Jadhav
Department of Electronics and Telecommunication Engineering, VES Institute of Technology, Mumbai, Maharashtra, India

Article Info
Volume 9, Issue 6
Page Number: 676-684

Publication Issue
November-December-2022

Article History
Accepted: 05 Nov 2022
Published: 30 Dec 2022

ABSTRACT

The imperative need to enforce safety measures to prevent deadly accidents exists in the world of urban traffic environments today. During 2021, two-wheelers have been reckoned for the maximum number of fatal roads accidents accounting for 69,240 fatalities, or 44.5 of total road accidental deaths, followed by cars (23,531 deaths, 15.1) and trucks/lorries (14,622 deaths, 9.4%). Accidents may happen regularly as a result of drivers' carelessness and imperfect indicators of faulty warning signs on the road. Road safety policy's primary focus for several decades included techniques like signs, speed limits, and straightening bends. The system provides the Global Positioning System (GPS), Geographic Information System (GIS), and Global System for Mobile Communications (GSM) to cater to the requirements of some intelligent vehicle monitoring systems. The research presented in this study sheds light on the vehicle's decision-making process by using a novel approach.

Keywords : Accident Prevention, Accident Detection, Global Positioning System, Global System for Mobile communication, Intelligent Vehicles, Sensor Systems, Vehicle Safety

I. INTRODUCTION

Most countries have witnessed a 3% loss in GDP as a result of traffic accidents. Despite the tremendous commitment and attempts to stop traffic accidents continue to lead to a rising number of fatalities, injuries, and hospitalization in the nation. There is a substantial economic impact associated with road traffic accidents for the victims, their families, as well as for entire countries. The cost of medical care and lost wages for injured victims, as well as caring expenses for family members who must take time off from work or school to look after the injured, contribute to these losses.

The lives of almost 1.3 million people are cut short every year as a result of road accidents. Additionally, 20 to 50 million people suffer non-fatal injuries, and many of these people develop disabilities as a result.

For children and young adults aged 5 to 29 years, fatal road accidents are the main cause of death.

The term "crash severity," which denotes the risk of a fatality in a road crash, can be used to evaluate the impact of road accidents in India. The incidence of fatalities in a traffic accident increases with collision severity. Save Life Foundation data show that India's road crash severity increased from 37.5 in 2020 to 38.6 (deaths per 100 crashes) in 2021. According to data that is presently available, China came in second place behind India among the top 20 countries for road crashes in 2016, with a crash severity of 31.4. (29.64)

According to the National Crime Records Bureau (NCRB), in 2021 there were 4,03,116 road accidents, up from 3,54,796 in 2020. In the meantime, the number of fatal traffic accidents rose by 16.8%, from 1,33,201 in 2020 to 1,55,622 in 2021. 3,71,884 individuals were hurt in traffic accidents last year. Additionally, the number of fatalities per 1,000 cars rose from 0.45 in 2020 to 0.53 in 2021.

Speeding accounted for 59.7% of all incidents (2,40,828 out of 4,03,116 cases), which resulted in 87,050 fatalities and 2.28,274 injuries, according to a cause-by- cause analysis of traffic accidents. 1,03,629 accidents (25.7% of all accidents) were caused by reckless or irresponsible driving or overtaking, which resulted in 42,853 fatalities and 91,893 injuries. Poor weather conditions were to blame for 2.8% of these accidents (11,170 out of 4,03,116 instances).

II. RELATED WORK

The existing technologies in the market have a primary focus on the live Global Positioning System (GPS) with 3m (three meters) tracking accuracy. These devices are not very accurate in critical scenarios, especially in the absence of any light. Which are a critical factor in most rural areas and tier-two cities. In places where there is a deficiency of light available the tracking of the vehicle is not precise and the GPS can give some other location.

Some pre-build systems consist of only one of the components in the category of safety systems, in addition to it. The minimum cost of these single components in the market is around ₹8000 which proves to be a lot expensive for just one feature. The overspeeding alerts give the driver of the vehicle when he/she is traveling at a speed that is more than the designated speed on that particular road.

Most of the devices that are developed [5], [6], [7] in the market, focus on only one aspect, i.e., either speed control or safety system. Since overspeeding results in 58.7% of the total accidents, there is a need to install a safety system in every vehicle that sends an alert to the nearby refuge.

III.COMPONENTS USED

The proposed system is built using the following components.

A. MSP430F5529

The Texas Instruments MSP430F55xx microcontrollers (MCUs) are a part of the MSP430TM system control and communication family of ultra-low-power microcontrollers, which include assorted components with peripheral sets aimed at various applications. The architecture is optimized to achieve longer battery life in portable measuring applications when paired with numerous low-power modes.

Figure 1: MSP430F5529

The microcontroller comes equipped with a potent 16- bit RISC CPU, 16-bit registers, and constant generators that let the code run as efficiently as possible. The devices can transition from low-power to active mode in 3.5 s (typically) thanks to the digitally controlled oscillator (DCO) [8].

B. Node MCU/ESP8266

Figure 2: Node MCU

Node MCU is a low-cost open-source IoT platform. It first came with hardware based on the ESP-12 module and firmware that runs on Espressif Systems' ESP8266 Wi-Fi SoC. Support for the 32-bit ESP32 MCU was later added. A circuit board acting as a dual in-line package (DIP) that incorporates a USB controller with a smaller surface-mounted board holding the MCU and antenna is the prototyping hardware that is frequently utilized. The DIP format's selection makes breadboard prototyping simple. The ESP-12 module of the ESP8266, which is a Wi-Fi SoC combined with a Tensilica Xtensa LX106 core and is extensively used in IoT applications, served as the design's initial foundation [9].

C. Neo-6M GPS Module

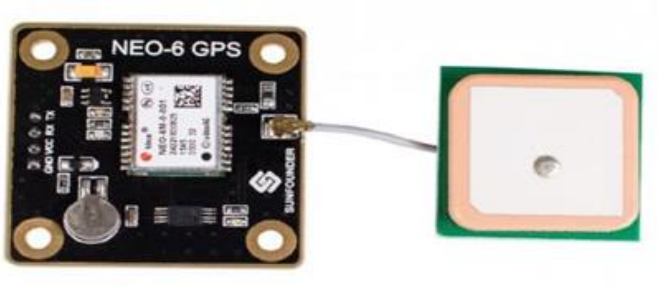

Figure 3: Neo-6M GPS Module

The NEO-6M GPS module is a full GPS receiver with an integrated 25 x 25 x 4mm ceramic antenna that offers a powerful satellite search capability. The power and signal indicators let you keep an eye on the module's condition. When the main power is unintentionally turned off, the module can still save data because of the data backup battery [10].

D. SIM900A GSM

Figure 4 : Neo-6M GPS Module

The module is the smallest and cheapest module for GPRS/GSM communication. It is common with Arduino and microcontrollers in most embedded applications. The module offers GPRS/GSM technology for communication with the use of a mobile sim. It uses a 900 and 1800MHz frequency band and allows users to receive/send mobile calls and SMS. The keypad and display interface allows the developers to make customized applications with it. Furthermore, it also has modes, command mode, and data mode. In every country, the GPRS/GSM and different protocols/frequencies operate. Command mode helps the developers to change the default setting according to their requirements [11].

E. MPU 6050

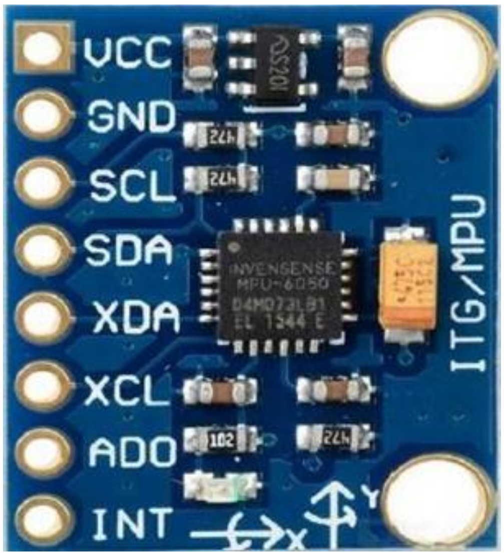

Figure 5: MPU6050

A full 6-axis Motion Tracking Device is the MPU6050 sensor module. In a compact design, it incorporates a 3- axis gyroscope, 3-axis accelerometer, and digital motion processor. In addition, it contains a temperature sensor built right into the chip. To connect with the microcontrollers, it has an I2C bus interface. To interface with other sensor devices like a 3-axis magnetometer, a pressure sensor, etc., it features an auxiliary I2C bus. MPU6050 can deliver a full 9-axis Motion Fusion output if a 3-axis Magnetometer is connected to the auxiliary I2C bus.

F. Ultrasonic Sensor

Figure 6: Ultrasonic Sensor

An ultrasonic sensor is a piece of technology that uses ultrasonic sound waves to detect the separation between a target object and itself before turning the sound's reflection into an electrical signal. The speed of audible sound is greater than the speed of ultrasonic waves (i.e., the sound that humans can hear). The transmitter (which generates sound using piezoelectric crystals) and the receiver are the two major parts of an ultrasonic sensor (which encounters the sound after it has traveled to and from the target).

IV. METHODOLOGY

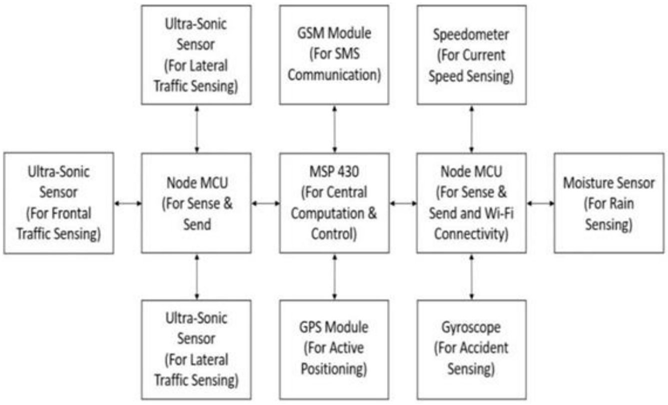

Figure 7 : Block Diagram of the System

MSP is interfaced with ESP using SPI UART The system demonstrates two functions, a speed control system, and a post-plan of action after an accident.

Focussing primarily on the speed control system:
A reference speed is provided to the system prior, and exceeding that speed limit initiates a warning signal to the system.

Accident monitoring:
It is detected with the help of crash sensors [Vibration sensors], and MPU6050, the GPS further tracks the location and is connected to the nearby hospitals and police stations with the help of a GSM module.

The system is designed in the hardware and software domain as follows.

Hardware domain:

The MSP430F5529 microcontroller serves as the central computation and control unit in the system, coordinating the various sensors and devices connected to it. The ultrasonic sensors are used to detect the presence of nearby vehicles or obstructions, and the NodeMCUs are used to interface these sensors with the MSP430.

The speedometer and DHT sensor are used to monitor the speed of the vehicle and the moisture level of the road, respectively. If the vehicle exceeds a predetermined reference speed limit, the speedometer will detect this and provide a warning. The DHT sensor will provide the driver with information about road moisture, which can affect the safety of the vehicle.

The gyroscope is used to detect accidents by monitoring the toppling angle of the vehicle. If the angle exceeds a preset threshold, the system will consider it an accident. The GPS module is used to determine the exact location of the vehicle in the event of an accident, and this information is provided to the GSM module, which can then send SMS messages to the driver's family members to inform them about the accident and the location of the vehicle.

The Energia IDE is used for coding the system, and the necessary libraries for the GPS and GSM modules are included in the code. The NodeMCUs are used to interface with the MSP430, making it easier to handle the various sensors and devices connected to the system.

Software Domain:

The Energia IDE is used for coding the MSP430 microcontroller, while the Arduino IDE is used for coding the NodeMCUs. The flowchart you provided outlines the steps and tasks that are performed by the system.

The rear NodeMCU is used for WiFi connectivity, and establishing a connection with the WiFi network is the first task to be performed. Once the connection is established, the NodeMCU can communicate with servers and other devices on the network.

The NodeMCU then establishes a connection with the MPU sensor and the DHT sensor and begins its routine in a loop. The system obtains the maximum posted speed for the current road by processing information from the OpenStreetMaps server, which is refreshed every minute. The system then uses data from the various sensors to calculate the maximum speed for the vehicle, which is used for speed control. At the same time, the gyroscope is continuously monitored for signs of an accident. If an accident is detected, a message is sent to the driver's relatives via the GSM module.

Overall, the software and hardware work together to provide real-time monitoring and control of the vehicle's speed, location, and safety.

Step 1 (Connection Establishment State):

To establish a connection to a WiFi network using a NodeMCU module, you can follow these steps:

1. Include the necessary libraries in your code. To connect to a WiFi network, you will need to include the WiFi.h library.
2. Initialize the WiFi connection. You will need to specify the SSID (name of the WiFi network) and password for the WiFi network you want to connect to. You can do this using the WiFi.begin(ssid, password) function.

3. Check for a successful connection. You can use the WiFi.status() function to check the status of the WiFi connection. If the function returns WL_CONNECTED, it means that the connection was successful.

Once the connection is established, you can use the WiFi connection to communicate with servers or other devices on the network.

If the connection fails, it will keep trying until it succeeds or you stop the program.

Step 2 (Data Procurement Step):

In this step, various data parameters of the surroundings are obtained using multiple sensors attached to the peripherals of the three microcontrollers. As there are three computers in action simultaneously, a lot of data will be procured. The front NodeMCU procures data on surrounding traffic. The Central MSP 430 acquires data on the current location using the GPS module. Finally, the rear NodeMCU acquires data on humidity, atmospheric temperature, and the acceleration and inclination of the vehicle (Which are the parameters for accident sensing). The rear NodeMCU acquires data regarding the maximum posted speed of the current road.

Step 3 (Data Transfer and Computation Step)

A system that is designed to calculate the maximum allowable speed for a vehicle based on various factors such as the geocode of the current location, the posted speed limit of the road, the traffic density, and the humidity and atmospheric temperature. The MSP430 microcontroller is being used to transfer the geocode data to the rear NodeMCU, which is responsible for performing a reverse geocoding operation to determine the posted speed limit. The front NodeMCU is being used to calculate the traffic density based on data from three other NodeMCUs. Once all of this data has been collected and processed, the rear NodeMCU will use it to calculate the maximum allowable speed by combining the data on the base speed limit, traffic density, humidity, and atmospheric temperature.

Step 4 (Monitoring and Limiting Step):

The value of the maximum speed will be transferred to the MSP430 to limit the actual speed of the vehicle.

Step 5 (Accident Monitoring and Reporting Step):

This step runs in parallel right after the Connectivity Step (Step 1) is completed. The data of current vehicle acceleration and inclination as acquired from the MPU6050 connected to the rear NodeMCU is processed to determine sudden changes in acceleration (shock) or/and inclination (topple) to decide whether an accident has occurred or not. It further produces a signal "accident" that attains a value of 1 when an accident occurs and 0 otherwise.

Step 6 (Accident Reporting Step):

1) To communicate with the relatives of the driver in case of an accident, you can use a variety of methods, such as SMS, email, or phone call.
2) To send an SMS message, you can use a SIM card module such as a GSM module, which can be connected to the MSP430 microcontroller through a serial interface. You can then use AT commands to send an SMS message to a specific phone number.
3) To send an email, you can use a WiFi module such as the NodeMCU to establish a connection to the Internet and then use a library such as the Arduino SMTP library to send an email through an email server.
4) To make a phone call, you can use a GSM module as mentioned above, and use AT commands to initiate a phone call to a specific phone number.

V. WORKING

The MSP430 microcontroller serves as the central point for accumulating and processing data from the various sensors and devices connected to the system. It is responsible for controlling the GPS and GSM modules, as well as the NodeMCUs, which act as interfaces between the MSP430 and the peripherals.

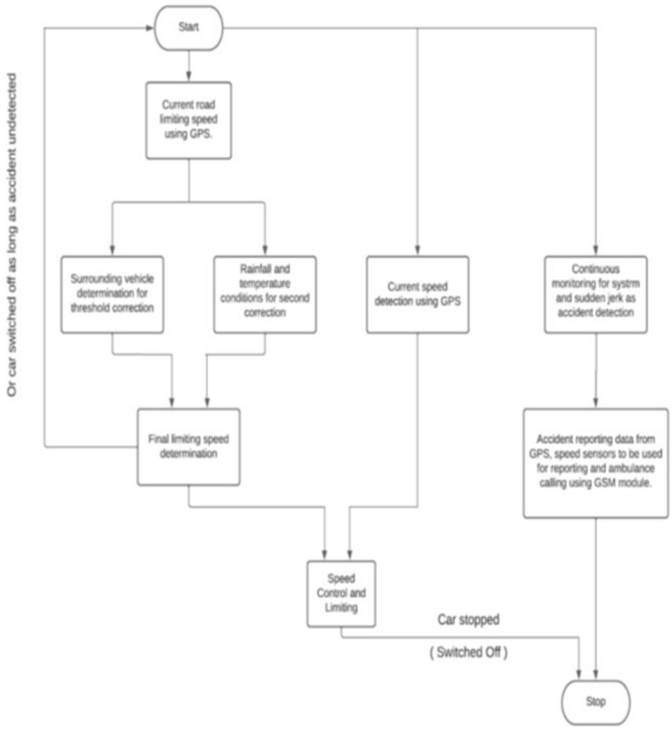

Figure 8: Flow Chart of the System

The speedometer is used to detect the speed of the vehicle, while the ultrasonic sensors are used to detect the presence of objects in multiple directions. The moisture/rain sensor is used to detect rain, which can affect the threshold speed of the vehicle. The gyroscope is used to detect sudden movements or jerks, which may indicate an accident.

The GPS module is used to determine the position of the vehicle, which can be used for accident reporting and other purposes. The GSM module is used to send SMS messages, which can be used to inform the driver's relatives about the location of an accident.

Overall, the system described in the description uses a combination of sensors and devices to gather and process data about the vehicle's environment and status, and to take appropriate actions based on that data.

VI. RESULT

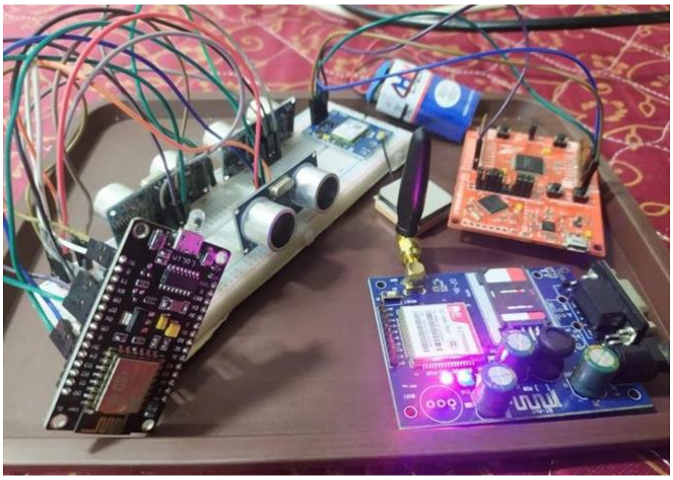

Figure 9: Working Prototype (1)

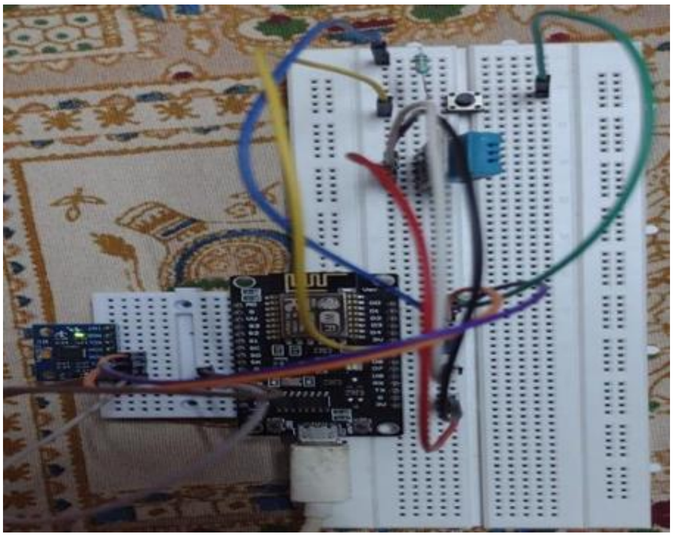

Figure 10: Working Prototype (2)

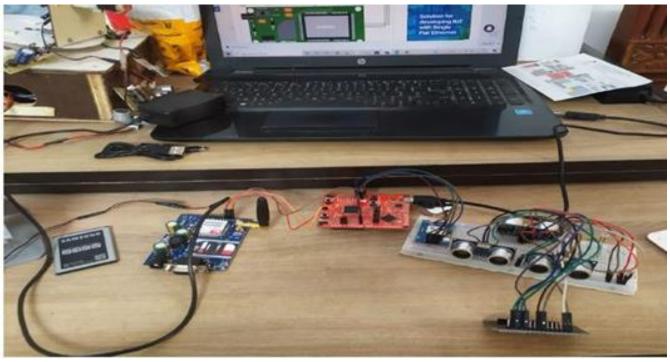

Figure 11: Working Prototype (3)

A GSM Module is connected to the MSP430 and contains a 3G SIM card and an antenna for sending SMS messages to the exact location indicated in the code. In addition, the NodeMCU is interfaced with 3 ultrasonic sensors for traffic analysis.

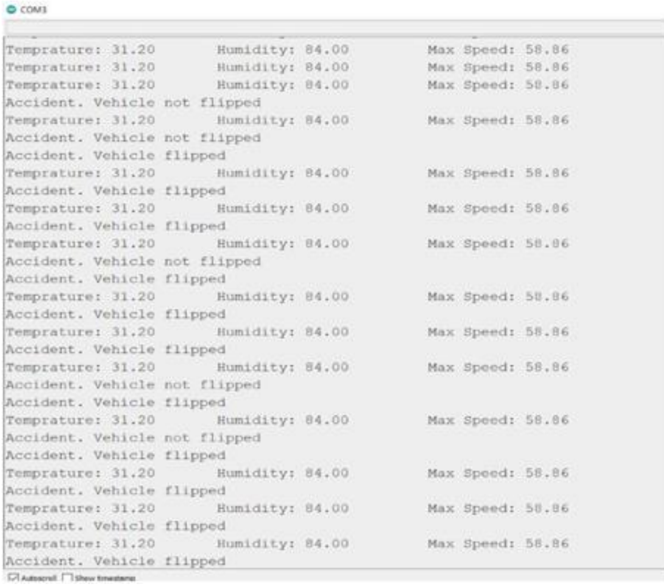

Figure 12 : Serial monitor displaying Accident Instances

When the threshold speed is exceeded, the vehicle speed is reduced and the gyroscope signals the NodeMCU if the vehicle tilts. If the threshold speed is not exceeded, the vehicle speed is reduced. Additionally, the com port window snip shown above shows temperature and humidity with the system detecting a vehicle flip in case of an accident.

VII. CONCLUSION

Safe and secure traveling is a pivotal need of any human society. Road accidents cause the loss of precious life and resources. This prototype gives the design and paradigm of a hybrid hardware-software solution, thereby providing a solution to road accidents. A comprehensive Vehicle Safety System and Speed Control System are successfully implemented in one single package. The accidents are detected by the vibration sensors and accelerometers present inside. Location detection is done using GPS to know the whereabouts of the accident and the GSM module used informs the person's nearest ones and nearby refuge through a text message. In addition to accident safety, this blueprint also deals with protection from climatic conditions like rain.

VIII. CONCLUSION

In our study, the results showed that PRP is a safe and effective treatmentmodality for chronic non-healing ulcers. Decrease in pain was observed in post PRP treatment.Delivering of growth factors to target site enhances the wound healing rates of chronic non healing ulcers.PRP seems to be efficient to treat chronic non healing ulcers which are non responsive to classical conservative treatments. Using PRP to treat chronic wounds/ulcers may not only enhance healing, but also prevent lower extremity amputations caused by nonhealing wounds.There by reducing over all hospital stay, inconvenience of constant medication and morbidity.

IX. REFERENCES

[1]. A. Celesti, A. Galletta, L. Carnevale, M. Fazio, A. Ĺay- Ekuakille and M. Villari, "An IoT Cloud System for Traffic Monitoring and Vehicular Accidents Prevention Based on Mobile Sensor Data Processing," in IEEE Sensors Journal, vol. 18, no. 12, pp. 4795-4802, 15 June 15, 2018, DOI: 10.1109/JSEN.2017.2777786.

[2]. M. S. Mahamud, M. Monsur and M. S. R. Zishan, "An Arduino based Accident Prevention and Identification System for Vehicles," 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), 2017, pp. 555-559, DOI: 10.1109/R10- HTC.2017.8289021.

[3]. R. k. Thangavel, S. Athithan, S. Sarumathi, M. Aruna and B. Nithila, "Blackspot Alert and Accident Prevention System," 2019 10th International Conference on Computing, Communication and Networking Technologies (ICCCNT), 2019, pp. 1-6, DOI: 10.1109/ICCCNT45670.2019.8944412.

[4]. S. Nanda, H. Joshi and S. Khairnar, "An IOT Based Smart System for Accident Prevention and Detection," 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), 2018, pp. 1-6, DOI: 10.1109/ICCUBEA.2018.8697663.

[5]. Panzarella, R. (2012). Vehicle safety system (U.S. Patent no. 8,190,345 B1). U.S. Patent and Trademark Office.

[6]. Kannon et al. (2017). Vehicle Proximity Warning System (U.S. Patent no. 2017/0178512 A1). U.S. Patent and Trademark Office.

[7]. Salomonsson et al. (2019). Vehicle Safety System for Controlling a Safety Feature (U.S Patent no. 10,239, 479 B2). U.S. Patent and Trademark Office.

[8]. Texas Instruments, “MSP430F5529 LaunchPadTM Development Kit,” MSP-EXP430F5529LP User’s Guide, SLAU533D Sept. 2013 [Revised Apr. 2017].

[9]. Expressif Systems, “ESP8266EX,” Datasheet, Version 4.3 Jun. 2015.

[10]. ublox, “Neo-6 ublox 6 GPS Modules,” Datasheet, GPS.G6-HW- 09005-E Aug. 2009 [Revised Dec. 2011].

[11]. SIMCom, “SIM900_ATC AT Commands Set,” Datasheet, SIM900R01_ATC_V1.00 Jan. 2010.

Cite this article as :

Ishan Kharat, Atharva Kulkarni, Dhaval Mahajan, Kartik Avhad, Sumit Jadhav, "Active Safety System in Vehicles using Sensor Network Model", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 9 Issue 6, pp. 676-684, November-December 2022. Available at doi : https://doi.org/10.32628/IJSRST229689

Journal URL : https://ijsrst.com/IJSRST229689