GPS and GSM-based Smart Vehicle Tracking System

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ABSTRACT

Vehicle tracking is an essential part of the automotive industry to provide safety and security. The increasing number of vehicles in road traffic brings the importance of smart real-time tracking systems. Incautious and careless driving leads to accidents with serious fatalities and injuries that cause terrible social and economic costs. And hence, research on specific crash detection systems is so overly needed and is a significant issue in automotive systems safety. A vehicle tracking system has been developed and put into operation with the aim of monitoring the movements of any vehicle that is equipped with it, regardless of its location or time. This innovative system is based on a combination of a smartphone and an Arduino UNO, which are widely used technologies and cost-effective as compared to other options. The device installed in the vehicle uses GPS and GSM technology to function effectively. Though several crash detection algorithms have been invented, their coverage based on a few scenarios has been limited. Our tracking vehicle system is effectively implemented and designed to track the movement and location of any equipped vehicle from any longer distance irrespective of direction. Moreover, our proposed idea is to make effective use of popular technology with a combination of a smartphone along with an Arduino. A GSM module has been used in the context of this study to make it easier to send and receive SMS messages. The GPS module is used by the vehicle tracking system used in this investigation to acquire geographic coordinates at predefined intervals. Using the GSM module, these coordinates are transferred and updated in a database. The latitude and longitude of the vehicle's current location are included in the SMS messages, which are acquired by the Arduino UNO from the GPS module and then texted to the car's owner using the GSM module. The position can also be seen on a Google map on a smartphone in addition to being shown on an LCD screen. This enables the user to continuously track the location of the vehicle and calculate its distance and arrival time at a given destination. The proposed algorithm disguised between both driving and parking modes is to minimize any kind of disturbance and inaccurate crash detection incidents. The performance had been assessed effectively under hypothetical conditions between parking and driving modes.

Introduction

Maintaining cars as well as keeping an eye on driver behavior and enforcing safe driving procedures, are all important aspects of ensuring the safety of your drivers. You can build maintenance schedules and get automatic notifications based on odometer readings or scheduled maintenance using the digital maintenance solutions that many fleet tracking companies offer. Also, you may build up a digital workflow for inspections and maintenance tasks, enabling your maintenance crew and drivers to submit issues that need to be fixed right away. Sharp braking, acceleration, cornering, and speeding are all examples of poor driving habits that GPS trackers with integrated accelerometers may identify to then warn drivers and management about. Fleet managers can have even better visibility into driver behavior, such as inattentive driving, tailgating, and red-light running, using AI-enabled dashcams. (*5 Benefits of GPS Tracking*, n.d.)

It is a wise idea for everyone as it helps reduce the number of car accidents daily. It also focuses on improving car crash detection in all cases. Due to it being a major and key issue the entire world is facing. That's why it must be considered and established in a specific manner. The proposed project idea is to use an IoT device to implement this project, a GPS and GSM-based vehicle tracker like Arduino, sensors, etc. Furthermore, it includes features such as security, IoT devices, and Cloud computing. Cloud computing will be as the RFID card reader details will be stored in the database of the website. We are not focusing on a particular organization. Moreover, as it had been previously stated, this topic is relevant and extremely important, and necessary to reduce such accidents today.

Objectives and Discussions

To create a vehicle tracking system based on Arduino that uses GPS and GSM technologies. Improve car crash detection and further decrease the number of daily car accidents. Design a website with access control security measures that allow real-time tracking of vehicles. Increase awareness about reducing car accidents. Implementing the advantages of the proposed project idea for better safety.

GPS and GSM Based Vehicle Tracking System

The vehicle tracking and location system is intended to locate and monitor vehicles in real time utilizing GSM and GPS technology. It gives a quick and easy way to gather vital information for enhancing service quality. The GPS-based vehicle tracking system is specifically developed to determine any vehicle's exact location and convey the data to the proper authority through SMS. The system has a GPS modem to retrieve longitude and latitude coordinates, and GPS data is used for geographic positioning and time. The device consists of an onboard module installed discreetly in the vehicle being tracked, which includes a GPS receiver and a GSM modem. A base station monitors data from several cars, and the system communicates location data to the monitoring unit on a continual basis (Naing et al. 2019)

Accident Detection and Alert Systems

The main goal of creating this website and combining real-time devices and accident alert systems. is to restrain accidents by sending an alert message to the verified and registered mobile phone through wireless communication technology techniques. Therefore, if any accidents occur anywhere, the alert message is instantly transferred to that specific mobile phone registered via the GSM module. As we will be using different components to establish the proposed website. By using those components, we are going to make a device that can give the magnitude of the crash. Moreover, we are also including a real-time tracking device. The device will send a message and call the registered mobile number. As it can be monitored through a private website with a security method of username and password. The software that will be used to establish the device and connections is "Arduino" software, as well as "Virtual Studio Code" for testing the website that is going to be created by "Web Press". The project tasks are anticipated to be. finalized and completed within two months. As it will commence in March 2023 and proceed to its final stages and be concluded by mid-May 2023. The Omani government has launched several initiatives aimed at reducing the number of accidents on the country's roads, including stricter traffic laws, increased enforcement, and public awareness campaigns (Gomathy, 2022).

In addition to investing in new technologies to prevent accidents, there is also a need to improve emergency response times in the event of an accident. This includes training first responders and ensuring they have the necessary equipment and resources to quickly rescue and treat accident victims. While new

technologies like driverless cars and flying taxis have the potential to revolutionize transportation, they also come with their own unique safety risks that will need to be addressed. This may require new regulations, safety standards, and technologies specifically designed for these types of vehicles.

Improved Crash Detection Algorithm for Vehicle Crash Detection

However, nowadays vehicle theft is a rising trend. People cannot avoid using vehicles. Therefore, this issue needs to be addressed. Creating our device, along with designing our website and establishing it based on their requirements, will be an efficient way to keep an eye on them without being closed. In fact, these systems don't only reduce car accidents but also help keep theft under control. GPS and GSM are mainly used to track vehicles in these systems. Those systems are used by the user to determine the location of the vehicle along with the distance it had traveled. The created system will be reliable and sound. (Naing et al., 2019).

Technical Requirements

Software Implementation for Vehicle Tracking System and Accident Alert System

The combination of hardware and software components is necessary for the construction of a vehicle tracking system. The software comprises the tracking platform and related applications, while the hardware normally consists of GPS tracking devices that are put in automobiles.

Users can manage vehicle whereabouts, routes, and performance information in real-time using the tracking platform. Additionally, it sends alerts for any veering off planned routes or the use of vehicles without authorization. The program may also produce reports that offer details on fleet utilization, fuel consumption, and other important variables. Implementing a vehicle tracking system can help organizations save money, manage their fleets more effectively, and perform better overall by giving them access to valuable data and insights.

GPS Module

The Global Positioning System (GPS) in vehicle tracking systems is commonly used to provide users with information such as the location coordinates, speed, time, and so on, anywhere on Earth. In this work, a GPS module, and a GPS receiver available from the Sparkfun website, are adopted to implement the in-vehicle device. The GPS module has a GPS receiver with an antenna. There are two slide switches and one push button switch. Along with a Node MCU, which Controls a single device function, It's a microcontroller usually part of a system.

The SM5100B GPS module is identical to the Neo 7m GPS module and offers detail about the GPS module. When the DLINE is selected, Rx and Tx in the GPS module will be connected to microcontroller digital pins 2 and 3, respectively. If the UART was selected, Rx and Tx in the GPS module will be connected to microcontroller digital pins 0 and 1, respectively. In this work, Tx and Rx in a GSM/GPRS module use microcontroller digital pins 2 and 3. So, the GPS switch 1 must be set to the UART position, otherwise, if the DLINE position is selected its digital pins will overlap that of the GSM/GPRS module. Even when UART is selected while trying to upload program code to the Arduino, users will see an error message in the microcontroller because the UART uses the same pin numbers that are used for programming, but nothing should get damaged. For these reasons, the GPS module should select the switch in the UART position after the source code is uploaded. It is required for getting the location information.

The GPS receiver module uses the 220-channelEM-406A SiRF III receiver. Once the microcontroller and the GPS module have everything assembled, the GPS module is almost ready to get the vehicle's location information. The Tiny GPS library was used to communicate with and access data from the GPS module. The EM-406 works at 4800 bps, but if users are using another type of GPS, they should identify the correct baud rate for their specific device. (Byoungman and YoungSeop, 2020)

GSM Module

The SIM800L GSM/GPRS module is responsible for establishing connections between an in-vehicle device and a remote server for transmitting the vehicle's location information, using TCP/IP connection through the GSM/GPRS network.

RFID Tracking System

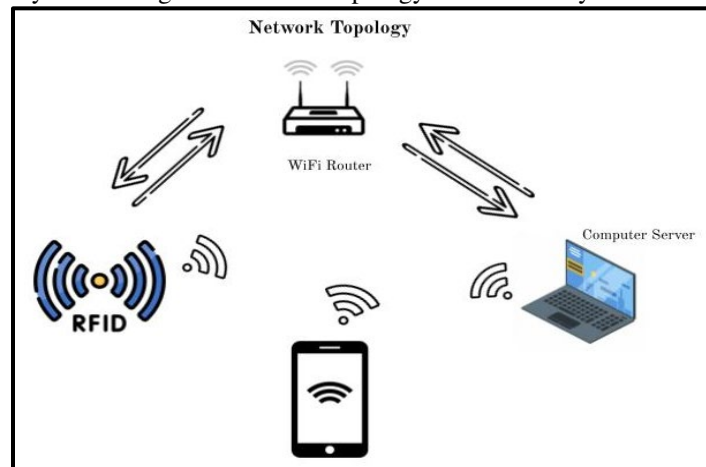We have verified our system through this network topology of the RFID system.

Figure 1. Model of RFID System

Arduino

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense and control the physical world. The project is based on a family of microcontroller board designs manufactured primarily by Smart Projects in Italy, and also by several other vendors, using various 8-bit Atmel AVR microcontrollers or 32-bit Atmel ARM processors. These systems provide sets of digital and analog I/O pins that can be interfaced with various expansion boards. The boards feature serial communications interfaces, including USB on some models, for loading programs from personal computers. For programming the microcontrollers, the Arduino platform provides an integrated development environment (IDE) based on the Processing project, which includes support for C, C++, and Java programming languages.

Shock Sensor

The sensor used to detect accidents is a shock sensor. This is a single-stage shock sensor; it detects any hard impact acted on it. The output from the sensor after impact will be +5v and connected to the INT (pin 12) the of processor. These sensors are fixed on all sides of the car to detect the imp that act occurred on it. These outputs from sensors are sent into the OR gate to detect at least one impact. It is integrated into the circuit system by connecting all the sensors to or gate whose output is connected to the int pin of the microcontroller. These sensors are connected in such a way that they detect force impact occurring from any side of the car. This is concerned with the safety of the system of the human driving the car so that once an accident is detected the paramedics can reach the location as soon as they can.

Data Analysis

To collect the necessary data, we utilized multiple-choice questions as well as open-ended questions. Because it is more efficient and takes less time for students to respond. The questions were primarily opinion-based because it's essential to understand other people's points of view in order to produce a valuable solution that benefits everyone. Different answers were given to each question, which aided us in making the final decision on our topic and how to proceed with it.
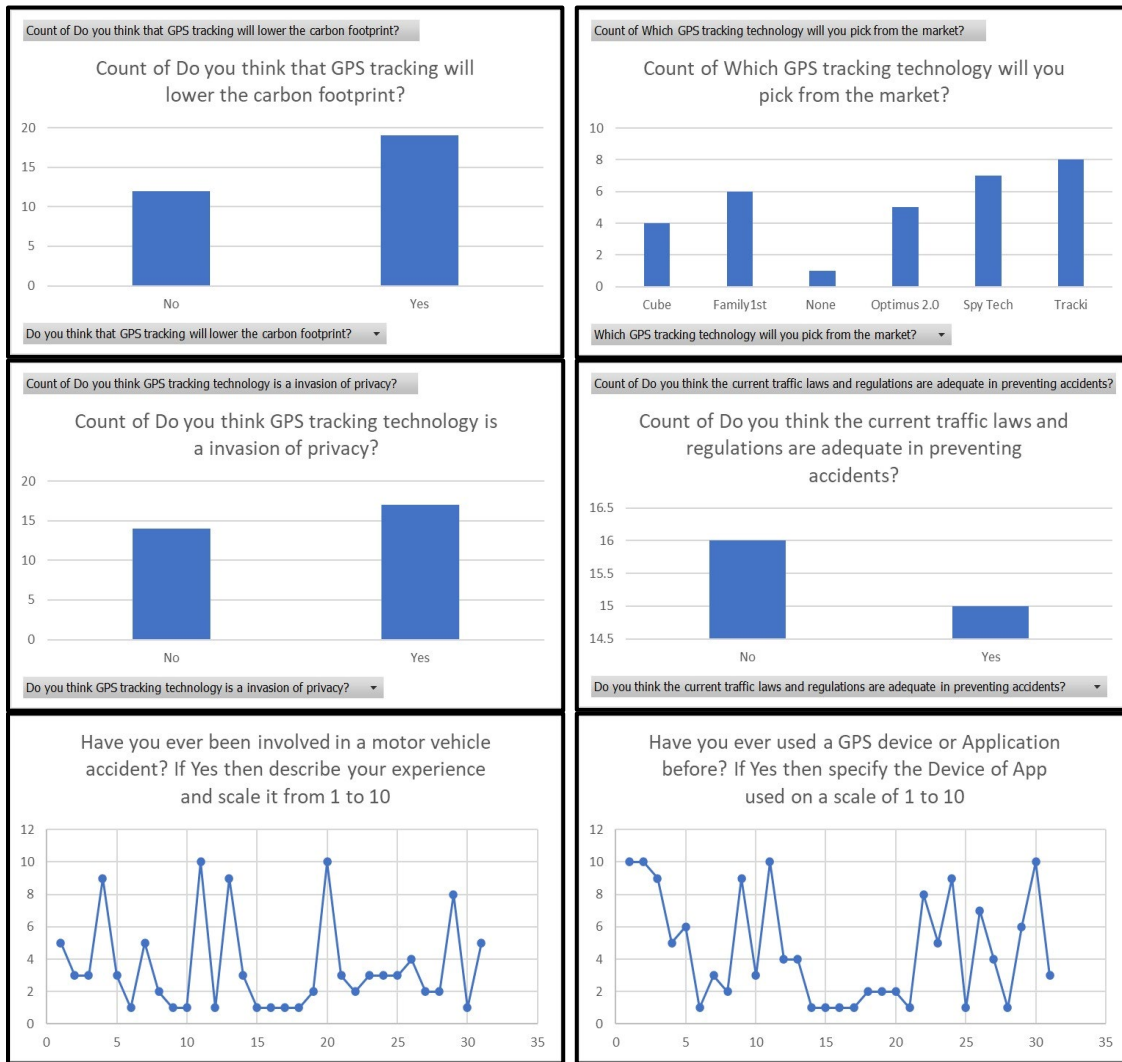
Figure 2. Graphs of the Questionnaire

According to the graph, the majority of respondents believe that GPS tracking will help to reduce carbon footprint. The "Tracki" device received more votes, suggesting that it is more efficient and improves user awareness. It stands out from the competition by offering features like location monitoring. This graph shows that there are different opinions on whether GPS tracking violates privacy or not. While a significant proportion of respondents indicated that GPS tracking violated their privacy, others indicated that this was not the case. Since privacy is a personal issue, both points of view are valid and should be considered. According to the chart results, the majority of respondents said "no", indicating that despite efforts to raise awareness and follow safety recommendations, accidents continue to happen as they are often the result of human error. There have been many serious accidents and no doubt implementing a GPS tracking system would reduce these types of incidents. Based on the graph, most GPS users are satisfied with the features offered. The use of GPS is expected to increase as the size increases. Consequently, investing in the development of this application can result in increased productivity and security.

Case Studies

We reviewed and evaluated various themes and titles after completing extensive studies in many areas of our project. However, since everything can change, we had to do additional research to stay up to date. We started brainstorming in the first week of our project and finally settled on a "GPS and GSM Based Intelligent Vehicle Tracking System" in the second week. We hoped to improve the current GPS surveillance system by connecting it to RFID databases containing personal information such as registered user numbers. Our method uses a smartphone and an Arduino UNO, both inexpensive and commonly used technologies. The device installed in the vehicle uses GPS and GSM technology to ensure its correct operation.

Social Media

Social media is one of our primary data collection methods. We are all aware of how successful and current social media is nowadays. We were prepared to review personal technical social media accounts that contained personal viewpoints and accounts linked to future assets in addition to the internet and articles. We studied a lot of YouTube videos to obtain an idea of how to further implement it utilizing an Arduino device.

Process Modeling

Three main systems called Vehicle Tracking System, Accident Alert System, and RFID Tracking System have been developed to demonstrate the functions of the proposed system.
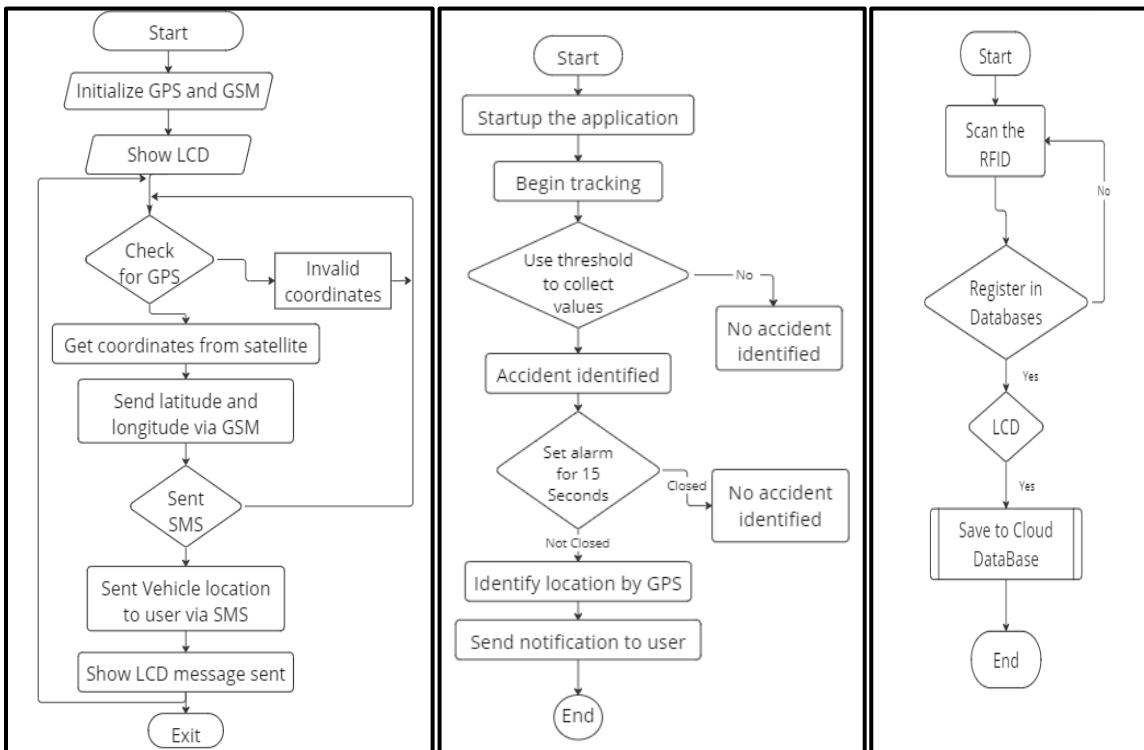

Figure 3. Vehicle Tracking System Flowchart. **Figure 4**. Accident Alert System Flowchart. **Figure 5.** RFID Tracking System Flowchart.

During the car tracking system process, the device is designed to locate the accident by combining a GSM device and a GPS device to send a message to the user via SMS, which is then shown on the device's LCD.

Accident detection is recognized throughout the process of the Accident warning system, if any, the accident has been detected. GPS will be used to determine the exact location of the location that will be transmitted to the user or the registered phone. As a result, the user will be alerted if the car has made an unusual movement.

The RFID Tracking System procedure begins when the user scans the RFID. Once that is completed, the user must register it in databases. This confirms that the data has been saved to the cloud database.

Implementation

The device that we have made uses three different technologies: GPS, GSM, and RFID.

RFID Technology

Only after an authorized user successfully logs into the system will the GPS and GSM technology begin to function. All login information is saved in a database management system. However, if an unauthorized person tries to obtain access to the system, he or she will be unable to log in or use GPS or GSM technology.

GPS and GSM Technology

As we are combining a car monitoring system and an accident alarm system in a single device, they are inseparably connected, which means that one cannot function without the other.

We would be able to track the gadget using a published application (Arduino App) because it provides us with latitude and longitude directions. We can even see the speed of the vehicle in which the device is carried or fitted; it also sends a speed alert message to the registered mobile number provided during the coding; and if the vehicle exceeds the desired speed limit, the speed count increases to one every time the vehicle exceeds the limit, and this message is transmitted using the GPS & GSM module.

We can also see if a vehicle was involved in an accident. If a vehicle is involved in an accident, the coordinates (position) of the vehicle will change automatically, an accident LED installed in the app will begin blinking, and an accident alert notification will be sent to the registered mobile number with a Google map link through which the user can locate the accident spot (Naing et al. 2019).
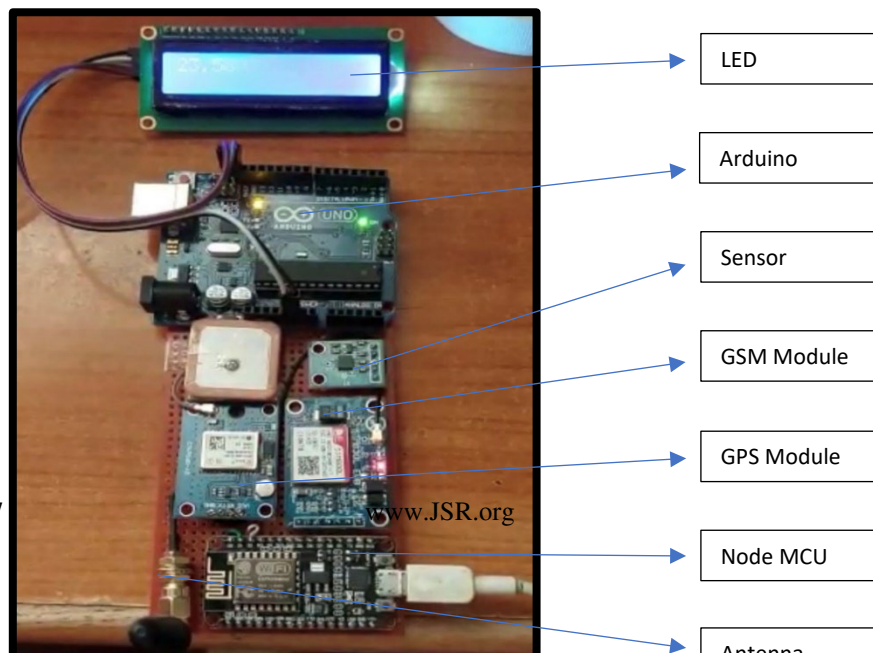
Figure 6. The working module of the Vehicle Tracking System

Result

Every time a vehicle accident occurs, the device sends a message to the predetermined numbers with the location and time of the accident so that assistance can be provided. The GSM module will be used to send the message, which is like "Vehicle Tracking and Accident Alert System: Accident Alert......!" and it also includes a link to Google Maps. With the aid of the GPS module connected to it, this system displays the location of the car where the accident has occurred, and as a result.
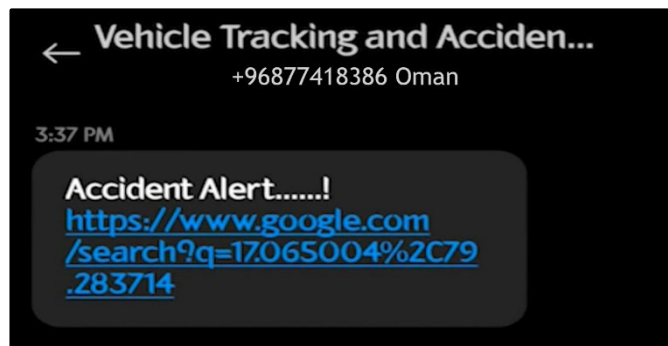

Figure 7. The Expected Result of Vehicle Tracking & Accident Alert System Notification Message
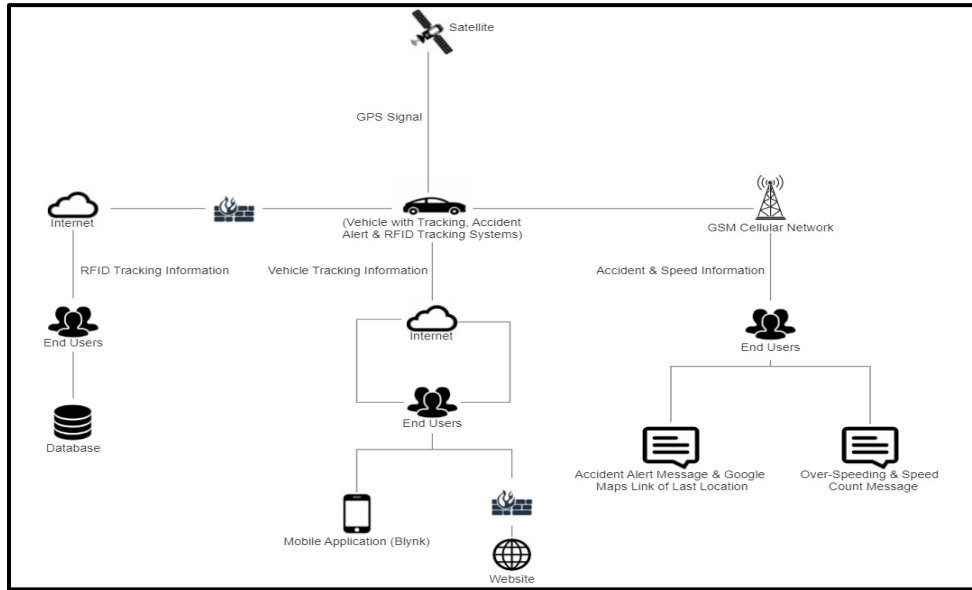
Network Design

Figure 8. Network Design of the RFID Tracking System, Vehicle Tracking System, and Accident Alert System.

In order for a device to actually collect the location data and transmit it to a server or cloud-based platform for processing and analysis, many separate protocols and interfaces must communicate with each other.

The Arduino gadget with GPS module and GSM module serves as a tracker in this diagram. The Arduino gadget uses the GPS module to collect location information from GPS satellites and the GSM module gives it cellular access so it can transmit location information over the GSM network to a server or platform. The gadget is meant to locate the accident during the car tracking system process by combining a GSM device and a GPS device to deliver a message to the user via SMS, which is then shown on the device's LCD. If an accident has been identified, it is acknowledged throughout the course of the Accident warning system. GPS will be utilized to determine the precise location of the location, which will then be relayed to the user's registered phone. As a result, if the car makes an odd movement, the user will be notified. When the user scans the RFID, the RFID Tracking System method begins. After that, the user must register it in databases. This verifies that the data was saved to the cloud database.

Conclusion

The tracking system has been an important factor in maintaining our cars, in terms of security. New and improved technologies should rise too in order to prevent or reduce the level of accidents. As this is going to also help and aid Oman's economy as well as meet up with Oman's vision of 2040. As theft is getting popular nowadays. Installing different features will not only reduce that, but it can also make the tracking system efficient since we have various features that we added to improve the existing system into a device that can be reliable by all car drivers. By using those components, we are going to make a device that can give the magnitude of the crash. Moreover, we are also including a real-time tracking device. As it can be monitored through a private website with a security method of username and password. Combining accident alert system and real-time device.

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