ACCIDENT DETECTION AND AVOIDANCE USING VEHICLE TO VEHICLE COMMUNICATION (V2V)

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Abstract - *The number of road accidents has been increasing every year, resulting in a significant loss of life and property. The lack of advanced safety measures in vehicles and irresponsible driving behavior like drunk driving are the major causes of these accidents. The demand for a reliable and efficient safety system that can prevent road accidents and reduce the number of fatalities is increasing. There is a need for a system that can detect collisions and drunk driving and send alerts to the concerned authorities in real-time with minimum delay. Currently, there are some existing safety systems that can detect collisions and perform alcohol detection at vehicle start, but they do not provide a comprehensive solution to the problem. The proposed safety system utilizes advanced sensor technologies such as crash sensors, acceleration sensors, vibration sensors, alcohol sensors, IR sensor, GPS and GSM modules. The proposed safety technique integrates Vehicle-to-Vehicle (V2V) communication and has a basic automated parking feature, which can park the vehicle safely if the driver is detected to be under the influence of alcohol. The automatic parking feature enables the vehicle to slow down along with automatic turning ON of the parking indicator and also steering the vehicle towards the sideways of the road for parking. The system can detect collisions and drunk driving in real-time and send alerts to the concerned authorities in the form of a URL which denotes the exact location. The vehicle to vehicle (V2V) communication feature ensures that other vehicles on the road are informed of the drunk driving situation, thereby reducing the risk of further accidents. The proposed safety system can significantly reduce the number of accidents caused by collisions and drunk driving, ultimately leading to a reduction in the loss of life and property.*

Key Words: **Arduino UNO, Crash, Vibration, Accelerometer, GPS, GSM, V2V, Automated parking.**

1. INTRODUCTION

Road accidents have been a major cause of loss of life and property, and the number of such accidents has been increasing every year. The major causes of these accidents are the lack of advanced safety measures in vehicles and irresponsible driving behavior. The demand for a reliable and efficient safety system that can prevent road accidents and reduce the number of fatalities is increasing. One of the critical factors that contribute to such accidents is the delay in ambulance arrival time [7-8]. In many cases, by the time medical help reaches the accident site, it is often too late, and precious lives are lost. This delay is usually due to traffic congestion or the inability to locate the exact location of the accident. There is a need for a system that can detect collisions and drunk driving and send alerts to the concerned authorities in real-time with minimum delay. Existing safety systems can detect collisions and perform alcohol detection at vehicle start, but they do not provide a comprehensive solution to the problem. Advanced sensor technologies such as crash sensors, acceleration sensors, vibration sensors, alcohol sensors, GPS, and GSM modules where it is proposed in [6]. Whereas our proposed system can send alerts to the concerned authorities in the form of a URL that sends geographical co-ordinates. Alcohol consumption can impair a driver's judgment, coordination, and reaction time, making it extremely dangerous to operate a vehicle. While the use of alcohol sensors is becoming more common in vehicles to prevent drunk driving, they only check for alcohol consumption at the start of the vehicle [11]. This means that a driver may start driving while sober, but their alcohol levels may increase as they continue to drive, leading to dangerous situations on the road. Our proposed system can detect drunk driving in real-time and also enables the automated parking of the vehicle as a line follower robot prototype as in [10], thereby reducing the risk of accidents while parking. The V2V communication feature that has been implemented using nRF24L01 model ensures that other vehicles on the road are informed of the situation [9], reducing the risk of further accidents. The proposed safety system provides a comprehensive solution to the problem of road accidents and can significantly reduce the number of fatalities caused by such accidents.

2. LITERATURE REVIEW

In [1], the author proposed a an IoT-based system to reduce road accidents in Bangladesh, the system also sends an SMS alert with location data to the vehicle owner in case of an accident with unknown causes, but there may be compatibility and reliability issues in areas with poor connectivity or outdated infrastructure.

Sharanabasappa, J. N. et.al [2], discussed how IoT can help solve social problems, specifically, driving under the influence. By embedding sensors into vehicles, IoT can monitor drivers and prevent drunk driving. While this solution has potential, its effectiveness is limited by the cost of implementing the technology and the willingness of individuals to adopt it.

Divi, L. K. et.al [3] determines that the accident detection system is an important tool that can potentially save many lives by quickly alerting emergency services when an accident occurs. It uses vibration and accelerometer sensors to detect accidents and also has the capability to detect alcohol in the driver's system. However, its effectiveness is limited by the availability and reliability of the network and the quality of the sensors used. Further research is needed to optimize the system for real-world use.

Venkata Ramani Shreya Yellapantula. et.al [4] examined V2V technology for improving heavy road vehicle safety, but limitations include complex traffic environments and the impact of latency on collision avoidance algorithms. The study suggests a variable time headway and minimal impact of latency on vehicle spacing, but further research is needed to evaluate effectiveness in diverse traffic scenarios and preventing collisions with non-motorized road users.

Ghatwai, N. G. et.al [5] observed the use of wireless communication technologies for vehicular networks can greatly improve road safety and efficiency. This paper presents an implementation of a complete vehicle-to-vehicle communication system and a blind spot detection system using ultrasonic sensors, Raspberry Pi, RF modules, and GPS modules. Limitations include the need for further testing in complex traffic environments and the high implementation costs.

In the paper [6], [7] the authors developed a proposal to increase road safety is the drowsiness and accident detection system, which utilizes sensors like vibration, heartbeat rate, and eye flicker. This system not only alerts the driver but also sends alerts to the driver's family through GPS and GSM technology in case of an accident or abnormal driver behavior. In addition, GPS technology can be used to monitor a vehicle's speed in real-time and detect accidents. When an accident occurs, the system can send the accident location, time, and speed to an Alert Service Center to improve emergency response times and potentially save lives.

Choudhury, A. et.al [8], discussed the problem of automobile accidents due to poor communication and delayed medical assistance. The proposed solution involves using an Arduino device to detect accidents, monitor the driver's heart rate, locate the accident, and send an SMS to the nearest hospital, police station, and driver's relative with a Google Maps link to the location and heart rate of the driver for the quickest arrival of medical assistance and better chances of survival.

In [9], the author describes a wireless alarm system designed for residential areas. The system is controlled by a microcontroller and uses the nRF24L01 wireless communication module for two-way transmission. The design aims to achieve frequency stability, reception, and emission integration. Users can send alarm signals through a sub-machine, and the host-machine receives and displays their address before sending out a warning. The system has undergone multiple experiments and has been found to be effective in timely warning users.

The paper [10] focuses on a specific type of robot, the sensor-based black line follower, which follows black lines on white backgrounds or vice versa and suggests that these robots have potential applications in industrial and domestic settings, such as transportation, delivery services, and floor cleaning. This paper outlines a simple and cost-effective circuit design for the black line follower robot and discusses its practical implementation.

3. PROPOSED SYSTEM

3.1 OBJECTIVE

The primary goal of this effort is to lower the number of fatalities brought on by auto accidents and also the most important factor for the dangerous problem facing society. Various factors involved in car collisions such as drunk driving. In this work, the post-accident safety, information system and autonomous system is what we suggest. As is common knowledge, when an accident occurs, the injured victim may not be able to call for help, and due to improper care, it is also possible that the person may have to lose their life. Consuming alcohol during driving can seed serious accidents for various reasons and sometimes death since many drivers can't control the vehicles. This technique is extremely beneficial in this type of emergency to preserve lives, receive medical care quickly and prevent tragic accidents. The system architecture of the system we've proposed is in the below Fig -1.

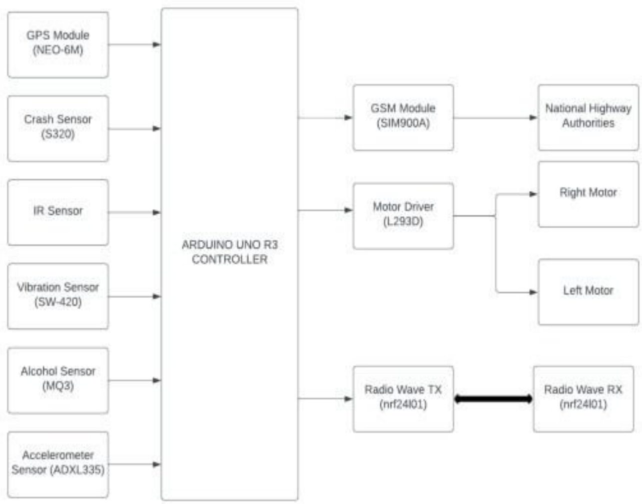

Fig -1: Block Diagram

3.2 SYSTEM MODEL

The accident will be detected by our suggested system, which will then inform others so they can respond appropriately. The ARDUINO UNO board, Accelerometer, Crash sensor, Vibration sensor, GPS Module, GSM Module, MQ3 Alcohol sensor, NRF24L01 Module, L293D Motor Driver and IR sensor make up the entire system. The position of the car is initially detected using an accelerometer. Crash sensor and vibration sensor are used to check for collisions, and the GSM module activates them to send messages.

These sensors' primary function is to find the accident. When an automobile accident happens, the GPS system immediately records the accident's current coordinates. Following that, the coordinates will convert into a URL (Google maps) and is given to the GSM Module, which promptly transmits it to the corresponding authorities so they can act appropriately without wasting any time.

The MQ3 Alcohol sensor used for detecting alcohol by breathing directly into it, then microcontroller will act accordingly in response to the detected alcohol percentage by transmits a signal via a NRF24L01 (radio transceiver) to rear vehicles on the road, indicating that the driver is under the influence of alcohol and intends to turn left. As a result, the left indicator of the vehicle begins to blink, and the vehicle automatically slows down and turns left by controlling the DC motors. To control motor movements a driver circuit L298N IC is used. The system utilizes infrared sensors for line sensing when approaches the solid white edge line. The Arduino microcontroller receives the input signal from infra-red sensors and sent the output signal to DC motor driver L293D. Once the vehicle crosses the line then double indicator on the vehicle starts to blink to alert other drivers to indicating the vehicle's intention to stop.

3.2.1 ARDUINO

The Arduino UNO board serves as the system's microcontroller. The Arduino board has currently been employed in a variety of IoT-based applications due to its ease of integration with various devices (such as sensors, different modules, etc.). The Arduino platform has been used for the programming. It has an integrated development environment (IDE) built in to interface with many kinds of devices. A programming language like C is essentially open-source software that connects to the Arduino hardware and allows you to upload any programme using a USB cable.

3.2.2 ACCELEROMETER

An electromechanical tool called an accelerometer is used to measure acceleration. It might be static (like the steady force of gravity) or dynamic (like moving or vibrating). The transducer that detects acceleration and is used to detect object movement is called an accelerometer. A 3-axis accelerometer called the ADXl335 is employed in this system. It is a low-profile MEMS sensor made up of micro-structures on a silicon wafer that are held in place by polysilicon springs. It establishes the object's coordinate with respect to Earth using gravitational attraction. It has two supply pins and three analogue pins for the three axes. It is primarily used for scrolling, vehicle crash detection, etc.

3.2.3 CRASH SENSOR

Electromechanical technology is used in crash sensors. It detects force using actuators that are positioned at the front and back. Our suggested system finds the collision brought on by the mishap. Depending on the force, it employs forming or breaking the electrical connection. This sensor's primary mode of operation is to determine if an object is present or absent from the environment in order to estimate the likelihood that an event will occur.

3.2.4 VIBRATION SENSOR

3.3 to 5 volts are required to operate the SW-420 vibration module. The sensor uses an LM393 comparator to detect whether a vibration exceeds a threshold and output digital data (Logic Low or Logic High, 0 or 1). When the sensor is functioning normally, it outputs logic low; when a vibration is detected, it outputs logic high. Three peripherals are included in the module: two LEDs, one for power status and the other for sensor output. Additionally, a potentiometer is available for adjusting the vibration's threshold point. The module will be powered by 5V in this project.

3.2.5 GSM MODULE

One type of circuit for establishing connectivity between a mobile device and the GSM network is a GSM module. The most crucial component of this module is the modem, which is powered by the power supply circuit to establish connectivity with the network and send messages. It is very helpful to convey information to the concerned authorities. via a GSM-based communication system. The data on the Arduino board has been transmitted in this system. Here, voice calls and text messages can be made and received to the predefined person using the GSM module SIM900A that is attached to the Arduino board. Dual-Band 900 MHz and 1800 MHz are used by the module, which runs on a 3A power source.

3.2.6 GPS MODULE

This module is highly useful for using the GPS system to find where an accident occurred. This information can also be used to monitor the vehicle's speed, which is very useful for estimating the likelihood of a collision. The NEO 6M GPS module has been utilised in this system to locate the car. The main advantages of this module are that it is simple to integrate with the Arduino module, simple to use, and responsive, all of which are extremely helpful when sending the location to the predetermined number in order to obtain assistance as quickly as possible. Three satellites are used to track the location out of the 27 satellites in orbit.

3.2.7 MQ3 ALCOHOL SENSOR

Utilising the MQ3 Alcohol Gas Sensor, it was created. This less expensive semiconductor indicator can detect alcohol concentrations between 0.05 and 10 mg/L. Its conductivity reduces as the concentration of alcohol gases increases. This has a very high susceptibility to alcohol and a very high tolerance to smoke, fog, and fuel disruptions. This module offers both optical and analogue outputs. Similar to a standard breathalyser, this sensor is excellent for identifying alcohol concentrations in your breath.

3.2.8 NRF24L01 in V2V COMMUNICATION

The nRF24L01 is an industrial, scientific, and medical (ISM) band 2.4GHz ultra-low power (ULP) 2Mbps RF transceiver IC. with peak RX/TX currents less than 14mA, a sub-A power down mode, sophisticated power management, and a supply voltage range of 1.9 to 3.6V. A full 2.4GHz RF transceiver that supports a high-speed SPI interface for the application controller is integrated inside the nRF24L01.The primary function of the V2V system is to enable communication between the vehicles whenever alcohol consumption is detected, though the majority of communication consists of information being broadcast from vehicle to vehicle. Each manage specific numerous signals indicating that "I am drunk and i want to take a free left," which is the main task of the V2V system.

3.2.9 IR SENSORS

The technology that our vehicle is proposing uses IR sensors, which are made up of two diodes, one of which emits rays, to sense the line. It must be given to another. If the receiver can pick up the reflected ray, the robot is on black, and if it can't, the vehicle is on white. IR reflectance sensors have a matched pair of infrared transmitter and receivers. These gadgets measure the amount of light that is reflected into the receiver in order to function. Because the receiver also responds to ambient light, the device functions best when ambient light is effectively blocked and when there is a close proximity (less than 5mm) between the sensor and the reflecting surface. For the detection of white and black surfaces, IR reflectance sensors are frequently employed. Black surfaces reflect badly while white surfaces typically reflect well.

3.2.10 MOTOR DRIVER L293D

A motor driver L293D is used to regulate motor motions. DC motors, pins, and relays receive control signals from this twin H-Bridge motor driver circuit. This concurrently controls the direction and speed of a pair of DC motors. The electrical circuit can operate DC motors with maximum current ratings of 2A and voltage ratings ranging from 5 to 35 Volt. Two DC motors rotate the wheels in either a clockwise or anticlockwise motion. The motor speed is slowed down by the reduction gears. DC motor goes rearward when input at pins 1 and 2 is high or low, accordingly. However, when the input at pins 1 and 2 is low or high, respectively, the motor will advance. When both inputs are the same, the motor will halt.

4. RESULTS AND DISCUSSIONS

After functioning of the project, it's time to have a glance at hardware. Fig. 1. is the image of the alcohol Detection System. When the switch of battery is ON, the entire circuit gets power and starts functioning.

When the condition is normal, meaning no ethanol is detected in the driver's breath within the 0 to 25 cm i.e., between the steering and the driver (d) sensed by the MQ3 sensor, the vehicle continues moving forward.

However, when the sensed ethanol value in the driver's breath exceeds the legal drinking limits (greater than 400), the controller promptly triggers the nRF24L01 module to send alert message, which is installed in the vehicle. The nRF24L01 is a wireless transceiver module designed to operate within the worldwide ISM frequency band. This module enables the transmission and reception of data using a specific radio frequency for communication purposes.

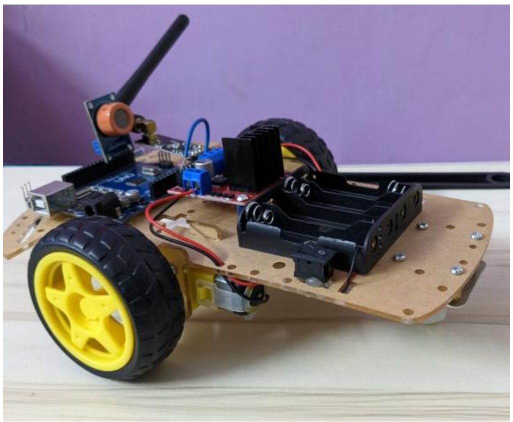

Fig-2: Working model of alcohol Detection System

When the sensed ethanol value crosses the threshold (greater than 400), the nRF24L01 immediately sends an alert message to the tailgating vehicles within microseconds, informing them of the drunk driving situation. Additionally, it notifies the tailgating vehicles that the vehicle is about to take a free left for auto-parking.

Simultaneously, the vehicle slows down, activates the left indicator, and steers towards the sideways of the road for parking. This maneuver is facilitated by an IR sensor fixed at the bottom of the vehicle, which detects the parking line.

Once the IR sensor crosses the white line, the parking line sensor sends a signal of '1' to the controller, indicating that the vehicle has reached the parking area.

Upon successfully parking, the vehicle's engine automatically turns ‘OFF’, and the parking sidelights are turned ‘ON’. tabular representation of the vehicle's movement during the entire operation is shown in the TABLE-1.

Status	Ethanol at d (ppm)	V2V Communication nRF24L01 transmission	Vehicle Movement	Parking line detection IR sensor (0-Black or 1-White)	LED Indicator	Motor Rotation	
						LEFT	RIGHT
Stone Cold Sober (value<120)	90	Nil	Straight	0	OFF	ON (Forward)	ON (Forward)
	118		Straight	0	OFF	ON (Forward)	ON (Forward)
Drinking but within legal Limits (120 to 400)	210		Straight	0	OFF	ON (Forward)	ON (Forward)
	320		Straight	0	OFF	ON (Forward)	ON (Forward)
DRUNK (value>400)	421	V2V Communication established and alert message sent to the tailgating vehicles	Slow left	0	LEFT ON	ON (Forward)	ON (Forward)
	470		Slow left	1	LEFT ON	ON (Forward)	ON (Forward)
	500		Stopped	0	PARKING Both ‘ON’	STOP	STOP
	540		Stopped	0	PARKING Both ‘ON’	STOP	STOP

TABLE-1: Accident-avoidance module

Fig-3. shows the image of the Accident Detection System. When the battery switch is turned ‘ON’, the entire circuit receives power and starts functioning.

Fig-3: Working model of Accident Detection System

In the ideal state, the micro-controller begins monitoring the accelerometer sensor, crash sensor, and vibration sensor values. To test the system, an accident scenario was simulated by vigorously shaking the vehicle and crashing its sides.

After conducting a test where the module was vigorously shaken under rough road conditions, the sensor's readings were recorded, and the corresponding output was observed. It was concluded from the test that the threshold value should be set to a value lower than 50. The output of the crash sensor can only be '0' or '1'. Under normal conditions, it continuously outputs '1' until a sudden impact occurs, which triggers a switch to '0'. Therefore, the threshold value is defined as '0'.

When the output of the vehicle's vibration sensor exceeds the threshold value simultaneously with a sudden impact on the crash sensor, it indicates that the vehicle has been involved in an accident. The behavior of the system under various conditions is presented in Table-2.

Conditions	Vibration sensor mV	Crash sensor (0 or 1)	Inference
Ideal state when the vehicle is in stop condition	1019	1	Ideal state keep observing the sensors reading
	1020	1	
	1015	1	
When the vehicle is running on the smooth road (less vibration in the vehicle)	917	1	The vibration didn’t exceed the threshold value of less than 50; continue observing sensor readings.
	803	1	
	879	1	
When the vehicle is running on the rough road (High vibration in the vehicle)	34	1	Vibration exceeds threshold, no impact on crash sensor; continue observing sensor readings.
	23	1	
	21	1	
When the vehicle met with an accident (High vibration and sudden impact on crash sensor)	23	0	Both the sensor exceeds threshold, considered as an accident and alert to be sent
	22	0	
	24	0	

TABLE-2: Accident detection module

Explanation of Table-2. under two conditions:

1. When the system is not considered an accident:

The vibration sensor readings were observed as 1019, 1020, and 1015, all indicating that the vibration didn't exceed the threshold value of 50. The crash sensor reading for each observation was 1, suggesting no impact or sudden crash was detected. Hence, the system will continue monitoring the sensor readings.

2. When the system is considered an accident:

The vibration sensor readings were observed as 23, 22, and 24, all indicating that the vibration exceeded the threshold value. The crash sensor reading for each observation was 0, indicating a sudden impact on the crash sensor was detected. In this case, both sensors exceeded their thresholds, and the system classifies it as an accident. An alert message, along with the GPS location of the vehicle, will be promptly sent to notify the registered authority via the GSM Modem. If both, the vibration sensor readings indicate high levels of vibration and the crash sensor detects a sudden impact, the controller will determine that the vehicle has been involved in an accident. In such a scenario, the controller will immediately send an alert message, along with the precise GPS location of the vehicle, to the registered authority via the GSM Modem, as depicted in Fig-4.

When the vehicle met with an accident, the accelerometer sensor detects the sudden change in acceleration and deceleration. The sensor measures the changes in the vehicle's velocity along the X, Y, and Z axes, and if there is sudden changes in X, Y, and Z axes, the accident is determined.

At the point when the measured X, Y and Z axis by accelerometer sensor crosses the actual vehicle threshold value, it implies that the vehicle has been met with an accident and the controller immediately sends emergency alert message along with GPS location of the vehicle.

At the point when our vehicle is hit by another vehicle from the front side then it is supposed to be front accident. The MEMS Accelerometer will detect the X and Y coordinates of our vehicle and if MEMSX >=160mV and MEMSX <= 175mV and MEMSY >= 180mV and MEMSY <= 195mV finishes up as Front Accident. One of the type of accident occurs among the four types of accidents.

At the point when our vehicle is hit by other vehicle from the left side then it is supposed to be left accident. The MEMS Accelerometer will detect the X and Y coordinates of our vehicle and if MEMSX >= 185mV and MEMSX <= 200mV and MEMSY >= 160mV and MEMSY <= 175mV the sensor finishes up as Left Accident.

At the point when our vehicle is hit by other vehicle from the right side then it is supposed to be right accident. The MEMS Accelerometer will detect the X and Y coordinates of our vehicle and if MEMSX >=130mV and MEMSX <= 150mV and MEMSY >= 160mV and MEMSY <= 175mV the sensor closes as Right Accident

At the point when our vehicle is hit by other vehicle from the posterior then it is supposed to be back accident The MEMS Accelerometer will detect the X and Y coordinates of our vehicle and if MEMSX >=160mV and MEMSX <= 175mV and MEMSY >= 130mV and MEMSY <= 150mV the sensor closes as Back Accident.

When the accident is detected the emergency alert message along with GPS location of the vehicle as shown in the Fig.-4. is sent to the registered authority by the GSM Modem

Fig-4: Screenshot of message received

5. CONCLUSION AND FUTURE SCOPE

The proposed system utilizing advanced sensors such as the crash sensor, acceleration sensor, and vibration sensor can address some of the common issues faced by individuals overseeing a large number of automobiles. the data collected can be used to manage traffic flow and reduce congestion on the roads. These advanced features can further enhance the safety and efficiency of our proposed safety system and make driving safer for everyone on the road. Overall, the proposed system is a significant step towards improving road safety by not only detect accidents and inform concerned authorities but also in reducing the number of accidents.

The system can be further improved by incorporating machine learning algorithms for more accurate predictions of collision detection. Additionally, our project can be extended to include more advanced features such as predictive maintenance, driver behavior analysis, and traffic management. The data collected by various sensors can be analyzed to predict potential maintenance issues and alert the driver before any major breakdown occurs.

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