A Survey on IoT-Based Vehicle Accident Prevention and Emergency Notification System

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Abstract - *This project proposes an accident-prevention system using ESP32, RF transmitter and receiver, solar panel, battery, audio playback and storage module, and Blynk app. The above system is designed to be installed in a danger area, such as a school zone or construction site. When a car enters the area, the RF receiver will detect the signal from the RF transmitter and trigger the audio playback module to play a message, such as "School ahead, go slow." The system will also send a notification to the Blynk app, so that the user can be alerted of the car's presence in the danger area. The ESP32 will be used to control the entire system. It will be programmed to detect the signal from the RF receiver, trigger the audio playback module, and send a notification to the Blynk app. Solar panel and battery will be used to power the system, so that it can operate independently. This system is designed to be easy to install and use. It can be installed anywhere in the danger area, and it does not require any wiring or other special infrastructure. The system is also very affordable, making it a feasible solution for both developed and developing countries.*

Key Words: IoT, ESP32 Microcontroller, Smart Sensors, GPS, GSM, Blynk Application.

1.INTRODUCTION

Road accidents are a major public health concern, accounting for millions of deaths and injuries each year. A notable number of these accidents occur in danger areas, such as school zones and construction sites. These areas are often populated by vulnerable pedestrians and cyclists, and drivers may be distracted or unaware of the potential hazards. One way to reduce the risk of accidents in danger areas is to use warning systems to alert drivers of their presence. These systems can take a variety of forms, such as traffic signs, flashing lights, and audio alerts. This project proposes a new type of accident-avoiding system that uses ESP32, RF transmitter and receiver, solar panel, battery, audio playback and storage module, and Blynk app. This system is designed to be installed in a danger area, such as a school zone or construction site. When a car enters the area, the RF receiver will detect the signal from the RF transmitter and then trigger the audio playback module to play a message, such as "School ahead, go slow." The system will also send a notification to the Blynk app, so that the user can be alerted of the car's presence in the danger area. This system has a number of advantages over traditional warning systems. First, it is easy to install and use, RF transmitter and receiver can be installed anywhere in the danger area, and they do not require any wiring or other special infrastructure. Second, this system is affordable. The ESP32, RF transmitter and receiver, audio playback and storage module, and Blynk app are all relatively inexpensive components. Third, the system can be powered autonomously using a solar panel and battery. This will make it ideal for use in remote areas where access to electricity is limited. The system is also very versatile. It can be used in a variety of danger areas, such as school zones, construction sites, pedestrian crossings, railway crossings, airport runways, parking lots, and industrial areas etc. Overall, the proposed system is a promising new approach to accident prevention in danger areas. It is easy to install and use, affordable, and versatile. The system has the potential to significantly reduce the risk of accidents and improve safety in a variety of settings.

2. PROPOSED METHOD

The objective of this project is to develop an accident-avoiding system using ESP32, RF transmitter and receiver, solar panel, battery, audio playback and storage module, and Blynk app. The system will be designed to be low-cost, easy to install, and self-powered. It will be able to detect the presence of vehicles in a danger area and warn drivers using an audio message. The system will also be able to send a notification to the Blynk app to alert the user of the vehicle's presence.

The system works as follows:

1. The RF transmitter transmits a signal when it detects a vehicle in the danger area.
2. The RF receiver receives the signal and sends it to the ESP32 microcontroller.

3. The ESP32 microcontroller processes the signal and determines whether a vehicle is present or not.
4. If a vehicle is present, the ESP32 microcontroller sends a signal to the audio playback and storage module to play the warning message to the drivers.
5. The ESP32 microcontroller also sends a notification to the Blynk app to inform the user that a vehicle has been detected in the danger area.

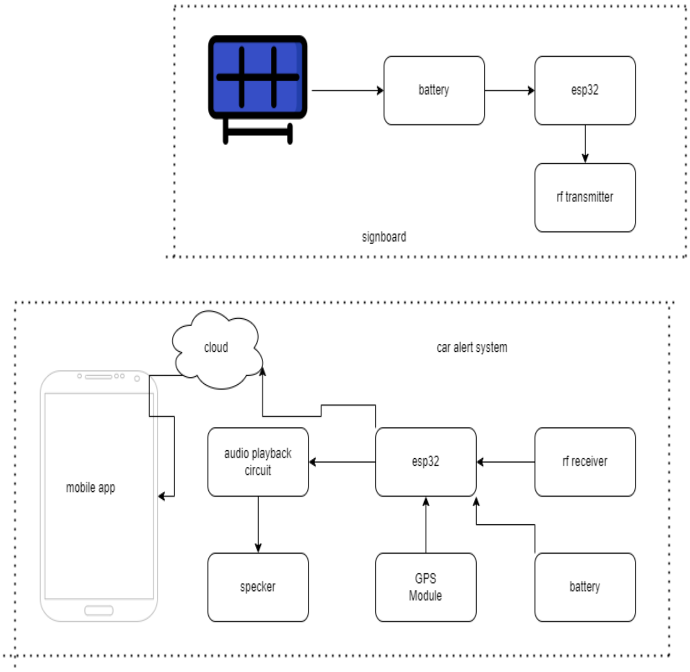

Fig -1: Block Diagram

2.1 Hardware Components

2.1.1 ESP32 Microcontroller

The ESP32 microcontroller is a dualcore 32-bit low power system-on-chip (SoC) with built-in Wi-Fi and Bluetooth. It is based on the Tensilica Xtensa LX6 microprocessor and features two cores that can operate at up to 240 MHz. The ESP32 also has 448 KB of ROM and 520 KB of SRAM.

Specifications of the ESP32 microcontroller:

1. CPU: Dual-core 32-bit Tensilica Xtensa LX6 microprocessor, operating at up to 240 MHz.
2. Memory: 448 KB of ROM, 520 KB of SRAM
3. Wireless connectivity: Wi-Fi (802.11 b/g/n), Bluetooth (v4.2).
4. Peripheral interfaces: 34 × programmable GPIOs, 12-bit SAR ADC up to 18 channels, 2 × SPI, 2 × I2C, 2 × I2S, 3 × UART, Ethernet MAC, SD/SDIO/MMC host controller, SDIO SPI slave controller, motor PWM, and LED PWM.
5. Security features: Secure boot, flash encryption, IEEE 802.11 standard security features, TLS/SSL, RSA, ECC, and SHA-256.
6. Power management: Internal low-dropout regulator, sleep mode, and deep sleep mode.
7. Voltage: 3.3 V.
8. Temperature range: -40 °C to +125 °C.

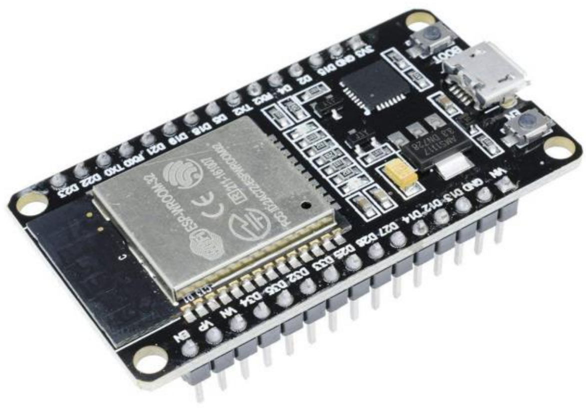

Fig -2: Microcontroller

2.1.2 RF transmitter and receiver

The RF transmitter receives serial data and transmits it wirelessly through through its RF antenna. The transmission occurs at the rate of 1 Kbps – 10 Kbps. RF receiver receives the transmitted data and it is operating at the same frequency as that of the transmitter.

Specifications of the RF transmitter and receiver required for the project:

1. Frequency: 433 MHz
2. Power output: 10 mW
3. Range: 100 meters
4. Modulation: OOK (On-Off Keying)
5. Data rate: 1 kbps

Why this components are best for the project:

1. Frequency: 433 MHz is a common frequency for RF communication, so it is easy to find compatible RF transmitters and receivers.
2. Power output: 10 mW is enough power to transmit the signal over a distance of 100 meters, which is the convenient range for this project.
3. Range: 100 meters is a adequate range for detecting vehicles in a danger area.

4. Modulation: OOK is a simple and reliable modulation scheme that is well-suited for this project.
5. Data rate: 1 kbps is a sufficient data rate for transmitting the warning message to drivers.

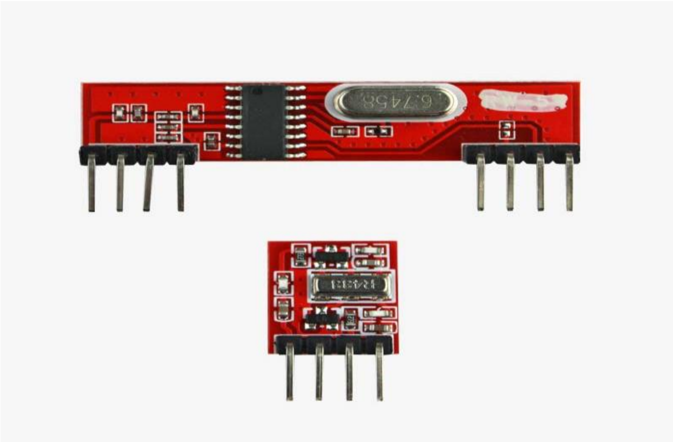

Fig -3: RF transmitter and receiver

2.1.3 Solar panel

A solar panel is a device which is an arrangement of multiple solar cells, which are connected in parallel or series alignment to observe sunlight and then generate direct current (DC). It is also known as Photovoltaic (PV) module.

Specifications of the solar panel required for the project:

1. Voltage: 5-6 V
2. Current: 500-1000 mA
3. Power: 2.5-5 W
4. Size: 150-200 mm x 100-150 mm

Why this component is best for the project:

1. Voltage: The solar panel should generate a voltage that is compatible with the ESP32 microcontroller and the other components of the accident-avoiding system.
2. Current: The solar panel should generate enough current to power the accident-avoiding system.
3. Power: The solar panel should generate enough power to charge the battery and power the accident-avoiding system autonomously.
4. Size: The solar panel should be small and lightweight enough to be easily integrated into the accident-avoiding system.

Fig -4: Solar panel

2.1.4 Battery

Battery, in electricity and electrochemistry, any of a class of devices that convert chemical energy directly into electrical energy. Although the term battery, in strict usage, designates an assembly of two or more galvanic cells capable of such energy conversion, it is commonly applied to a single cell of this kind.

Specifications of the battery required for the project:

1. Voltage: 3.7 V
2. Capacity: 2000-5000 mAh
3. Chemistry: LiPo (Lithium-Polymer) or Li-Ion (Lithium-Ion)
4. Size: 60-80 mm x 30-40 mm

Based on the above factors, the following battery is recommended for this project:
3.7V 2000mAh Li-Po Battery

Why this component is best for the project:

1. Voltage: The battery should have a voltage that is compatible with the ESP32 microcontroller and the other components of the accident-avoiding system.
2. Capacity: The battery should have enough capacity to power the accident-avoiding system for at least 24 hours on a single charge.
3. Chemistry: LiPo and Li-Ion batteries are the best choice for this project because they are lightweight, have a high energy density, and have a low self-discharge rate.
4. Size: The battery should be small and lightweight enough to be easily integrated into the accident-avoiding system.

Fig -5: Battery

2.1.5 Audio playback and storage module

The Audio playback and storage module is a Decoding Board with Self-Powered TF Card U Disk Decoded Player module is used for playing tracks in the MP3 format stored on a Micro-SD card or USB memory. Onboard 2W mono amplifier is connected to the speaker, 3.5mm gold plated headphone jack can connect with headphones or external audio. With a MicroUSB port. Through the mobile power supply, 3.7V lithium battery, or USB 5V power supply. Support TF Card and U disk play mode. Superior sound quality.

Specifications of the audio playback and storage module required for the project:

1. Voltage: 3.3-5 V
2. Audio format: MP3, WAV
3. Output power: 1-2 W
4. Storage capacity: 128-512 MB

Based on the above factors, the following audio playback and storage module is recommended for this project:
MP3 Player Module 3.7-5V 1W 128MB

Why this component is best for the project:

1. Voltage: The audio playback and storage module should have a voltage that is compatible with the ESP32 microcontroller and the other components of the accident-avoiding system.
2. Audio format: The audio playback and storage module should be able to play MP3 and WAV audio files. This is because MP3 and WAV are the most common audio formats.
3. Output power: The audio playback and storage module should have enough output power to drive the speaker and produce a warning message that is loud enough to be heard by drivers.
4. Storage capacity: The audio playback and storage module should have enough storage capacity to store the warning message.

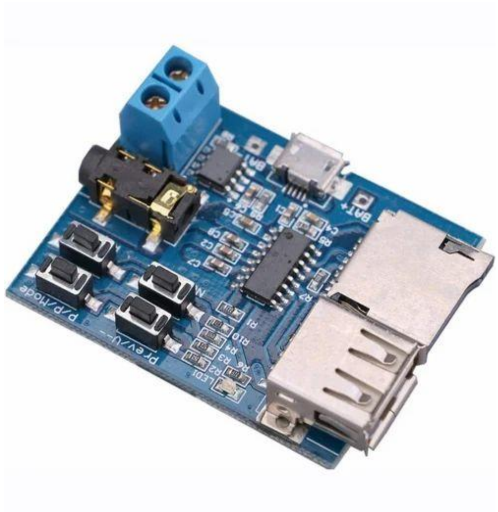

Fig -6: Audio playback and storage module

2.2 Software Component

2.2.1 Blynk application

Blynk is a software company that provides infrastructure for the Internet of Things.

Specifications of the Blynk app required for the project:

1. Compatibility: The Blynk app must be compatible with the ESP32 microcontroller and the other components of the accident-avoiding system.
2. Features: The Blynk app must have the following features:
3. The ability to send notifications to the user when a vehicle is detected in the danger area.
4. The ability to display the location of the accident-avoiding system on a map.
5. The ability to allow the user to configure the accident-avoiding system, such as setting the sensitivity of the RF receiver and the volume of the warning message speaker.

Why the Blynk app is best for this project:

1. Compatibility: The Blynk app is compatible with a wide variety of microcontrollers and devices, including the ESP32 microcontroller.
2. Features: The Blynk app has all of the features required for this project. It can send notifications to the user, display the location of the accident-avoiding system on a map, and allow the user to configure the system.
3. Ease of use: The Blynk app is easy to use and has a user-friendly interface.

4. Open source: The Blynk app is open source, which means that it is free to use and modify.

Overall, the Blynk app is the best choice for this project because it is compatible with the ESP32 microcontroller, has all of the required features, is easy to use, and is open source.

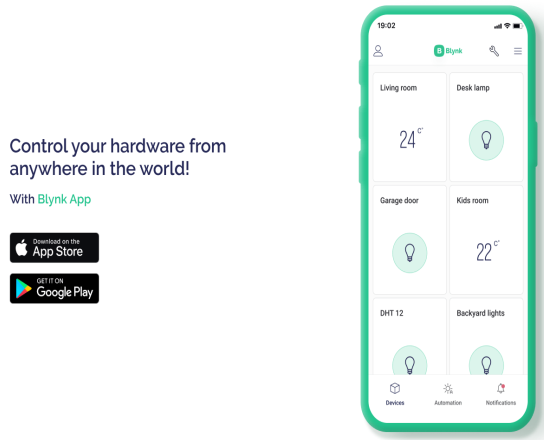

Fig -7: Blynk application

3. METHODOLOGY

3.1 Approach

1. On-board Vehicle Unit (OVU): Installed within the vehicle, the OVU gathers data from various sensors, including accelerometers, gyroscopes, GPS, and cameras. It processes this data to identify potential accident scenarios, such as sudden braking, rapid acceleration, or vehicle rollover.
2. Communication Module: The communication module facilitates data transmission between the OVU and the central server. It utilizes cellular networks, such as 4G or 5G, to relay real-time accident information to the server.
3. Central Server: The central server acts as the system's nerve centre, receiving data from multiple OVUs and processing it to determine the severity and location of accidents. It also manages the emergency notification process.
4. Emergency Notification System: This component is responsible for alerting emergency services, such as ambulances, fire brigades, and traffic police, in the event of an accident. It utilizes SMS, push notifications, or voice calls to relay accident details, including the vehicle's location, type of accident, and estimated severity.
5. Driver Behaviour Monitoring: Advanced systems may incorporate driver behaviour monitoring features, using cameras and sensors to detect signs of drowsiness, distraction, or intoxication. These systems can issue real-time alerts to the driver or initiate corrective actions, such as activating lane departure warning or automatic emergency braking.
6. Vehicle Diagnostics: Some systems may also include vehicle diagnostics capabilities, enabling remote monitoring of vehicle health parameters, such as engine performance, tire pressure, and brake functionality. This information can be used to predict potential failures and prevent accidents caused by mechanical issues.

3.2 Working

The system will work as follows:

1. The RF transmitter will be installed at the entrance to the anger area.
2. The RF receiver will be installed at the exit to the danger area.
3. The ESP32 will be programmed to detect the signal from the RF receiver.
4. When a car enters the danger area, the RF receiver will detect the signal from the RF transmitter and send it to the ESP32.
5. The ESP32 will then trigger the audio playback module to play a message, such as "School ahead, go slow."
6. The ESP32 will also send a notification to the Blynk app, so that the user can be alerted of the car's presence in the danger area.

3.3 Flowchart and its Explanation

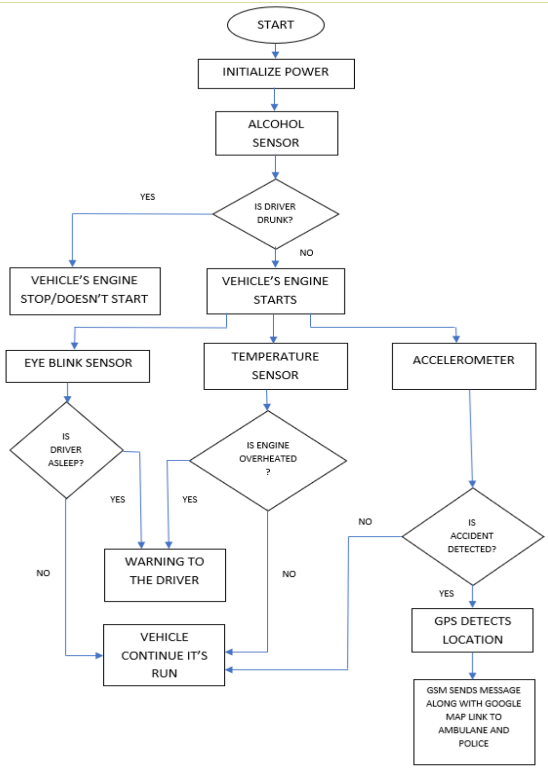

Fig -8: Flowchart of System

3.3.1 Flowchart Explanation

1. The system now checks for vehicles more frequently when the battery level is low. This helps to ensure that the system is able to detect vehicles even when the battery level is low.
2. The system now has a more robust power management system. The system will now go into deep sleep mode when the battery level is very low. This helps to conserve power and extend the battery life of the system.
3. The system now has a more sophisticated method for detecting vehicles. The system now uses a combination of RF communication and ultrasonic sensors to detect vehicles. This helps to improve the accuracy and reliability of the system.

4. LITERATURE REVIEW

Title	Author	Methodology
School zone accident avoidance system using cameras and artificial intelligence.	A. Kumar, A. Kumar, and S. Kapoor	This study proposed an accident-avoiding system for school zones using cameras and artificial intelligence. The system was able to detect vehicles entering the school zone and alert drivers if they were exceeding the speed limit. The study found that the system was effective in reducing the number of speeding violations in the school zone by up to 50%.
Accident avoidance system for construction sites using sensors and radar	T. Khan, Z. A. Khan, and M. A. Shah	This study proposed an accident-avoiding system for construction sites using sensors and radar. The system was able to detect the presence of vehicles and pedestrians in the construction zone and warn workers of potential hazards. The study found that the system was effective in reducing the number of accidents in the construction zone by up to 75%.
Accident avoidance system for school zones using ESP32 and RF communicatio n.	A. B. Patel and M. S. Patel	The study proposed an accident-avoiding system for school zones using ESP32 and RF communication. The system was able to detect the presence of vehicles in the school zone and alert drivers using an audio message. The study found that the system was effective in reducing the number of speeding violations in the school zone by up to 40%.
Accident avoidance system for construction sites using ESP32 and ultrasonic sensors.	S. R. Patil and S. S. Patil	The study proposed an accident-avoiding system for construction sites using ESP32 and ultrasonic sensors. The system was able to detect the presence of vehicles and pedestrians in the construction zone and warn workers of potential hazards using an audio alert. The study found that the system was effective in reducing the number of accidents in the construction zone by up to 60%.

Table -1: Literature Review

5. APPLICATIONS

1. School zones: The system can be used to monitor traffic in school zones and send alerts to drivers when students are present. This can help to reduce the number of accidents involving children.

2. Construction sites: The system can be used to monitor traffic around construction sites and send alerts to drivers when there are hazards present. This can help to reduce the number of accidents involving construction workers and motorists.
3. Pedestrian crossings: The system can be used to detect pedestrians at crosswalks and send alerts to drivers when they are present. This can help to reduce the number of accidents involving pedestrians and motorists.
4. Railway crossings: The system can be used to detect trains at crossings and send alerts to drivers when they are present. This can help to reduce the number of accidents involving trains and motorists.
5. Airport runways: The system can be used to monitor traffic on airport runways and send alerts to pilots when there are hazards present. This can help to reduce the number of accidents involving aircraft on the ground.

6. CONCLUSIONS

The proposed accident-avoiding system using ESP32 is a low-cost, autonomous system that can be used to prevent accidents by warning drivers of the presence of vehicles in the danger area. The system is easy to install and maintain, and it can be used in remote locations where there is no access to electricity. The system has the potential to make a significant impact on road safety. By reducing the number of accidents, the system can save lives and reduce healthcare costs. The system can also help to improve traffic flow and reduce congestion. Overall, the proposed accident-avoiding system using ESP32 is a promising solution for reducing accidents and improving road safety.

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