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Vehicle Accident Alerting and Monitoring with IOT-based Data Analytics

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Abstract— An IoT-based smart accident reporting and environmental monitoring system is being designed and implemented in this project. To identify vehicle accidents, the system uses accelerometer data that is higher than a certain threshold; to identify fires, it uses data from a flame sensor. After an event is detected, the system uses GPS to pinpoint the spot and sends the information to an emergency response team using a GSM module. In addition, the system keeps tabs on variables like humidity, temperature, alcohol, smoke, and carbon monoxide levels using the right sensors. These data points are received by the IoT platform, which may then analyze and display them in real-time. Potentially applicable in smart transportation systems, this integrated approach enhances safety via facilitating rapid accident reaction and environmental monitoring. Topics covered include thingspeak, sensors, IoT, GPS, data monitoring, ESP8266, and hazard warnings.

I. INTRODUCTION

Many sectors, including transportation, have been impacted by the dramatic shifts brought about by recent technological developments. Industry is deeply troubled by the financial fallout, physical damage, and loss of life caused by automobile accidents.

While efforts have been made to improve road safety via infrastructure upgrades and driver education, the reaction to accidents might be much better if data was monitored effectively and reports were made promptly. In such a setting, the incorporation of IoT technology offers a practical answer. Vehicles, sensors, and emergency systems can work together thanks to the Internet of Things (IoT) and the real-time device connections it enables. An efficient system for data monitoring and vehicle accident reporting might be developed with the use of Internet of Things (IoT) technology, which was the focus of this research. Not only does this kind of device allow for faster emergency responses, it also helps enhance road safety by providing crucial data on accident patterns. A "Smart Vehicle Monitoring System" may increase safety on the road by identifying vehicles with RFID and fingerprints, detecting collisions with vibration sensors, and exchanging data in real-time via GSM, GPS, and an Arduino Mega. [1]: Yes. To lessen the occurrence of transportation accidents, this research offers an An IoT-based system that monitors the speed of vehicles in real-time. An IR speed sensor, LCD, microcontroller, and buzzer are all part of the system that alerts drivers when they go above the speed limit. By providing timely feedback, it encourages drivers to practice safer practices and adhere to speed restrictions [2]. Careless driving is a contributing reason to the high traffic accident incidence in Bangladesh. In order to make cars safer, this study introduces an Internet of Things monitoring system. Thesis supporters claim that using this system would lessen the frequency of accidents and hasten responses to emergencies [3].

II. RELATED WORKS

This project introduces a "BlackBox" module that monitors road conditions and vehicle dynamics with the aim of improving road safety in Bangladesh. By integrating real-time accident detection with analysis of previous data, the module has the potential to reduce traffic accidents by as much as 80% via early notifications to authorities [4]. With the goal of reducing accident rates and saving lives, this research details the creation and implementation of a crash notification system [5]. The system aims to ease the challenges of increasing automobile ownership and traffic bottlenecks. This research proposes a GPS-based accident notifier system that can monitor vehicle speed in real-time, detect potential crashes by looking for sudden decreases, and immediately send location and timing data to emergency services via GSM. The goal is to enhance rescue operations and save lives [6]. The efficacy of emergency response is enhanced by this innovative strategy, which decreases the time between incidents and medical help. In doing so, it enhances road safety and reduces injury severity, highlighting its crucial role in preventing fatal traffic accidents [7]. This system enhances vehicle safety by detecting crashes and unauthorized movements and allowing for rapid alerts to emergency services and car owners using the combination of GSM, sensors, and microcontrollers [8]. This Internet of Things technology helps improve reaction times and rescue operations for accident victims by instantaneously notifying public safety organizations about accidents. It also offers essential information and accurate geographic coordinates [9]. Using Arduino, GPS, and GSM modules, this automated system notifies family members and emergency officials as soon as an accident happens, improving response times and providing important location information [10]. In order to ensure that homeowners may turn off unnecessary alarms and that rescue workers get rapid medical treatment, this research presents an automated accident detection system that utilizes ZigBee technology and sensors [11]. This article takes a look at several strategies and technology that might lessen the likelihood of automobile accidents in mountainous areas, particularly when drivers are faced with challenges like steep inclines and narrow turns [12]. An Internet of Things (IoT) system that may automatically notify hospitals, insurance companies, and law enforcement of crises is presented in this article as ISADICS, with the aim of improving accident management [13]. In an attempt to reduce casualties via rapid emergency response, the program shown in this research utilizes automobile sensors to detect potential crashes and promptly notify medical authorities [14]. With the use of an accelerometer and a heart rate monitor, this system can identify accidents, send a signal to nearby hospitals, and exchange location data via a smartphone app so that people may get medical help quickly [15].

III. METHODOLOGY

A car accident warning and data monitoring system's components, architecture, and implementation approaches are described in this section. Constantly keeping an eye on the surrounding situations and sending out quick alerts in the event of an accident or fire is the main purpose of the system. You can see the suggested system's block diagram in "Fig. 1". Figures 2 and 3 illustrate the comprehensive connection diagrams for the accident reporting and data monitoring systems, respectively.

A. Arduino UNO

The system's operations and processing of sensor data are overseen by the core microcontroller, the Arduino UNO. It gathers data from a number of sensors, connects with other devices (such the SIM800L GSM and GPS modules), and makes choices depending on thresholds that have been set. The ADXL335 and flame sensors are constantly being monitored by the system.

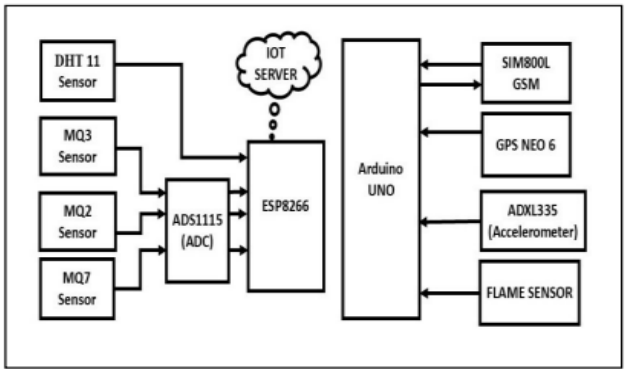


Fig. 1. Block diagram of proposed system

B. GPS NEO6 Module

You may get your precise geographic location data, such latitude and longitude, in real time with the help of the NEO6M GPS receiver module. In the event of an accident, the technology can pinpoint the exact position of the car and notify first responders accordingly.

C. SIM800L GSM Module

The purpose of the SIM800L GSM module was to transmit data across a GSM network. Whenever there's an emergency, this module may notify a predetermined phone number of the car's position and any accidents that have occurred. Included in the alert message are GPS coordinates and other facts according to the sort of alarm (fire, accident, etc.).

D. ADXL335 Accelerometer

A continuous acceleration measurement was taken using an ADXL335 accelerometer along all three axes of the vehicle. If there is an unexpected change in acceleration that is greater than a certain threshold, the Arduino UNO will trigger an alarm system to notify the user that an accident may have occurred. In order to detect accidents, rollovers, and abrupt deceleration, an accelerometer is essential.

E. Flame Sensor

It is possible to detect fires using the vehicle's flame sensor. After the sensor picked up a signal that indicated the presence of flame, the SIM800L module alerted the Arduino UNO, which in turn activated the fire alarm. The finding of the fire is immediately sent to emergency contacts via an alarm message.

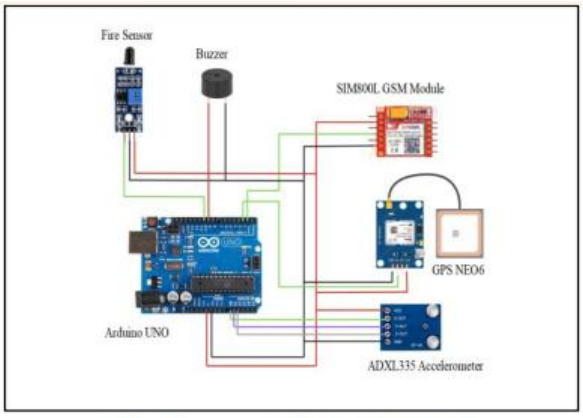


Fig. 2. Connection diagram for reporting system

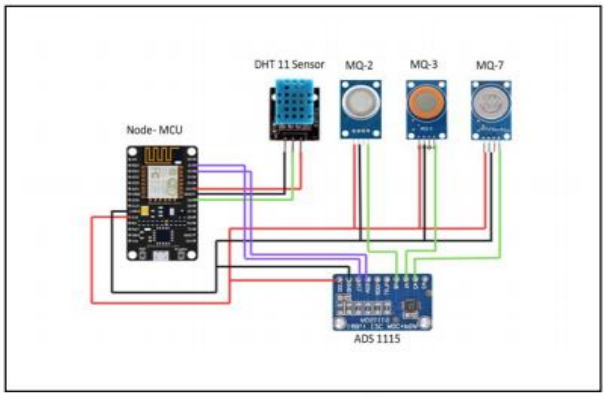


Fig.3. Connection diagram for data monitoring

F. NodeMCU (ESP8266)

The main microcontroller and Wi-Fi communication device was the NodeMCU (ESP8266). This gadget communicated with every sensor, analyzed the data, and sent it over the Internet to an Internet of Things server. After receiving real-time data from the sensors, the NodeMCU analyzed it and wirelessly sent it to the IoT server.

G. DHT11 Sensor (Temperature and Humidity)

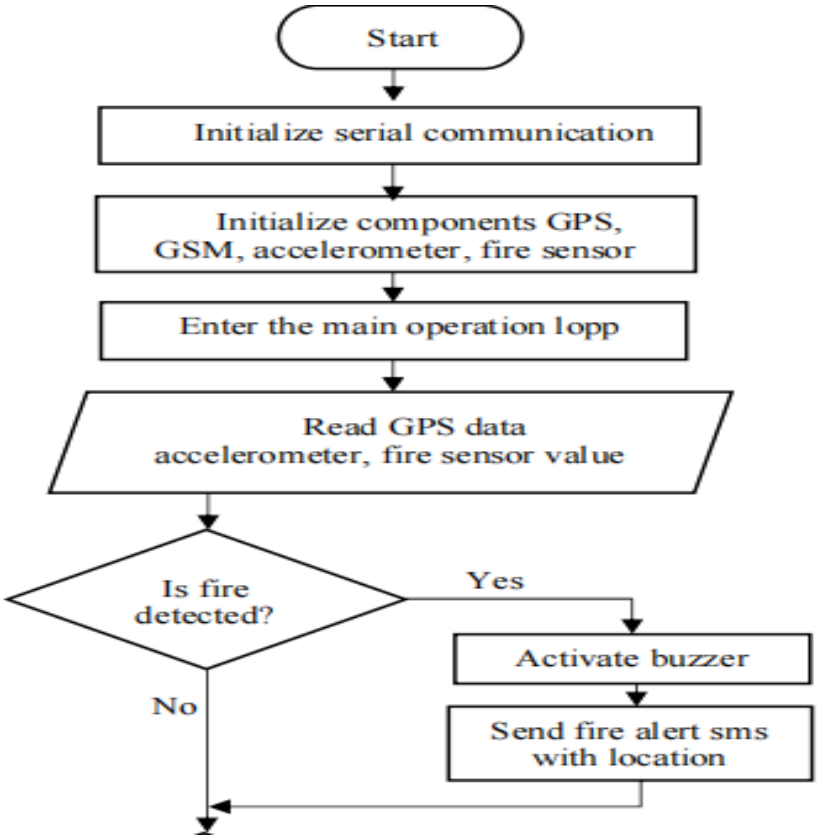
With the use of a DHT11 sensor, we were able to gauge the car's interior temperature. An important component in detecting unpleasant or dangerous environmental conditions is a DHT11 sensor, which gives real-time data on the relative humidity and temperature inside a vehicle.

H. MQ2 Sensor (Smoke Detection)

The MQ2 sensor picked up on smoke and flammable gasses including propane, butane, and methane. The MQ2 sensor is always looking for levels of smoke and gas in the air to provide an early warning system for potential fire hazards or harmful gas leaks inside the vehicle.

I. MQ7 Sensor (Carbon Monoxide Detection)

Carbon monoxide (CO) levels were monitored with the MQ7 sensor. CO is an important signal for identifying engine issues or incomplete combustion in a vehicle. The MQ7 sensor monitors the car's carbon monoxide levels and helps identify very high concentrations of this odorless and toxic gas.



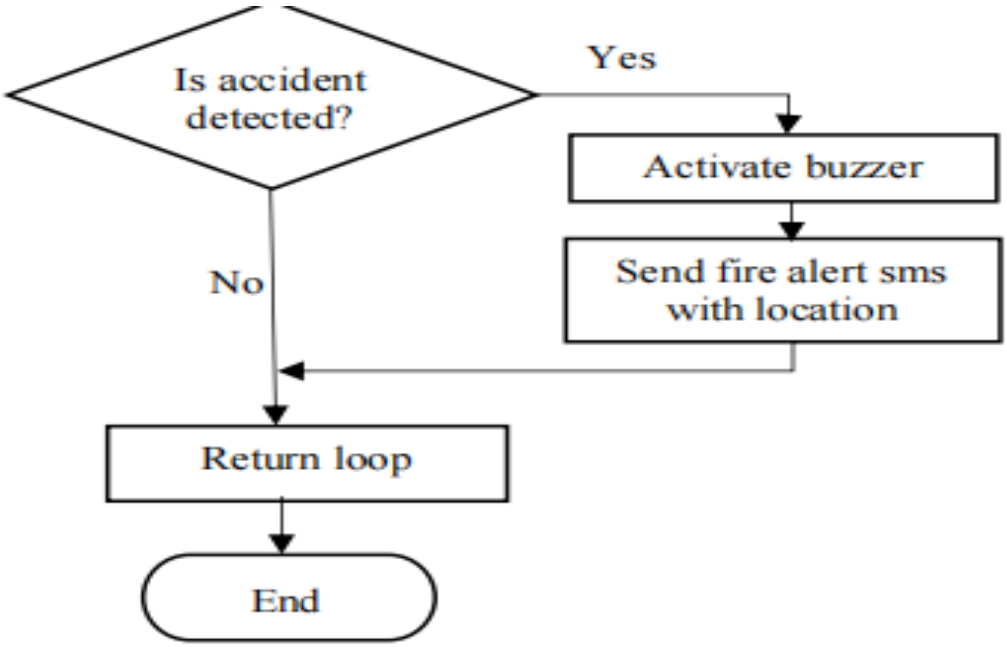


Fig. 4. Flowchart of accident reporting system

J. MQ3 Sensor (Alcohol Detection)

To detect traces of alcohol in the air, the MQ3 sensor was used. A potentially hazardous situation might arise if the driver has drunk alcohol or if there is an excessive level of alcohol in the vehicle's surroundings, which the MQ3 sensor helps to monitor.

K. ADS1115 (ADC)

The ADS1115 is a very precise and power-efficient 16-bit analog-to-digital converter (ADC). Sensor monitoring, embedded systems, and data collecting are just a few examples of the many applications that rely on it for accurate analog-to-digital conversion.

L. Thingsspeak Server

Data was collected, visualized, and analyzed in real-time using thingspeak, an open-source IoT analytics platform. We utilized the in-built plotting capabilities to visualize the data for efficient automation and monitoring, and for complex analytics.

M. Flowchart

When an accident is detected, it is the job of the Arduino UNO to send out an alarm. "Fig. 4" is a flow diagram depicting the operation of the accident reporting system. Sending data to an IoT platform and keeping tabs on sensors are the responsibilities of the NodeMCU. "Fig. 5" is a data monitoring system flow diagram.

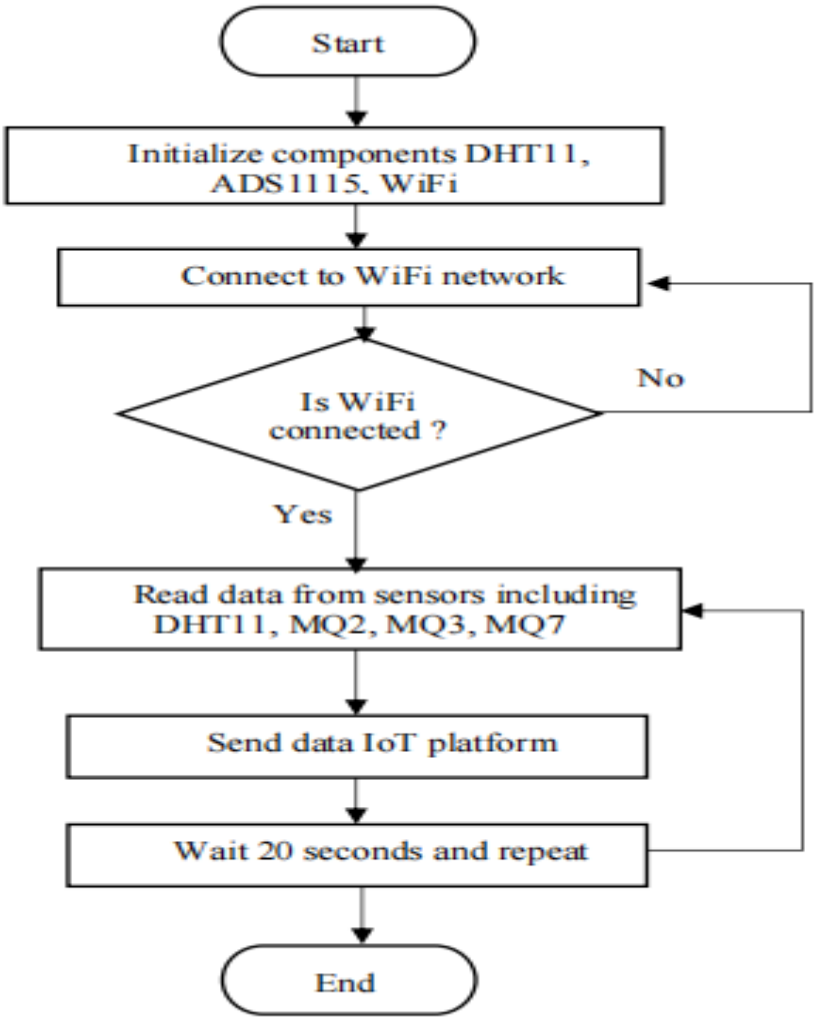


Fig. 5. Flowchart of data monitoring system

IV. IMPLEMENTATION AND RESULTS

Improving vehicle safety and monitoring systems via the use of sensor technologies, real-time connection, and the Internet of Things is becoming more important. The IoT is crucial to our system because it connects many sensors and allows them to communicate data in real-time. For example, the MQ-3 can detect the driver's breath alcohol level, while the DHT11 can monitor the car's interior temperature and humidity. This data is collected by an Internet of Things platform, which then analyzes it to determine what causes accidents. The Internet of Things basically makes our system smarter and more responsive, which drastically cuts down on accidents and makes roads safer for everyone. Furthermore, it efficiently notifies distant users using SMS notifications and the Internet of Things platform for sensor data. Drivers and emergency contacts get quick and actionable information via this technology, which improves vehicle safety and eventually speeds up reaction times in critical circumstances. "Fig. 6" depicts the system that was put into place according to the approach.

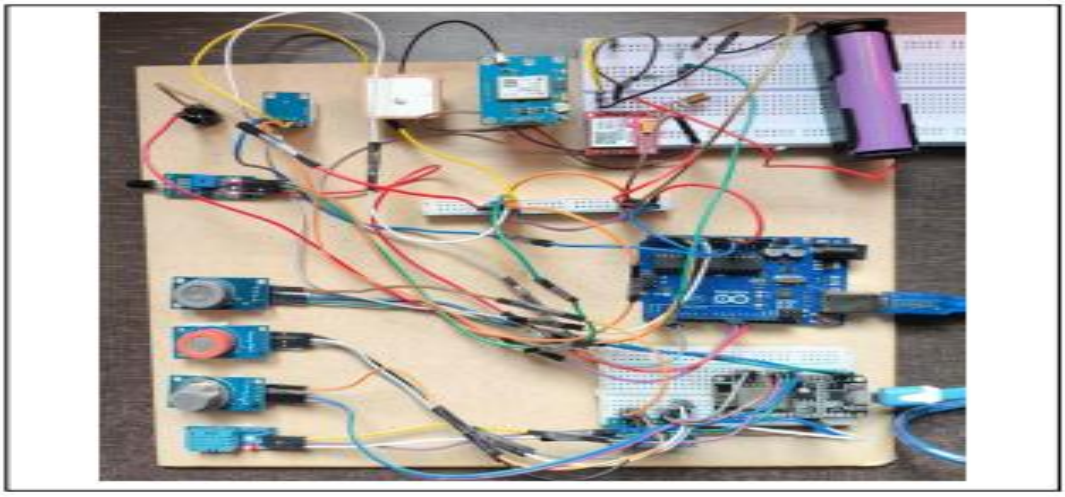


Fig. 6. Hardware Implementation of proposed system

A. Accident Detection and Reporting System

1) Real-Time Accident Detection: The system detected abnormal accelerations with the help of the ADXL335 accelerometer. A threshold value is determined experimentally from experiments that show how a vehicle normally decelerates following crashes and sudden braking. If the vehicle's speed suddenly dropped below this threshold, it was considered an accident. During testing, an accident detection mechanism was activated when the system detected controlled vehicle crashes. The GPS NEO6 module accurately tracked the locations of the vehicles during the event, within a margin of error of less than 2.5 meters. The following information was sent by SMS to predefined emergency contacts by the SIM800L GSM module, which was activated by the Arduino UNO upon detection. "Fig. 7" displays the location-related SMS that was received.
Alert message for an accident Oh no!
Latitude and longitude coordinates of the vehicle

Fig. 7. Accident notification via SMS

Secondly, the flame sensor can identify the existence of flames during simulated fire situations and report them. When the fire broke out close to the sensor, the system was quick to react—less than two seconds. Turning on the SIM800L GSM module allowed Arduino to send an emergency SMS to pre-specified contacts with the car's location, much like accident detection. The fire detection system had a perfect detection rate, never triggering false positives when there wasn't really a fire.

Fig. 8. Data monitoring through IoT platform

B. Data Monitoring

1) Temperature and Humidity Monitoring.

If we care about the comfort and safety of our passengers, we must monitor the temperature and humidity levels in automobiles. Taking readings of both humidity and temperature at the same time, the DHT11 sensor is an affordable and trustworthy module. The data is processed by the microcontroller that communicates with this sensor and then sent to an Internet of Things platform like thingspeak over Wi-Fi. By enabling real-time data visualization, storage, and analysis, Thingspeak paves the way for remote access and continuous monitoring. Using data updated every 20 seconds, visualizations of real-time fluctuations in temperature and humidity were constructed. The thingspeak platform and the DHT11 sensor can communicate with each other over Wi-Fi thanks to the ESP8266 microcontroller, which acts as a bridge. "Fig. 8" and "Fig. 9" display the thingspeak server's data graphically, including temperature, humidity, smoke, alcohol, and carbon monoxide.

2) Air Quality Monitoring

Smoke, alcohol vapor, and carbon monoxide (CO) were the three substances that the MQ2, MQ7, and MQ3 sensors were evaluated for. In order to ascertain the level of pollutants inside and to guarantee the safety of passengers, vehicle air quality monitoring is crucial.The MQ2, MQ3, and MQ7 sensors work together in this system to detect combustible gasses, alcohol vapors, and carbon monoxide, all of which are prevalent in automobile settings.Connected to a microprocessor called an ESP8266, the sensors collect data, process it, and then transmit it to an internet of things platform like thingspeak using wifi. Because of this, you can see the air quality inside the vehicle in real time and get alerts when the pollution level is too high.The technology provides a cost-effective and scalable solution to improve the air quality inside vehicles, which is great for passengers' health and comfort.

Fig. 9. Data monitoring through IoT platform

V. CONCLUSION

This research proved that an Internet of Things (IoT) system could effectively monitor data and report automobile accidents in real time. The use of sensors to track environmental and vehicle factors greatly enhances road safety by providing a holistic view of what's happening. Due to its simplicity and lack of substantial modification requirements, the suggested solution is both accessible and scalable, making it ideal for widespread adoption. Adding more metrics, such as risky overtaking strategies and driver concentration levels, may improve the monitoring system in the future. Better and safer transportation systems are possible because to this technology's incorporation of comprehensive data monitoring and accident detection.

VI. REFERENCES

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