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IOT Based Solutions for Accident Detection and Intimation

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ABSTRACT

In the event of a car crash, this work's clever accident detection and notification system—built on the ESP32 microcontroller—will be able to summon help quickly. In order to identify accidents in real time, the system incorporates an ADXL345 accelerometer, which monitors abrupt acceleration changes. To pinpoint exactly where the accident occurred, a GPS NEO-6M module is used. When an ESP32 microcontroller detects an impending collision, it analyses the data and immediately notifies pre-configured contacts—like the closest hospital and the caretaker of the vehicle's owner—via Telegram. The system's condition may also be readily stated using an LCD display that is linked to the ESP32, which provides real-time process updates. With this system in place, medical personnel will be able to respond much more quickly to crises, increasing the likelihood that patients will get life-saving treatment.

Keywords: LCD, ESP-32, Testing

I. INTRODUCTION

1.1 Work Description:

This paper incorporates a GPS NEO 6M module, an ADXL345 accelerometer, and an ESP32 microcontroller to identify and notify of incidents as they happen. By picking up on abrupt changes in acceleration and rotation, adxl345 accelerometers may identify vehicle accidents. Through the use of the GPS module, the technology is able to pinpoint the location of a likely accident and promptly notifies the closest hospital and a caregiver who has already been registered via Telegram. To further ensure the user can monitor the system's status, an LCD display is added for real-time process visualization. Improving accident victims' chances of survival, this solution provides a quick response system in crises, helping to eliminate delay in getting medical treatment. Because of its small size, low cost, and ease of deployment in many vehicle types, the system is an essential instrument for improving road safety.

Rapid identification and action are of the utmost importance in the fight against the increasing global fatality toll from traffic accidents. Waiting for medical assistance increases the risk of death for accident victims. We use an ESP32 microcontroller, an ADXL345 accelerometer, and a GPS NEO 6M module to create an accident detection and warning system.

The ADXL345 accelerometer is used by the system to identify sudden changes in acceleration and tilt, which are indicators of potential accidents. The GPS module finds the scene of the accident after it has been detected. After the data is processed by the ESP32, a registered caregiver and the closest hospital will get an immediate alert via Telegram with the location specifics. Users may also keep tabs on the progress thanks to the system's LCD display, which provides real-time information.

Reducing response time and making sure aid gets to the accident scene as fast as possible, the suggested system provides a proactive approach to emergency management. The may greatly aid in improving road safety and decreasing fatalities caused by accidents; it is also inexpensive and straightforward to install in any vehicle.

1.2 Objectives:

Reliable Accident Detection: Create a system that utilizes the ADXL345 accelerometer to identify potential collisions by detecting abrupt changes in acceleration and rotation.
Accurate Real-Time position Tracking: The precise position of the accident scene may be determined by integrating the GPS NEO 6M module.
Rapid Notification: In the event of an emergency, alarm systems that rely on Telegram may quickly communicate the exact location of the accident to the closest hospital and registered caregiver.
Enhancing Process Visibility: Make it simple to keep tabs on the system's performance with an LCD display that updates in real-time.
Affordable and extensible Solution: Create a solution that improves road safety for all vehicles, is simple to implement, and doesn't break the bank.
Improved Road Safety: Shorten reaction times in the case of an accident, leading to better odds of prompt medical treatment and higher overall survival rates.

1.3 Problem Statement:

One of the leading causes of mortality globally, traffic accidents, have increased due to long wait times for potentially life-saving medical care. Due to injuries or unconsciousness, accident victims sometimes cannot call for aid, which causes a considerable delay in response times. Current technologies for detecting accidents are either prohibitively costly, reserved for luxury cars only, or depend on human operators, who may make mistakes under pressure. Further delays occur because many systems do not immediately alert emergency personnel. The objective is to set up a cost-effective automated system that can detect accidents, pinpoint their locations, and notify caregivers and emergency services. Quick and effective emergency response is ensured by the solution's real-time updates and its ease of deployment in any vehicle..

II. LITERATURE SURVEY

Author: Abhirup Das et. al.
Publication:2017 8th Annual Industrial Automation and Electromechanical Engineering Conference(IEMECO)
Abstract: The daily tally of traffic accidents is rising. Knowing how drivers think makes it easy to implement measures to reduce the frequency and severity of deadly car crashes. The bulk of nighttime traffic accidents are believed to be caused by sleepy drivers. This research opens the door to the prospect of creating a system that can identify signs of sleepiness, distraction from the road, and alcohol influence, all of which have the potential to significantly lower the frequency of accidents. Instead, the action will be carried out by the pre-cautionary mechanism that is related to the aforementioned alert.The accident and its probable location might be recorded by the local police station, which helps in initiating medical aid. Because accident data are not easily accessible, medical aid is often not sought. This happens more often when there is less traffic, as at night, and on highways.

Author;Tariq Jamil et. al.

Publication: SoutheastCon 2016
Abstract: The disturbingly high number of fatal traffic accidents that happen every year might be drastically reduced with the help of modern automobile technology. The driver's health might be monitored automatically at set intervals by this technology while the car is in motion, guaranteeing everyone's safety.In this research, we show how to build a system that can detect when a motorist is about to blink their eyes and then either sound an alarm or have them use the brakes. The technology may alert the authorities to the driver's risky driving behavior if their level of concentration is repeatedly reduced. The design prototype's successful execution suggests this technology might help drivers remain alert, resulting in a decrease in traffic accidents.

Author: Tang Youming;Zhong Deliang;Zha Xinyu;Lv Na
Publication:2018 11th (ICICTA).
Abstract: Through an analysis of fatal injury data from the FARS database of the US National Highway Road Safety Administration from 2010 to 2016, we were able to identify several critical elements that contribute to catastrophic road accidents. Through an examination of traffic conditions utilizing the

principal component analysis (PCA) technique of multivariate statistical analysis, many critical elements that cause deadly traffic accidents may be determined. The results show that the most important factors are worn tires, damaged rims, a faulty exhaust system, and a broken connection.

Author: Daxin Tian;Chuang Zhang,Xuting Duan,Xixian Wang
Publication:IEEE Access (Volume:7)
Abstract: There is a significant daily mortality toll and disability toll from automotive accidents, which is exacerbated by untimely treatment and further accidents. An improvement in rescue efficiency and traffic safety might result from the use of automated car accident detection systems, which could decrease reaction times for both rescue organizations and adjacent automobiles. Automated accident detection is made possible with the use of machine vision and CVIS. In order to enhance CVIS accident detection using intelligent roadside devices, CAD-CVIS, a new picture collection, must be created. The wide variety of incidents, weather conditions, and accident sites included in CAD-CVIS help to make accident detection systems more versatile. Moreover, we construct the YOLO-CA model of the deep neural network for accident detection by using CAD-CVIS and deep learning techniques. We use a loss function with dynamic weights and Multiscale Feature Fusion (MSFF) to enhance the model's capability to identify tiny items. Finally, our experimental inquiry evaluating YOLO-performance CA's on this job shows that our proposed method can identify vehicle accidents in 0.0461 seconds (21.6FPS) with an average accuracy (AP) of 90.02%. In addition, we evaluate YOLO-CA in comparison to other object recognition models; the results demonstrate that YOLO-CA is much superior than its rivals in both accuracy and real-time performance.

Author: Omar Kassem Khalil
Publication:2017 10th International Conference on
Developments in eSystems Engineering(DeSE)
Abstract: To improve the quality of life of residents, boost the economy, and ensure Abu Dhabi's long-term environmental viability, the Abu Dhabi Department of Transport is committed to improving the country's transportation network. Crucial to this mission is research on traffic accidents in Abu Dhabi, which will aid in this endeavor. Despite a year-over- year decline, traffic accidents remain a serious issue in the Emirate of Abu Dhabi. Out of all the cities in the UAE, Abu Dhabi had the highest number of road accident fatalities in the last six years, with 5,564 people losing their lives, or almost two per day [8]. The severity index is supported by police statistics showing that 56,700 persons were killed and 63,406 were wounded in accidents between 2006 and 2011. Eighty percent of car accidents are caused by human mistake, according to studies [6]. Accidents caused by careless driving may result in serious injuries or even death. In order to make Abu Dhabi's roads safer, this research will provide telematics-based solutions to the Department of Transport. By enhancing road safety and drivers' efficiency, telematics systems may decrease road injuries and deaths. Analyzing bad luck and keeping tabs on and reporting driving problems are all part of these services.

III. SYSTEM DESIGN

3.1 Data Flow Diagram

- Vehicle Environment: This refers to the actual space inside the vehicle that might be the site of a fire or disaster.
- The processing of data from all sensors revolves on the ESP32 microcontroller.
- Accelerometer (ADXL 345): report accidents to the ESP32 based on acceleration variations it detects.
- The GPS NEO-6M Module informs the ESP32 of the vehicle's current position.
- Smoke and Fire Detector: Notifies the ESP32 of the presence of smoke or fire.
- Liquid Crystal Display (LCD): Shows user process and status information.
- Notifies the closest hospital and caregiver via the telegram service.
- Notifications on the accident and specifics about the location are sent to the nearest hospital and caregiver.

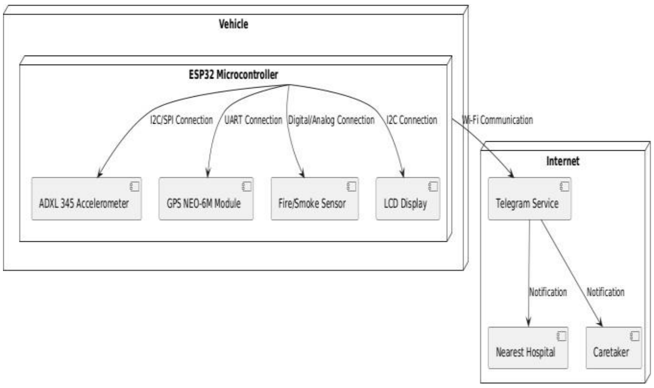

Fig. 1: Data Flow Diagram

3.2 Sequence Diagram

- When an accident is detected by the Vehicle Environment, the ESP32 Microcontroller is triggered.
- ESP32 looks to the ADXL 345 accelerometer for acceleration data and the GPS NEO-6M module for location data.
- After then, it uses the Fire/Smoke Sensor to see whether there's smoke or fire.
- An LCD panel shows the current state.
- At last, the ESP32 notifies the Nearest Hospital and Caretaker using the Telegram Service.

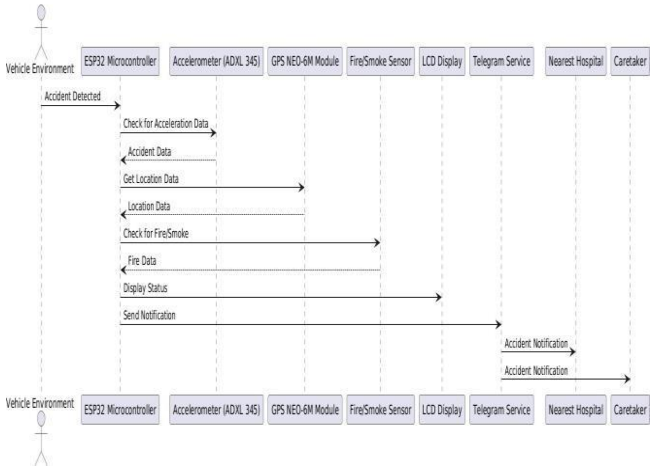

Fig. 2: Sequence Diagram

3.3 Use case Diagram

- Accident detection and system activation are handled by the vehicle's environment.
- The person responsible for care receives alerts on the incident.
- Notifys the nearest hospital of the accident.

Case Studies:

- One feature, "Detect Accident," uses the accelerometer to determine if an accident has taken place.
- Track Location: The GPS system is used to keep tabs on where the car is.
- Identify Smoke or Fire: Verifies if there is smoke or fire.
- The status is shown on the LCD display by selecting Display Status.
- Notify Hospital and Caregiver: Notifies the closest hospital and caregiver.

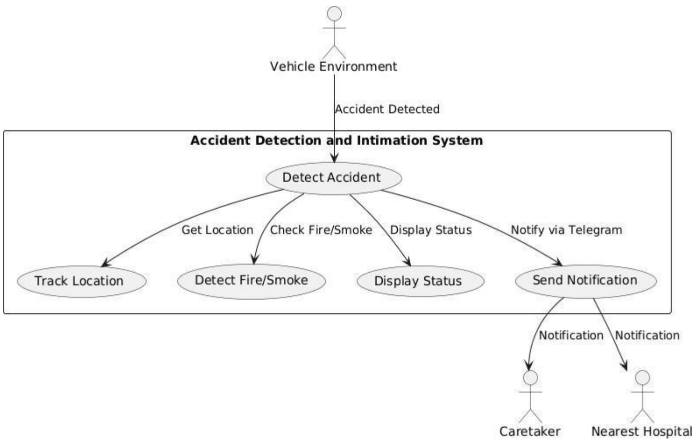

Fig. 3: Usecase Diagram System Implementation

As part of the setup process, you'll need to write code that communicates with the sensors and modules on the ESP32. The procedure is outlined below:

1. **Setup ESP32**: Get the ESP32 libraries set up so it can communicate with the ADXL 345 accelerometer, GPS NEO-6M module, smoke/fire detector, and LCD screen.
2. **Sensor Integration**:
   - Connect ADXL 345 so it can monitor acceleration changes and set it to sound an alarm when certain conditions are satisfied.
   - Get real-time location data by connecting the GPS module.
   - To detect the presence of smoke or fire in the car, connect the smoke/fire detector.
   - Link the LCD screen to provide current status in real- time.
3. **Telegram Integration**:
   - Develop a notification bot for usage with Telegram.
   - Use the Telegram bot to instruct the ESP32 to notify the closest hospital and caregiver in the event of an accident.
4. **Testing**:
   - To evaluate system's reaction, play the role of an accident or fire.
   - Verify that alerts, fire detection, and GPS functionality are all operational.
5. **Deployment**:
   - Make sure all connections are secure before installing the system in the car.
   - Verify functioning in a real-world setting by conducting final tests.

IV. ANALYSIS AND DEISGN

4.1 SYSTEM ARCHITECTURE

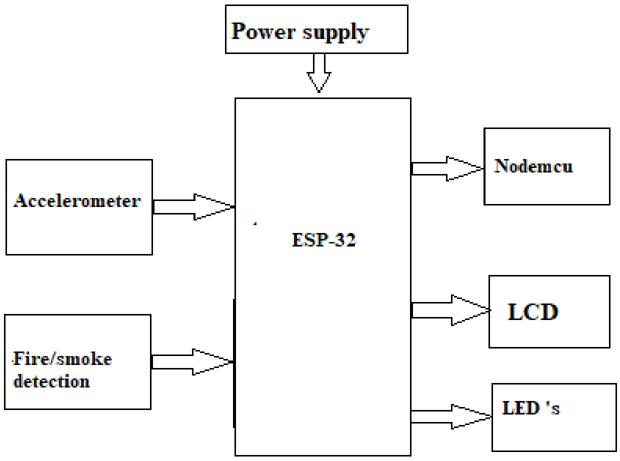

Fig. 4: System Architecture

Accidents:
In order to go to and from work, visit loved ones, and transport things, auto mobiles are indispensable. However, they often lead to major catastrophes. Accidents are defined as "an unexpected and unanticipated occurrence or circumstance, frequently occurring without prior purpose or rhyme" (Wikipedia). Despite how often they occur, road accidents are still the worst thing that can happen to drivers. The most unfortunate aspect is our failure to reflect on and rectify our roadside errors. Accidents and wrecks only occur when drivers are careless, even if most people are aware of the rules of the road and the statistical measures to follow.

Here are some of the most common causes of accidents:

1. Over Speeding
2. Drunken Driving
3. Distractions to Driver
4. Red Light Jumping

4.2 Accident prediction system

2 kinds of accident prediction system:

- Conventional method of accident prediction
- System for predicting accidents in real-time
- Time-Held Method for Foreseeing Accidents

Utilized long-term traffic data include average daily traffic over a year and hourly volumes.
It connects the dots between events and the traffic data gathered in real-time by different sensors
It can detect an accident rather than attempt to predict it. How an accident detection system differs from a prediction system Prediction takes into account changes to traffic conditions before to an accident, while traffic incident detection takes into account changes to traffic circumstances during an event.

4.3 Accident detection and reporting procedure Speed Measurement

There are many ways to find out how fast a car is going. Most cars have a speedometer as an example. Nevertheless, a device that can convert analog signals to digital ones is required to read the speedometer. A laser speed gun can only take readings in one specific location and in real time. Sending and receiving entirely independent data lines, or phrases, is the foundation of NMEA. Among them, GPRMC is the one that is transmitted the most frequently.

V. Unit Testing

One step in the software testing lifecycle is unit testing, which involves checking the proper operation of the application's tiny, independent sections, called units. Even though it's more often automated, unit testing may also be done manually. The purpose of unit testing is to ensure that software components are functioning as expected by executing them independently. Tables below include test cases and their outcomes.

5.1 Unit testing:

Table 1: Unit Test Case For Arduino Test

A SL # Case Study :	UTC-3
Name of Test:	Accident detection
Items that will be evaluated	Accelerometer sensor
Sample Input:	Input to sensor
Expected result:	Should detect the accident
Real results:	System detected the accident
Remarks:	Pass

A SL # Case Study :	UTC-1
Name of Test:	Power on Test
Items that will be evaluated	Arduino and other devices should turn on
Sample Input:	Input supply
Expected result:	Arduino should boot up
Real results:	All devices turned on
Remarks:	Pass.

Table 2: Unit Test case for Smoke Detection

A SL # Case Study :	UTC-2
Name of Test:	Fire Detection
Items that will be evaluated	Detection of fire
Sample Input:	Tested for input fire
Expected result:	Fire Detected
Real results:	Fire Sensor detected the fire
Remarks:	Pass

5.2 Integration Testing:

Assembling several parts of software and testing them together is what's known as software integration testing. At this stage of testing, we are looking for issues with the interplay between the integrated parts. Test stubs and test drivers are essential for integration testing. To ensure that all of an application's interdependent parts are functioning as intended, integration testing is necessary. This occurs after unit testing but before to validation testing. This test may be executed in one of two ways: either by testing integration from the top down or from the bottom up.

Table 3: Integeration Test Case for fire detection and intimation

Sl # Test Case : -	ITC-1
Name of Test: -	Fire Detection and Intimation
Item being tested: -	Smoke and fire detection
Sample Input: -	Flame
Expected output: -	Should detect fire and intimate
Actual output: -	Same ad Expected
Remarks: -	Pass.

Table 4 : Integration Test case for accident detection and Intimation

Sl # Test Case : -	ITC-2
Name of Test: -	Accident Detection and Intimation
Item being tested: -	Accident Detection
Sample Input: -	Input to accelerometer sensor
Expected output: -	Intimation to telegram application on accident detected
Actual output: -	Alert received on phone
Remarks: -	Pass.

5.3 System Testing:

A system must be tested to make sure that any software or hardware satisfies all of its requirements. System testing, which is a kind of black-box testing, does not need knowledge of the code or logic that runs the program. System testing is essential for the reasons given below:

Complete application testing is the first step of the software development life cycle (SDLC).
To make sure the software works as expected and meets all technical specs, it goes through a series of testing.
There is a high degree of similarity between the testing environment and the production environment.
Through system testing, we can confirm and validate the business requirements while also testing and validating the application architecture.

Table 5: System Testing Testcase

Sl # Test Case : -	STC-1
Name of Test: -	System testing
Item being tested: -	Intimation
Sample Input: -	Input to all sensors
Expected output: -	Should detect intimate
Actual output: -	Same as expected output
Remarks: -	Pass

VI. RESULTS

6.1 Results

A variety of simulated situations were used to effectively build and test the ESP32-based Accident Detection and Intimation System. The findings are as follows:

- **Accident Detection:** The ADXL 345 accelerometer reliably picked up on abrupt changes in the vehicle's acceleration, allowing for the identification of possible accidents. The algorithm demonstrated remarkable accuracy in differentiating between typical driving circumstances and accident situations.
- **Location Tracking:** The GPS NEO-6M module reliably pinpointed the vehicle's exact location to within a few meters every time. All of the necessary information was contained in the urgent messages received over Telegram.
- **Smoke and Fire Detection:** This feature kept an eye out for any indications of smoke or fire inside the car. As soon as the system identified such dangers, it immediately notified the ESP32, which sent off the alarms.
- **Status Updates:** The LCD screen showed current process information, such as sensor readings, detection status, and confirmation of notifications. The user was kept apprised of the system's functionality at all times thanks to this.
- **Telegram Notifications:** The solution effectively notified the closest hospital and a chosen caregiver using the messaging platform Telegram in the event of an emergency. Important details including the car's position, the time of the event, and the accident type were included in the alerts.

VII. CONCLUSIONS AND FUTURE SCOPE

7.1 Conclusion

Accident Detection and Intimation System, which makes use of ESP32, is one practical approach to automobile safety. The system provides a comprehensive plan for responding to accidents by detecting them, tracking the vehicle's location, assessing the risk of fire, and notifying authorities of an emergency. By integrating sensors, GPS, and communication modules, we have shown that these systems can work in the real world, which might save lives by making emergency services react faster.

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