A Study on Automatic Reporting of Vehicle Accident Sensors

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Summary: When a driver involved in a major collision is unable to report the incident due to physical or psychological impairment, critical time is often lost before a third party witnesses the accident and notifies emergency services. This delay in response can significantly impact the driver's safety and survival. To address this issue, this study proposes the design and implementation of an Arduino-based in-vehicle sensor system that detects collisions and automatically notifies the nearest fire or emergency response unit. The proposed system aims to minimize response time by autonomously alerting authorities immediately following an accident, even when the driver is incapacitated and unable to initiate the report. By deploying such a collision detection and alert mechanism, this research seeks to reduce fatalities and mitigate the overall impact of road traffic accidents.

Abstract

Key Words : Global Positioning System, Arduino Accident Sensor, Firehouse

Ⅰ. Introduction

In the era of the Fourth Industrial Revolution, humanity continues to pursue greater convenience and efficiency in daily life. Among the many innovations, the automobile stands out as a transformative advancement that has significantly reduced travel time and reshaped modern civilization. However, there remain challenges associated with its widespread use. Today, the majority of people own at least one vehicle, primarily for the convenience it provides. Despite this convenience, the fatality rate from traffic accidents has not significantly decreased. According to traffic accident statistics from the Prosecutor's Office, there were 227,148 accidents resulting in 3,781 fatalities in 2018, and 229,600 accidents with 3,349 fatalities in 2019. While the fatality rate decreased by 11% during this period, the number of injured individuals increased from 323,037 in 2018 to 341,712 in 2019, marking a 5.8% rise.

The severity of an automobile accident

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often determines the likelihood of fatalities, particularly if the critical "golden hour" for emergency response is missed. To address this issue, this study proposes a collision detection system based on Arduino technology. By installing an accident sensor near the vehicle's engine, the system autonomously alerts emergency services in cases where the driver is incapacitated and unable to make the call. This automated alarm system allows firefighters or first responders to be dispatched to the precise location of the accident, thereby increasing the efficiency of emergency response, extending the golden hour, and ultimately reducing fatalities and injuries caused by severe traffic accidents.

Ⅱ. Related Work

1. GPS (Global Positioning System)

GPS, or Global Positioning System, is a satellite navigation system that calculates the user's current location by receiving signals transmitted from GPS satellites. It is widely used in navigation systems for aircraft, ships, and automobiles and has recently found extensive applications in smartphones and tablet PCs. GPS operates by analyzing signals from four satellites to determine the precise location. By comparing the time information embedded in the signal sent by the GPS satellite with the time it is received by the device, the system calculates the distance light travels during that time difference. Using this data, the distance between the GPS satellite and the measurement location can be determined. Based on this calculation, the current position of the user can be pinpointed as lying on a spherical surface with the satellite at its center.

2. Arduino

Arduino is an open-source computing platform and software development environment designed to create interactive objects and digital devices capable of sensing and controlling the physical world. Based on a microcontroller board, Arduino supports various operating systems, including Windows, macOS, and Linux. The Arduino Integrated Development Environment (IDE) enables users to write, edit, compile, and upload source code to the microcontroller. The programming language used in Arduino is based on C++ and leverages standard library functions from C for functionality.

3. Wi-Fi

Wi-Fi is a wireless networking technology that provides data communication capabilities equivalent to those of wired LANs in terms of speed and quality. Essentially, it offers the performance of wired networks in a wireless environment. The term Wi-Fi is short for "Wireless Fidelity," reflecting its ability to deliver high-quality, reliable wireless communication.

4. Server

A server typically refers to either the hardware running a server program or the software itself, which provides services to other programs or devices. Servers perform essential functions within a network, such as monitoring and controlling the entire system, connecting to external networks via mainframes or public networks, and managing shared software resources (e.g., applications, files) or hardware resources (e.g., printers, fax machines). Servers play a pivotal role in facilitating seamless communication and resource sharing within and across networks.

III. Automatic Accident Sensor Reporting System

1. System Design

This study proposes a system design utilizing an Arduino board, GPS module, flame detection sensor, and temperature and humidity sensors. In the event of a traffic accident where the driver is incapacitated and unable to contact emergency services, the system automatically transmits critical data—including abnormal readings from the temperature and humidity sensors, flame detection sensor, and other devices—directly to the fire department. This ensures a rapid response to emergencies, even in scenarios where the driver cannot initiate contact.

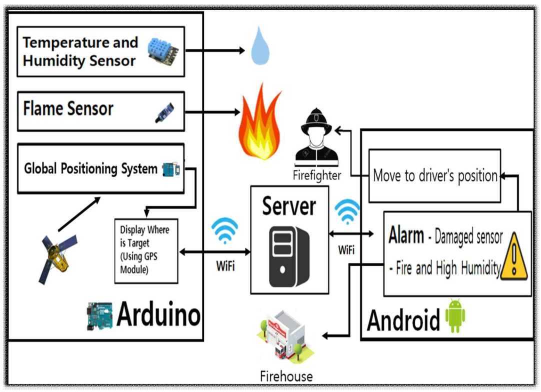

Figure 1. System Architecture

Figure 1 illustrates the system design, which enables the identification of the accident location via the vehicle's GPS and transmits critical data to the nearest fire station without requiring a manual report from a bystander. This design ensures that emergency responders are immediately dispatched to the scene of the accident. By reducing the response time compared to bystander-initiated calls, the proposed system can extend the golden hour for accident victims and significantly minimize fatalities caused by traffic accidents. If this system is properly implemented, it holds the potential to dramatically reduce casualties resulting from road accidents by delivering rapid alerts to emergency services.

2. System Implementation

```
DHT_Unified dht(DHTPIN, DHTTYPE):
uint32_t delayMS:
void setup() {
Serial.begin(9600);
dht.begin();
}

void loop() {
float humidity = dht.readHumidity();
float temperature = dht.readTemperature();

 if (isnan(humidity) || isnan(temperature)) {
  Serial.println("Failed to read from DHT sensor!");
return;
}

 Serial.print("Humidity: ");
Serial.print(humidity);
 Serial.print("% Temperature: ");
 Serial.print(temperature);
Serial.println("°C");

 delay(1000);
}
```

Figure 2. Temperature and Humidity Sensor Algorithm

The system, depicted in Figure 2, was developed on a Microsoft Windows 10 64-bit operating system using the Arduino Sketch IDE. Additionally, the Android

Minimum Required SDK was set to API 28 (Android 9.0 Pie), while the Target SDK was API 26 (Android 8.0 Oreo). As shown in the implementation, the DHT class is instantiated, and the serial port is configured to a baud rate of 9600. The DHT22 sensor is then initialized, followed by a minimal waiting period to ensure accurate data acquisition. The system attempts to read the temperature value, and if unsuccessful, it generates an error message: "Error reading temperature!". Once a successful temperature reading is obtained, the value is processed.

```
#include <SoftwareSerial.h>

int sensorValue = 0;
int led = 9;
int buzzer = 12;
int sensorPin = A0;

void setup() {
        pinMode(led, OUTPUT);
        pinMode(buzzer, OUTPUT);
        Serial.begin(9600);
}

void loop() {
        Serial.println("Flame Sensor");
        ensorValue = analogRead(sensorPin);
        Serial.println(sensorValue);

        if (sensorValue < 100) {
                Serial.println("Fire Detected");
                Serial.println("LED on");
                digitalWrite(led, HIGH);
                digitalWrite(buzzer, HIGH);
                delay(1000);

}
        digitalWrite(led, LOW);
        digitalWrite(buzzer, LOW);
        delay(sensorValue);
}
```

Figure 3. Flame Detection Sensor Algorithm

As shown in Figure 3, the LED is connected to port 9, and the buzzer is connected to port 12. Similar to the temperature and humidity sensor, the serial communication baud rate is set to 9600. If the sensor detects a value below 100, it identifies the presence of flames, outputs the message "LED ON", and triggers the LED to light up while the buzzer emits a sound. Once the Arduino executes the program, the sensor operation is concluded by entering the shutdown code, completing the process.

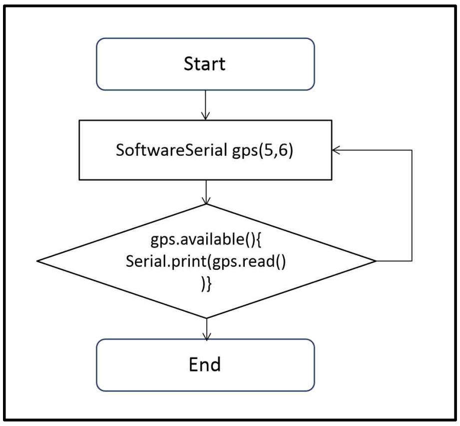

Figure 4. GPS Module Algorithm

Figure 4 demonstrates the algorithm for utilizing a GPS module to read latitude and longitude values displayed on the serial monitor. These values are then used by emergency responders to determine the precise location of the accident. In this study, the GPS module is mounted on the driver's vehicle. In the event of a major traffic accident, if anomalies are detected by the temperature and humidity sensor or the flame detection sensor, the system transmits the vehicle's location to the fire department, enabling them to respond promptly to the scene. This integration ensures accurate location tracking and minimizes response time during emergencies.

3. System Implementation Results

Figure 5. Arduino Board and System Implementation Result 1

Figure 5 displays the implementation results for the Arduino board and the temperature and humidity sensor. The image on the left shows the physical connection of the Arduino board to the temperature and humidity sensor. The image on the right illustrates the output of the sensor after running the program, where temperature and humidity values are displayed every second as per the input code [1].

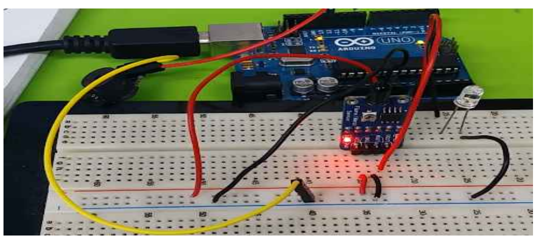

Figure 6. System Implementation Result 2

Figure 6 shows the results of integrating and testing the flame detection sensor. When heat is applied to the sensor, and the temperature rises beyond a set threshold, the LED lights up, and the buzzer emits a sound. Conversely, when the temperature decreases, the LED turns off, and the buzzer sound stops. This behavior demonstrates the successful implementation of the flame detection algorithm [2].

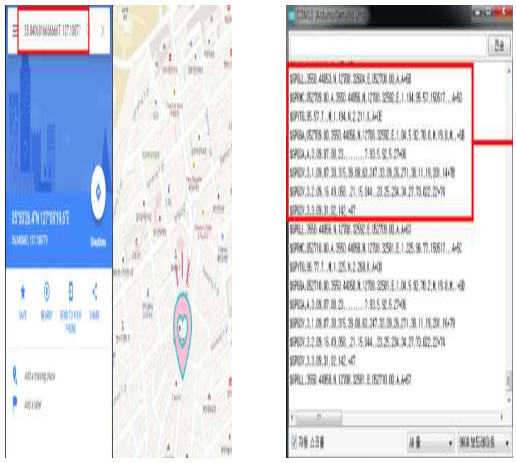

Figure 7. System Implementation Result 3

Figure 7 demonstrates the implementation of the GPS module for real-time location tracking. The image on the right displays the coordinates of the current location output through the serial monitor, captured using the GPS module as part of this study. The image on the left showcases the integration of a Wi-Fi module, which visualizes the current location on a map within the application. The red marker indicates the tracked location at the time of implementation, providing a clear representation of the system's capability to accurately display the user’s position [3].

IV. Conclusion

This study proposed a system integrating Arduino-based temperature and humidity sensors, a flame detection sensor, and a GPS module with a Wi-Fi module and server. The system is designed to send alerts to the fire department headquarters, enabling them to assess the occurrence and severity of a traffic accident. If deemed critical, the nearest fire station is dispatched immediately to the accident site. This automated accident sensor reporting system significantly enhances emergency response efficiency, contributing to more effective firefighting and lifesaving efforts.

Furthermore, with minor modifications, this system could be adapted for use in other modes of transportation, such as airplanes, expanding its potential applications across various mobility platforms. The implementation of such systems holds promise for further reducing casualties and improving safety in diverse environments.

V. References

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