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Car Accident Detection System Using IoT

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ABSTRACT

The aim of the project is to receive an alert message with the help of GSM, GPS, and various sensor technologies when a car meets with an accident. The advancement of vehicles is a decisive factor for the increasing population. According to the World Health Organization (WHO), more than 1,200,000 people die worldwide in road crashes, and about 50,000,000 are disabled each year. This project presents an Automatic Accident Detection and Human Rescue System that will detect accidents and save victims' lives by informing the rescue team. Vibration sensors, Global System for Mobile (GSM), and Global Positioning System (GPS) are used in this system. Accordingly, when a car meets with an accident, the vehicle number and address will be transferred to the control room or rescue team location via mobile. The responsible person can immediately trace and reach the location to treat the victim. This project not only ensures immediate response but also monitors health conditions through sensors. The combination of hardware and software components allows data to be detected and stored for further references.

Keywords—Iot, GSM, GPS, WHO

INTRODUCTION

Internet Of Things(IoT)

Internet of things refers to a massive network of everyday objects, from machinery and appliances to even animals. These objects are equipped with sensors that gather data and unique identifiers that allow them to connect and communicate. Crucially, this communication happens without the need for constant human involvement. Wireless technologies like Wi-Fi play a key role in enabling this machine-to-machine interaction. The true power of IoT lies in how these elements work together. This interconnectedness allows for remote monitoring and management of devices, automation of tasks, and the extraction of valuable insights from the collected data.

Car Accident Detection System Using IoT.

Road safety remains a paramount concern as car accidents continue to inflict a heavy toll on human life. Traditional accident detection methods, reliant on bystander intervention or delayed witness reports, have proven demonstrably inefficient. This necessitates the exploration of more robust and timely solutions. The Internet of Things (IoT) presents a transformative approach to car accident detection. By leveraging a network of interconnected sensors and intelligent processing systems, IoT-based solutions can offer real- time accident detection with unparalleled accuracy. This not only expedites emergency response but also facilitates the transmission of critical data, potentially saving lives and minimizing the impact of accidents. This introduction adopts a professional tone, emphasizing the critical nature of the problem and positioning IoT as a groundbreaking solution with the potential to revolutionize car accident detection.

Objective

- Real-time accident detection: The system should be able to detect an accident as soon as it occurs and send an alert to emergency services or a designated contact.
- Location tracking: The system should be able to track the location of the vehicle and transmit this information to emergency services so they can locate the accident scene quickly.
- Automatic emergency response: The system should be able to automatically call emergency services and provide them with the location and other important information about the accident.
- Data collection and analysis: The system should be able to collect and analyze data about the accident, including the speed of the vehicle, the direction of travel, and any other relevant factors, to help improve safety and prevent future accidents.

LITRATURE SURVEY

Accident Detection and Alert System (Research Gate, 2022)

Problem statement:

The aim of the project is to develop an accident detection and alert system that can automatically detect and report accidents on the road. The system should be able to detect accidents in real-time and send alerts to emergency services and nearby vehicles to prevent further accidents.

Technical algorithm:

1. The system uses an accelerometer and a gyroscope to detect sudden changes in motion, which can indicate an accident.
2. When an accident is detected, the system sends an alert to a central server via a wireless network.
3. The central server processes the alert and sends notifications to emergency services and nearby vehicles.
4. The system uses GPS to track the location of the accident and send this information along with the alert.
5. The system also has a camera that can capture images and video footage of the accident, which can be used for further analysis.

Gaps:

The algorithm does not specify how the accelerometer and gyroscope data are processed to detect accidents.

1. It is unclear how the central server processes the alerts and sends notifications.
2. The algorithm does not specify how the system distinguishes between a real accident and a false positive (e.g., a bump in the road).
3. It is unclear how the camera data is processed and transmitted to the central server.

IOT Based Vehicle Tracking and Monitoring System Using GPS and GSM (IJRTE, 2019)

Problem statement:

The authors Mounika, A. and Cheppuru, A. propose an Internet of Things (IoT) based vehicle tracking and monitoring system that utilizes GPS and GSM technologies. The system is designed to address the challenges of vehicle theft, accidents, and misuse. The authors identify the need for a reliable and efficient vehicle tracking system to prevent these challenges.

Technical algorithm:

1. The system consists of a GPS module, GSM module, microcontroller, and a mobile application.
2. The GPS module receives location data from satellites and sends it to the microcontroller.
3. The microcontroller processes the data and sends it to the GSM module.
4. The GSM module sends the data to the mobile application using SMS.
5. The mobile application displays the vehicle's location and other important information such as speed and fuel level.

Gaps:

1. The authors do not provide details on the specific microcontroller and GSM module used in the system. This information is crucial for replication and implementation of the system.
2. The authors do not discuss the security measures employed in the system to prevent unauthorized access to the vehicle's location data.
3. The authors do not address the issue of power consumption, which is critical for IoT systems, as the GPS and GSM modules require a significant amount of power.Smart Accident Detection and Alert System (IEEE, 2021)

Problem statement:

The authors aim to develop a smart accident detection and alert system that can detect accidents in real-time and send immediate alerts to emergency services to ensure prompt action is taken.

Technical algorithm:

1. The system uses an accelerometer to detect sudden changes in motion that indicate an accident has occurred.
2. Once an accident is detected, the system uses a GPS module to determine the location of the accident.
3. The system then sends an alert to emergency services that includes the location of the accident, as well as any relevant details about the accident (e.g., number of vehicles involved, severity of the accident, etc.).
4. The system also sends alerts to pre-designated emergency contacts of the driver involved in the accident.

Gaps:

While the technical algorithm described above provides a basic overview of the system, there are several important details that are not discussed, such as:

1. How is the accelerometer calibrated to detect accidents accurately and reliably?
2. How is the GPS module integrated into the system, and how does it determine the location of the accident accurately?
3. How does the system send alerts to emergency services and emergency contacts?
4. How does the system ensure that alerts are sent promptly and reliably?
5. How does the system deal with false positives (i.e., situations where the accelerometer detects sudden changes in motion that are not actually accidents)?

Overall, while the authors provide a general overview of the system, more detailed information is needed to fully understand how it works and how effective it is likely to be in practice.

Application for Car Accident Detection and Prevention Using Inbuilt Mobile Sensor Based on BIOA (ICCUBEA, 2019)

Problem statement:

The paper proposes an application for car accident detection and prevention using the inbuilt mobile sensor based on BIOA (Built-In-Object- Accelerometer) technology. The objective is to detect and prevent car accidents by monitoring the driver's behavior and sending alerts to the driver in real-time.

Technical algorithm:

1. The system uses the BIOA sensor in the mobile phone to measure the vehicle's acceleration and angular velocity.
2. The accelerometer data is used to detect sudden changes in the vehicle's speed, which could indicate a collision.
3. The gyroscope data is used to detect the orientation of the vehicle and determine its position on the road.
4. The system uses machine learning algorithms to analyse the data and determine the driver's behaviour, such as reckless driving or distracted driving.
5. If the system detects any unsafe behaviour, it sends an alert to the driver in real-time, such as an audible warning or vibration.
6. The system also sends alerts to emergency services if a collision is detected, providing the vehicle's location and other relevant information.

DESIGN

ESP-32 Microcontroller

A well-liked system-on-chip (SoC) is the ESP32. The popular ESP8266, which is frequently used in IoT applications, has been improved by this device. The ESP32 is a versatile chip for the creation of IoT projects and embedded systems in general since it contains Wi- Fi and Bluetooth capabilities.

Ultrasonic Sensor

An ultrasonic sensor is a device that uses ultrasonic sound waves to calculate a distance to an item. A transducer is used by an ultrasonic sensor to transmit and receive ultrasonic pulses, which then transfer information about the proximity of an item.

Level sensor

A level sensor measures the level or quantity of fluids. It can tell if a car is drowning or if it is caught in floodwaters.

Alcohol sensor/detectors

It is a reasonably priced semiconductor sensor that can find alcohol gas presence. Based on alcohol concentration, the sensor outputs an analogue resistive signal.

- It can determine if the motorist has consumed alcohol or not.

Accelerometer

A tool that accurately monitors acceleration is an accelerometer. detecting the variation of the vehicle, being the acceleration of a body in its own immediate rest frame.

GPS Unit

A GPS gadget is one that has the ability to receive data from GPS satellites and then determine its precise location. The gadget may display the location on a map and provide instructions if the software is appropriate.

Module GSM

The chip or circuit that will be used to establish communication between a mobile device or computer and a GSM or GPRS

system is known as a GSM module or GPRS module.

Motor
An electrical machine that transforms electrical energy into mechanical energy is an electric motor.
- Used to power the vehicle.

LCD Display
A flat-panel display or other electronically modified optical device that makes advantage of liquid crystals' light-modulating abilities is known as an LCD display.

Memory Card Module
A straightforward method for transferring data to and from a normal SD card is the micro-SD Card Module. You may use it to give your project bulk storage and data logging.

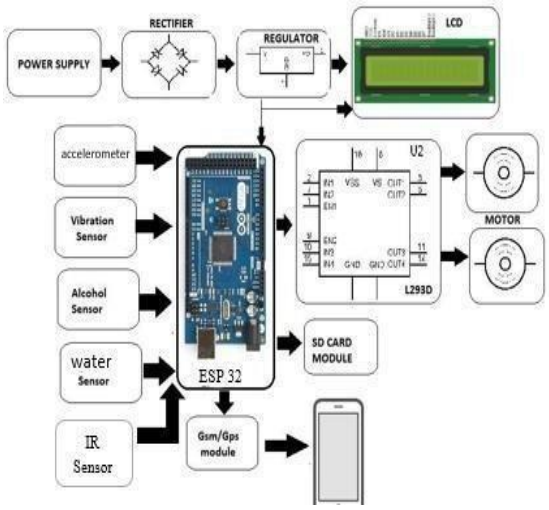

Figure 1. System Architecture

TESTING

Software testing ensures a software system function as designed by verifying its outputs match expectations and identifying any defects or missing requirements. This process involves executing the software and evaluating its functionality, performance, and other relevant attributes. Testing can be conducted manually by testers or through automated tools. It can also be categorized into two main approaches: white-box testing, where the internal code structure is examined, and black-box testing, which focuses solely on the software's external behavior. To ensure the robustness of our car accident detection system, we employed a two-pronged testing approach. First, we conducted thorough **unit testing** to meticulously examine the functionality of individual components within the system, such as sensor data processing modules and communication protocols. This granular testing helped us identify and rectify any errors within these isolated units. Secondly, we performed comprehensive **system testing** to assess the overall performance and integration of the entire IoT system. This involved simulating real-world accident scenarios and verifying the system's ability to accurately detect accidents, transmit data to emergency services, and function seamlessly as a whole.

The results of the testing activity are summarized in the below table.

Table 1. Unit Testing

Test Case	Description	Input	Expected Output	Actual Output	Result
1	Sensor data processing	Sample sensor data	Processed data meets defined thresholds.	Water & object detection through sensors	Pass

2	Accident detection	Processed data indicating an accident	Accident event triggered.	Accident message displayed	Pass
3	Emergency notification	Accident event triggered	Emergency notification sent.	SMS received	Pass
4	GPS tracking	Location data	Accurate location information.	Location link sent with a detection message	Pass
5	Data display	Processed data	Displayed data matches input.	Appropriate data displayed	Pass
7	System integration	Connect components together	Components communicate without errors.	Component wise output received	Pass

Table 2. System Testing

Test Case	Description	Input	Expected Output	Actual Output	Result
1	Test sensor & data collection.	Simulated car accident with IoT sensors.	Sensor and other data are collected & displayed.	Data from vibration & ultra- sonic sensor collected to display accident detection.	Pass
2	Processing of collected data.	Sensor data processed during car accident simulation.	Collected data processed with appropriat e output.	LCD displaying the accident detected message.	Pass
3	Test emergency service notification.	Detection of car accident.	Emergenc y message sent.	Notificati on message received with location details.	Pass
4	Test system reliability.	Continuous monitoring & testing over several days.	System operates without any failure.	Appropria te output displayed meeting the correct criteria.	Pass

This is the alert message that the alert centers and the person who has registered himself under the emergency contacts will receive immediately when an accident occurs. Using this simple message, the location of where the accident has occurred can be tracked and the person can be helped with first aid as early as possible.

CONCLUSION

In a nutshell, we have designed an accident detection system using IoT sensors which get simulated when an accident occurs. These sensors work in coordination with each other to gather the data at the time of the accident, process the collected data and if there is an emergency then forward the required information to the alert centers. Later the data that is collected can be viewed through the database for future references.

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