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Smart IoT based Accident Monitoring and Rescue System

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Abstract

Today's drivers face a significant danger of vehicle accidents; hence, it is critical to devise innovative strategies to mitigate their impact and expedite emergency responses, especially considering the significant mortality rate. The proposed Internet-based Automatic Accident Detection and Rescue System (IoT-ADRS) optimizes accident detection and rescue operations by leveraging Internet of Things (IoT) technology. The framework combines several sensors, such as accelerometers, gyroscopes, ultrasonic sensors, GPS modules, and MQ3 sensors, to precisely identify accidents in real time. The Arduino microcontroller analyzes data from several sensors to identify accidents. The system employs GSM modules to transmit critical information, including the exact position and time of the event, to emergency services in real time upon detecting an accident. It examines key components and their connections to gather important data, quickly sound alarms, and manage resources efficiently. This comprehensive study shows that IoT-ADRS improves accident response protocols, saves lives, and reduces the severity of road injuries.

Keywords: Accident Detection, Alert System, Accelerometer, GPS, GSM, Vehicle Ad-hoc Network, Human Rescue System

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1. Introduction

In urban areas, accidents are common, and while many can be easily managed, some occur at night when visibility is low. This makes it hard for ambulance drivers to find the accident spot using phone calls from bystanders [6-8]. Knowing the exact location of an accident can significantly reduce the time between the accident and the hospital. The main objective of this research is to help reduce the response time for accidents. At night, if an accident victim is unconscious, it can take hours for someone to find and report it. Saving this precious time can save lives [9-12]. To address this issue, an experimental setup was developed to automatically detect accidents without human assistance. After detecting an accident, the system sends the accident coordinates to the ambulance for easy location. Once the victim is in the ambulance, another setup continuously monitors the patient's vital signs to keep them stable [13-15].

1.1 Objectives

- The main goal is to keep rescue efforts moving as quickly as possible. Quick action can save lives by delivering medical care in a timely manner.
- The system intends to revolutionize emergency response mechanisms through the integration of IoT sensors, and real-time communication networks.
- In the case of a traffic collision, the system aims to shorten the time it takes for emergency services, including ambulances, to arrive.
- The technology can help with post-accident investigations in addition to providing an instant rescue. It captures pertinent information (vehicle speed, impact force, etc.) that is useful for road safety assessments, insurance claims, and court cases.
- Saving lives on the roads is the ultimate objective.

2. Literature Review

This research proposes a smart architecture for locating auto crashes using mobile edge computing. The approach offers advantages such as proximity, minimal processing and idle time, and vehicle recognition. The framework automates accident identification, leveraging simple cell phones for rapid data acquisition, and progressively delivers information to

stakeholders such as hospitals and departments. It also distinguishes accident scene images, primarily processing them on servers to mitigate false positives. [1].

They suggested a system that uses sensors to automatically detect accidents on the street and sends out alerts to nearby crisis managers and family members via GSM. It is fully automated, uses a Google map to locate the accident site, and manages traffic signals to help people get to the emergency clinic on time. This paradigm may be used successfully in densely populated countries such as India [2].

In order to provide medical assistance and other services as quickly as feasible after the disaster, this article describes a method that offers some ideas. An accelerometer and flex sensor can be used to detect an accident. An SMS sent via a GSM modem with the accident's location, time, and vehicle number can be sent to the appropriate parties, including the owner of the vehicle, the police, and the closest hospital. The vehicle's internal camera will broadcast live footage so that you can view the occupants' present condition [3].

This work utilizes Infrared sensors and Arduino UNO innovation. The framework operates at two levels: accident prevention and accident detection. In the detection phase, infrared sensors identify incidents and alert designated individuals via SMS using a GSM module with pre-programmed numbers and a GPS module for location tracking. In the prevention phase, IR sensors alert drivers of nearby vehicles when their proximity exceeds a specified threshold. This paper presents the prototype and simulation findings. [4].

This technology aims to provide emergency medical attention by alerting the nearest facility about the accident. To assess the severity of the collision, the user's pulse sensor detects irregular heartbeats based on the vehicle's accelerometer, which also measures the vehicle's tilt. The accelerometer and heartbeat sensor are connected to the smartphone via Bluetooth, allowing the system to make decisions and transmit information accordingly. An SMS message is sent from the Android application on the phone to notify friends and the nearest medical facility. The program also provides the precise location of the accident to expedite response times. [5].

3. Proposed Work

The inadequacies of the current accident detection and rescue systems are addressed in full by the proposed IoT-Based Automatic Accident Detection and Rescue System (IoT-ADRS). IoT-ADRS integrates a range of sensors, such as accelerometers, gyroscopes, and GPS modules, to identify accidents in real-time with high precision by utilizing the capabilities of IoT technology. These sensors gather information about the position, dynamics of the vehicle, and other pertinent factors. Arduino UNO used to analyze the data and look for indicators of an accident, like abrupt acceleration changes or departures from the norm. Figure.1 illustrates the block diagram and the Table.1 shows the components used.

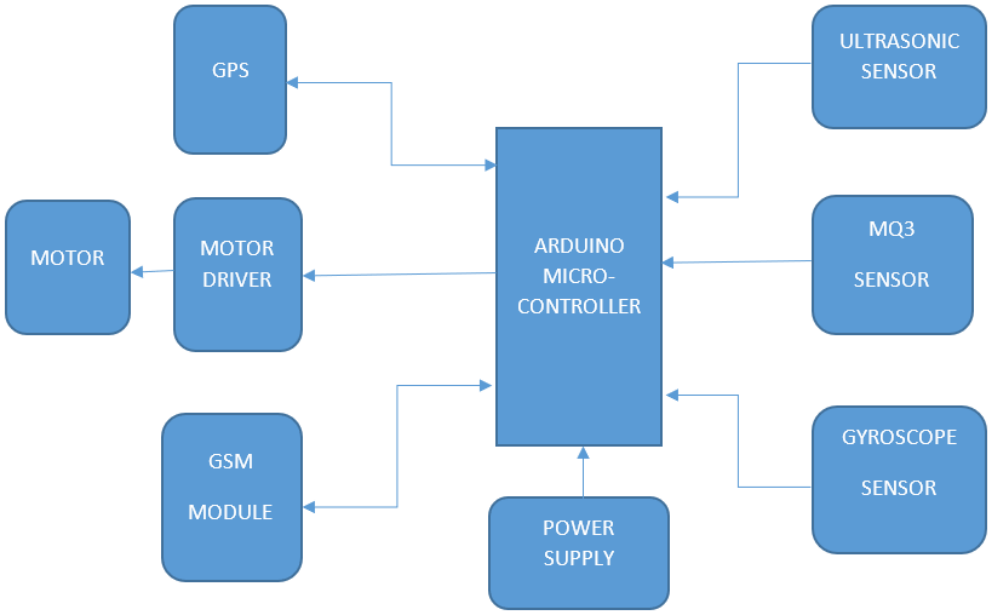

Figure 1. Block Diagram

Table 1. Components Used

NAME OF THE COMPONENTS	SPECIFICATION
ARDUINO MICROCONTROLLER	Data from several sensors can be processed by Arduino to identify mishaps.
ULTRA SONIC SENSOR	The ability of ultrasonic sensors to identify nearby objects or moving vehicles reduces the risk of collisions.
MQ3 SENSOR	If the driver's breath contains more alcohol than a predetermined threshold, the MQ3

	sensor can identify the presence of alcohol vapors.
GYROSCOPE	Gyroscopes monitor the tilt and rotation of the vehicle.
GPS	Accurate Location Tracking: GPS technology is utilized to track a vehicles exact location in real time, which is helpful while trying to find the scene of an accident.
GSM	When an accident is detected, GSM modules can send notifications to emergency agencies immediately, providing essential details like position and time.
MOTOR	When an accident is detected, motors can be utilized to trigger safety systems like airbags or automatic seatbelts.
MOTOR DRIVER	When an accident is detected, motor drivers provide precise control of motors, which can be utilized to trigger different safety systems like airbags or automatic door locks.
POWER SUPPLY	The core components of accident detection systems, sensors and microcontrollers like Arduino, require a steady and consistent power source in order to function accurately.

In an IoT-based accident detection and rescue system, several components work together to ensure swift response and aid. The GSM module enables communication through mobile devices, facilitating notifications during accidents. The GPS module provides precise location information by receiving signals from GPS satellites. At the system's core, the central processing unit analyzes data from the GPS module, MEMS sensor, and GSM module to detect

accidents and coordinate rescue efforts. On the right side, the sensor block includes an ultrasonic sensor for distance measurement, an MQ3 sensor to detect alcohol presence, and a gyroscope to detect sudden changes in orientation during accidents.

3.1 Working Principle

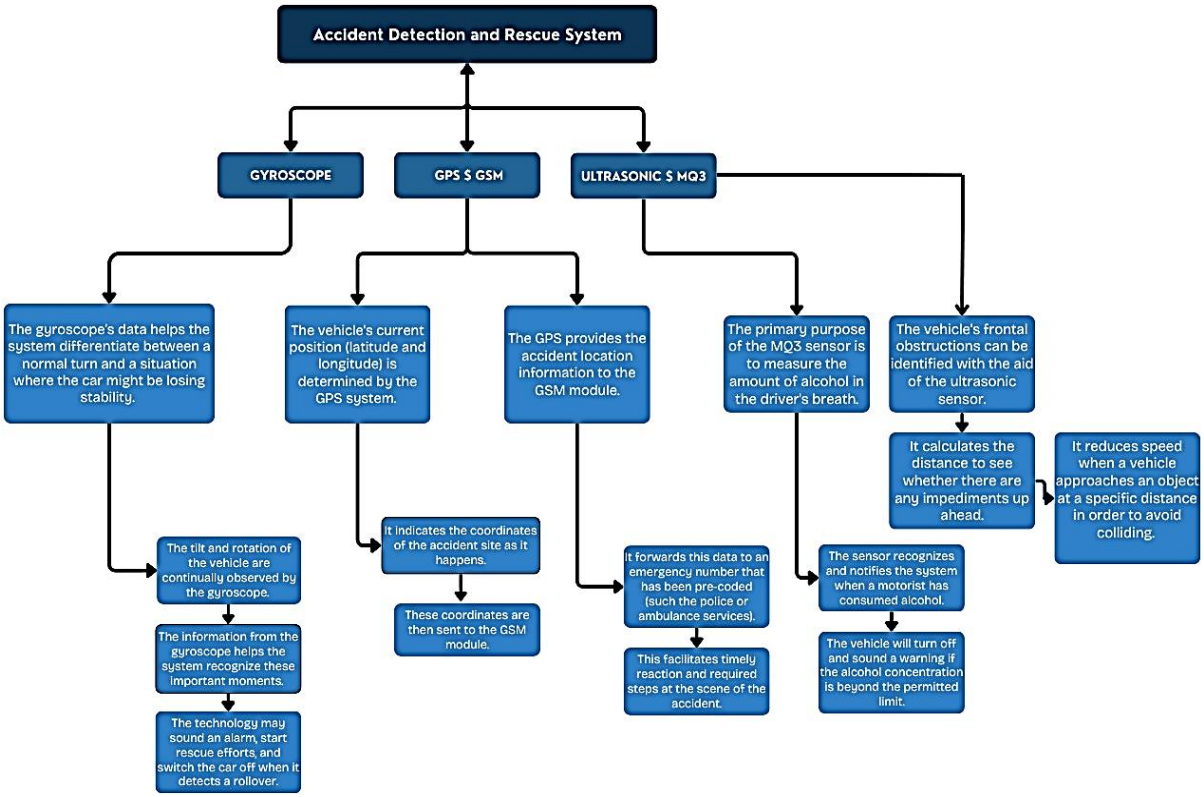

Figure 2. Flow Chart

All of the sensors in this ADRS, including the gyroscope, GPS, GSM, ultrasonic, and MQ3 sensors, are controlled by an Arduino microcontroller The Arduino manages sensor data processing and controls actions such as turning on and off the motor, which is powered by a vehicle's power source. The gyroscope tracks vehicle rotation and turns, vibrating to alert the user in emergencies when rotation exceeds a set threshold. GPS locates the vehicle and transmits the coordinates information through GSM, using a wireless cellular communication. Subscribers receive alert messages via SMS, with customizable message codes accommodating up to three phone numbers, including emergency services like ambulance, vehicle owner, and police. The MQ3 sensor detects alcohol and triggers actions such as shutting off the vehicle and emitting audible alerts. The ultrasonic sensor detects objects within a 15-meter range,

automatically reducing vehicle speed to avoid collisions. Figure 2 shows the proposed flowchart.

3.2 Software Used

3.2.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) serves as the primary programming environment for accident detection and rescue systems, leveraging its capabilities to control hardware components. In this application, C++ code is utilized within the Arduino IDE to configure threshold values for gyroscopic, ultrasonic, and MQ3 sensors. These sensors play critical roles, such as triggering alarm messages to specified phone numbers and emitting a beep when the vehicle shuts down due to an accident or detected alcohol consumption. Additionally, the Arduino IDE programs communication protocols for sending text messages or making calls to emergency services via a GSM module upon accident detection. This environment enables precise customization and control over the system's functionalities.

4. Results and Discussion

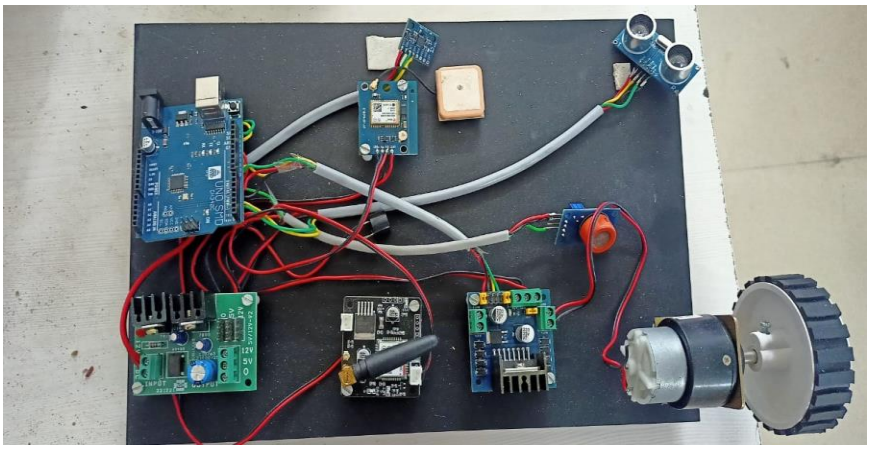

Figure 3. Prototype Model

Ultrasonic sensors for accident detection and rescue systems installed in automobiles is one proactive approach to increase road safety. Typically, these systems combine sensor and communication technologies to detect events and facilitate immediate rescue actions. The ultrasonic sensor, in concert with other sensors like accelerometers and vibration sensors,

monitors its environment for potential accidents or disasters. To avoid accidents, it recognizes obstructions and reduces the speed of the vehicle. Figure.3 shows the prototype of the proposed.

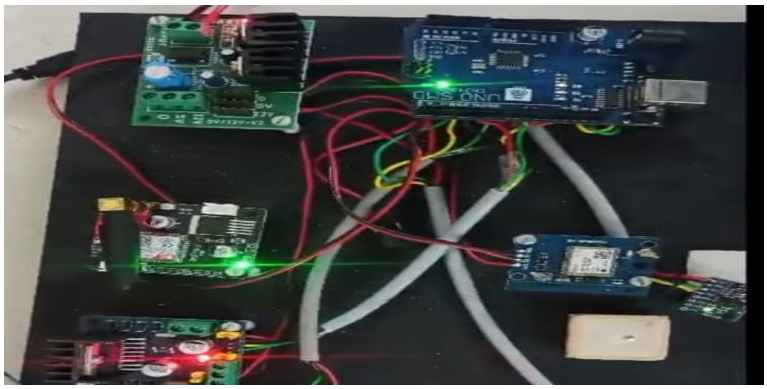

Figure 4. Vehicle Unit with GPS and GSM

A complex system that integrates communication and navigation technologies to track and control automobiles in real-time is a vehicle unit with GPS (Global Positioning System) and GSM (Global System for Mobile Communications). This gadget, which is mounted inside the car, periodically records GPS position data. Other vehicle data, including direction, speed, and different vehicle status indicators, can also be gathered by the GPS tracking device. The GPS gadget transmits its acquired data across the GSM network in almost real-time. Location and alert messages can be delivered to a central server or straight to the user's mobile device via this network, which is also used for mobile phone communications. Figure.4 shows the GPS and the GSM of the vehicle unit.

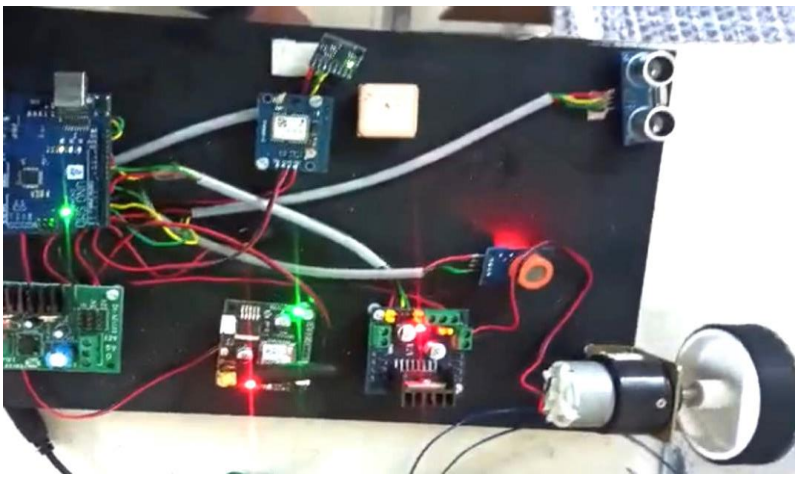

Figure 5. Vehicle Unit with MQ3 Sensor

To detect alcohol vapors in the driver's breath, automobile systems commonly employ the MQ3 gas sensor. When paired with an accident detection and rescue system, it can be incredibly successful in lowering the frequency of accidents caused by intoxicated drivers. The MQ3 sensor is used to measure the level of alcohol in the driver's breath. If the driver's blood alcohol concentration is higher than a certain threshold, it may indicate that they are intoxicated. If alcohol consumption is found the system will sound a beep and turn off the vehicle. Figure 5 shows the MQ3 sensor of the vehicle.

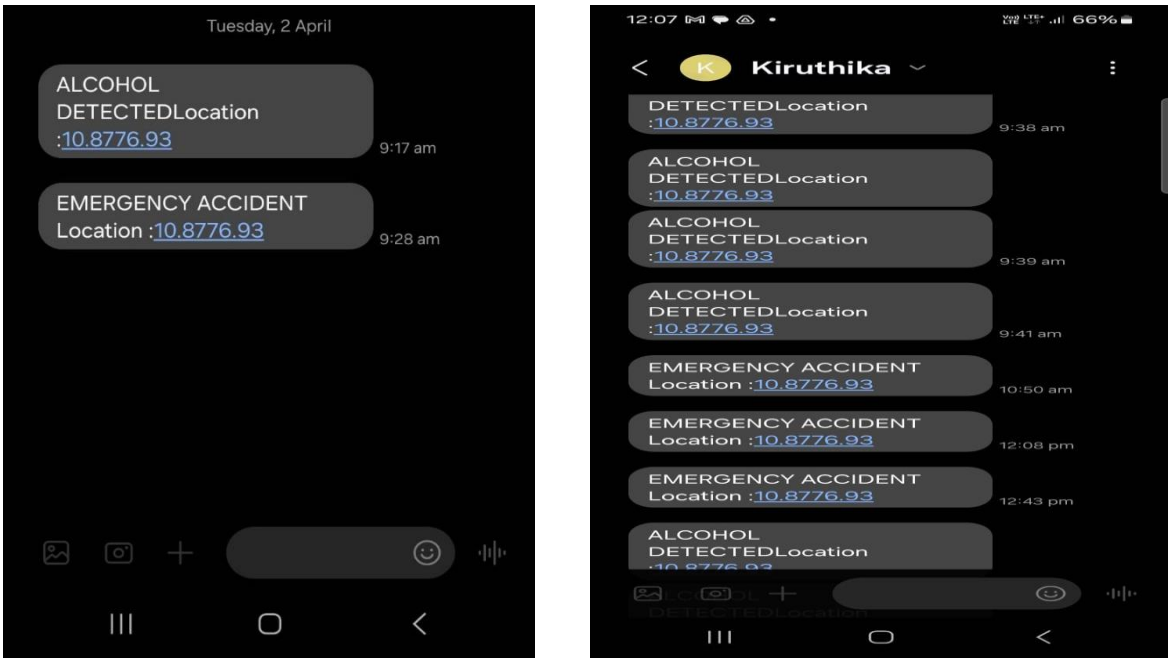

Figure 6. Alert Messages

The location of the accident will be shown on a Google map when a user clicks on the link. If we subscribe ambulance and police, the message will be directly sent to them for the rescue. Figure 6 depicts the alert message received.

5. Conclusion

The proposed IoT-based Automatic Accident Detection and Rescue System (IoT-ADRS) represents a significant advancement in enhancing emergency response capabilities and traffic safety. By integrating IoT technologies such as Arduino microcontroller and sensors, IoT-ADRS has proven effective in minimizing response times, improving stakeholder coordination, and reducing the impact of accidents on road safety. Future research will focus

on refining sensor technologies, utilizing artificial intelligence for predictive analytics, and ensuring seamless integration with existing infrastructure. IoT-ADRS holds the potential to revolutionize accident response and enhance transportation safety globally.

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