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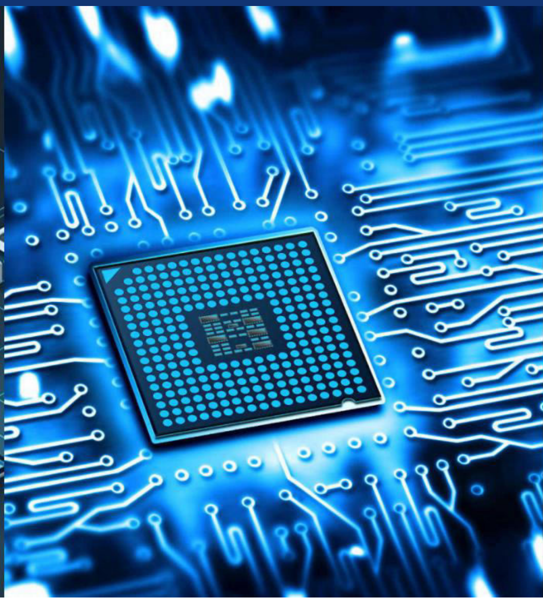

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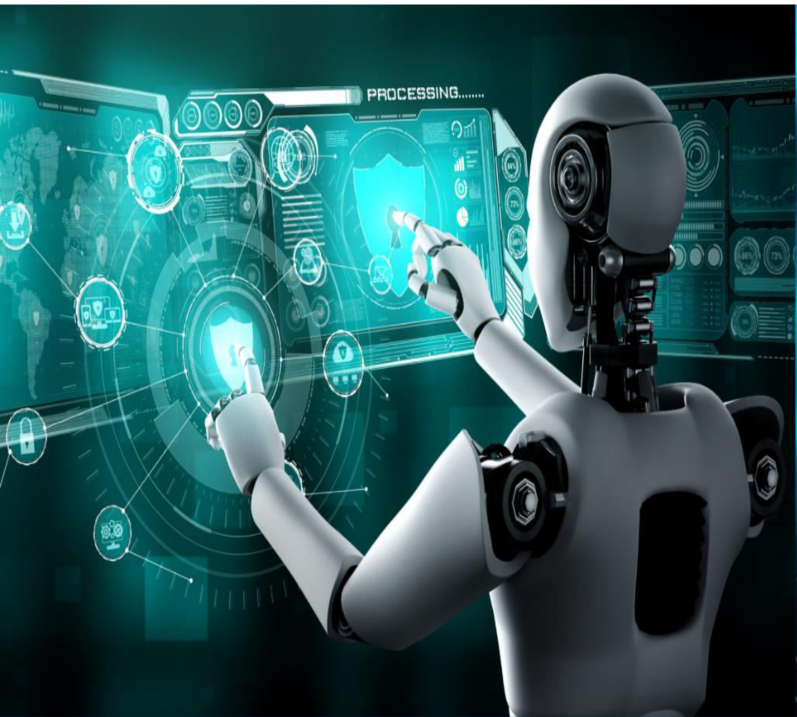


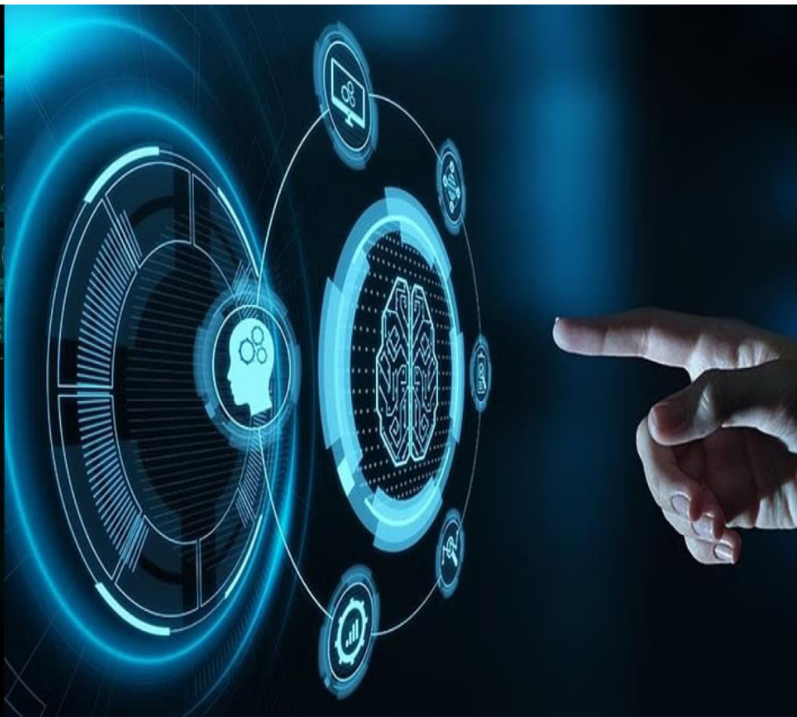

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# Intelligence Accident Detection and U-Turn Safety System using IOT

**P. Prathap [1], Dr. N. Sumathi [2], S. Santhosh [3]**

Department of Information Technology, Sri Ramakrishna College of Arts & Science, Coimbatore, India[1-3]

**ABSTRACT:** Due to sharp curves, narrow roads, poor visibility, and delayed access to emergency services, road accidents in hilly areas and dangerous hairpin bends pose a major threat to public safety. Signboards and mirrors are examples of conventional safety measures that are frequently insufficient to stop accidents or offer prompt assistance. This article describes an Intelligent Accident Detection and U-Turn Safety System Using IoT that was created especially for high-risk hairpin bend areas in hilly terrain in order to address these issues. The suggested system uses an Arduino Uno and an ESP8266 board to track road conditions and vehicle motion in real time. An MPU6050 IMU accelerometer is used to identify abnormal vehicle movements or abrupt impacts that point to an accident. Following the detection of an accident, the system uses a NEO-6M GPS module to obtain precise location data and sends emergency alerts via a SIM900A GSM module in the form of call and SMS notifications.

**KEYWORDS:** Intelligent Accident Detection, U-Turn Safety System, IoT, ESP8266, Arduino Uno, MPU6050, HC-SR04, SIM900A, GPS Neo-6M.

## I. INTRODUCTION

Due to sharp hairpin bends, narrow roads, steep gradients, and poor visibility brought on by fog, rain, or nighttime driving conditions, road transportation in hilly areas is extremely vulnerable to accidents. Serious collisions frequently occur in these high-risk locations, particularly during blind U-turns when drivers are unable to predict approaching cars [1]. Conventional safety features like mirrors, speed breakers, and warning signboards are ineffective and do not guarantee prompt accident response.

The delay in reporting accidents, which prevents victims from receiving emergency medical attention, is one of the main issues in such environments. [2] The severity of injuries and death rates are greatly increased by this delay.[3] The issue is made worse by the absence of intelligent alert systems and real-time monitoring.

Road safety can now be improved by integrating smart sensors, microcontrollers, and wireless communication modules thanks to developments in the Internet of Things (IoT) [4]. Real-time sensing, automated accident detection, accurate location tracking, and immediate communication with emergency services are all made possible by IoT-based systems.

The goal of this project, Intelligence Accident Detection and U-Turn Safety System Using IoT, is to increase safety in high-risk hilly areas with hairpin bends [5]. The system uses an accelerometer to automatically detect accidents, GPS to pinpoint the precise location, and a GSM network to send emergency alerts. In order to avoid collisions, ultrasonic sensors are also used to identify approaching cars during blind U-turns and issue advance warnings [6]. In hilly areas that are prone to accidents, the suggested solution seeks to improve driver awareness, shorten accident response times, and ultimately save lives.

## II. LITERATURE SURVEY

### 2.1 IoT-Based Accident Detection Systems

IoT-based accident detection systems utilizing sensors and microcontrollers have been proposed by a number of researchers. Accelerometer sensors, like the MPU6050, are frequently used to identify abrupt collisions or unusual vehicle motion. The system automatically sends out an alert when it detects an accident [7]. Although the majority of these systems only concentrate on accident detection after it has already happened, they greatly shorten the time needed to identify accidents.

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### 2.2 GSM and GPS-Enabled Emergency Alert Systems

Numerous studies have combined GPS and GSM modules to provide location-specific emergency alerts. [8] While GSM modules like SIM900A send SMS or call alerts to emergency contacts, GPS modules like NEO-6M provide latitude and longitude. [9]Although this method guarantees fast location tracking, these systems primarily function as post-accident notification systems and lack preventive safety features.

### 2.3 Accelerometer-Based Vehicle Crash Detection

Accelerometer-based crash detection is useful for detecting collisions by tracking abrupt changes in acceleration, according to research [10]. The accuracy and affordability of the MPU6050 make it a popular choice. Although this technique is dependable for identifying severe impacts, if it is not calibrated correctly, it may produce false alarms during speed breakers or on uneven terrain [11].

### 2.4 Ultrasonic Sensor-Based Blind Spot and U-Turn Safety

Some research focuses on employing ultrasonic sensors to identify approaching cars at hairpin bends and blind turns. [12] HC-SR04 sensors use buzzers or LEDs to measure distance and alert drivers. Although these systems enhance preventive safety, they are autonomous and lack accident detection and emergency communication capabilities [13].

### 2.5 Integrated Smart Transportation Safety Systems

The integration of various sensors and communication modules within an IoT framework is emphasized in recent literature. To increase road safety, these systems integrate GPS, GSM, accelerometers, and ultrasonic sensors. [14] Nevertheless, the majority of current systems are made for highways and urban roads, with little attention paid to hilly regions and hazardous hairpin bends [15].

### 2.6 Research Gap Identified

According to the literature review, current systems either concentrate on collision prevention or accident detection, but not both. [16]The particular difficulties of hilly terrain, like abrupt U-turns, poor visibility, and delayed emergency response, are rarely addressed by systems. This emphasises the necessity of an integrated solution created especially for areas with high-risk hairpin bends [17].

## III. PROPOSED SYSTEM

The goal of the proposed Intelligence Accident Detection and U-Turn Safety System Using IoT is to improve road safety in hilly areas, especially at hazardous hairpin bends where there is a high risk of accidents and poor visibility. Real-time accident detection and preventive safety are provided by the system's integration of sensing, processing, and communication modules.

The system's main control components are an Arduino Uno and an ESP8266 board. The vehicle's acceleration and orientation are continuously monitored by the MPU6050 IMU accelerometer. Without the need for human intervention, the system recognizes an accident when abrupt changes in motion, powerful impacts, or unusual tilting are detected above predetermined threshold values.

The NEO-6M GPS module finds the vehicle's exact location as soon as an accident is detected. This location data is put into a format that is easy to read, like a link to Google Maps. The SIM900A GSM module is then set up to send emergency SMS alerts and call notifications to a list of contacts, such as rescue teams or family members. This makes sure that help can get to people quickly, even in remote hilly areas.

The whole system runs all the time and on its own, so it can be used in real time. The proposed system is a smart, low-cost way to reduce accidents and save lives in high-risk hilly areas. It does this by combining accident detection, location tracking, emergency communication, and U-turn safety monitoring.

### 3.1 Features

#### 3.1.1 Automatic Accident Detection

The MPU6050 IMU accelerometer keeps an eye on how vehicles move all the time. Automatic detection of sudden impacts, unusual vibrations, or vehicle rollovers means that accidents can be reliably identified without any human help.

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**3.1.2 Real-Time Location Tracking**
The GPS NEO-6M module gives exact latitude and longitude information at the time of an accident. This exact location tracking helps rescue teams get to the scene of the accident quickly, especially in hilly areas that are hard to get to.

**3.1.3 Instant Emergency Alert Communication**
The SIM900A GSM module sends SMS alerts and call notifications to emergency contacts that have been set up as soon as it detects an accident. This makes sure that communication happens on time and cuts down on the time it takes for medical help to arrive.

**3.1.4 U-Turn Safety and Collision Prevention**
Two HC-SR04 ultrasonic sensors keep an eye on the movement of vehicles on both sides of blind hairpin bends at all times. The system sends out early warning alerts when cars get too close to each other to stop head-on collisions.

**3.1.5 Reliable Operation in Hilly and Low-Visibility Conditions**
The system is meant to work well in fog, rain, at night, and when visibility is low. Continuous real-time monitoring makes drivers more aware and makes roads safer in hilly areas that are more dangerous.

**3.1.6 Reduced Emergency Response Time**
The system cuts down on emergency response time by a lot by automatically finding accidents and sending location information right away. This is very important for saving lives.

**3.1.7 Low-Cost and Scalable Design**
The system is easy to scale up for use on many hairpin bends or hilly roads because it uses cheap sensors and microcont rollers.

**3.1.8 Continuous and Autonomous Operation**
The system runs 24 hours a day, 7 days a week, without any human supervision. This means that safety monitoring and accident detection are always happening.

## IV. WORKING METHODLOGY

There are three main phases in the system's operational methodology: Initialization, Monitoring and Detection, and Response Execution.

**A. System Initialization and Calibration**
When you turn on the Arduino Uno, it sets up all of the connected peripherals. The MPU6050 does a self-calibration process to find the basic gravitational constants. The Neo-6M GPS module starts looking for satellite fixes to get the first coordinates. At the same time, the ESP8266 connects to the local Wi-Fi gateway to make sure the IoT Cloud Channel is working. The SIM900A GSM module connects to the cellular network so that it can receive emergency calls.

**B. Monitoring and Safety Logic**
The system goes into a loop where it polls continuously and processes data from both the safety and detection sensors at the same time:• Safety Monitoring for U-Turns:

- **U-Turn Safety Monitoring**: The HC-SR04 Ultrasonic Sensors send out high-frequency pulses at regular intervals. The system figures out how far away things are in the car's side path. When a car is in the danger zone while turning, the Arduino sets off a local buzzer.

•**ImpactMonitoring**: The MPU6050 gives you motion data in real time. The processing unit looks at how much the tilt changes and how fast it does so.

**C. Accident Validation and Geolocation**
The system uses a dual-verification logic to cut down on false positives. If a high-impact force is immediately followed by an unusual tilt or a complete stop in motion, then the accident is confirmed. After being validated, the Neo-6M GPS module records the final location coordinates. Probots India notes that the module's high sensitivity allows it to maintain a position fix even in dense urban environments or under partial cover.

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**D. Alert Dissemination**

Cellular Alert: The SIM900A GSM module generates an SMS containing a Google Maps link to the accident site. This is sent to pre-programmed emergency contacts via the cellular network. Probots India notes that the module's high sensitivity allows it to maintain a position fix even in dense urban environments or under partial cover.

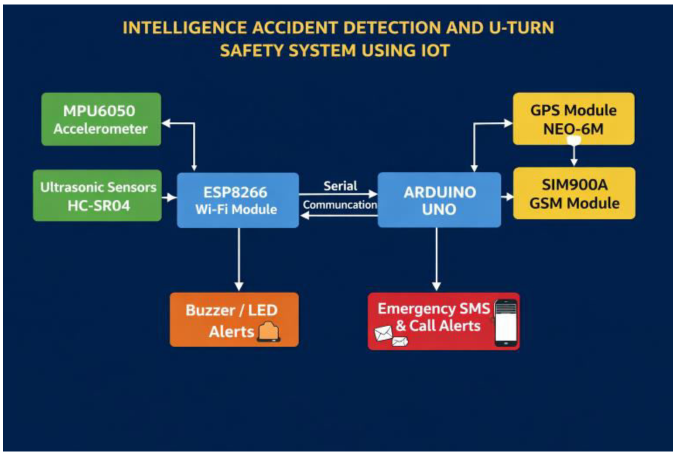


**Figure 4.1Block Diagram**

## V. HARDWARE DESIGN

The Neo-6M GPS module takes care of geolocation by using special serial pins to send real-time spatial coordinates. The safety unit has two HC-SR04 ultrasonic sensors that are placed to watch the area around the vehicle while it is making a U-turn. These sensors are connected to the Arduino's digital I/O pins (for example, pins 9 and 10) to send and receive trigger and echo pulses. To send emergency alerts, a SIM900A GSM module is used for serial communication. It gets its power from an external +5V adapter that can handle high peak currents during network transmissions. The ESP8266 NodeMCU connects to the Arduino's serial pins to act as a Wi-Fi gateway. It also makes it possible to use IoT features and log data in the cloud. All components are physically integrated on a Breadboard, ensuring a unified power rail and a common ground reference to maintain signal integrity across the entire hardware framework.

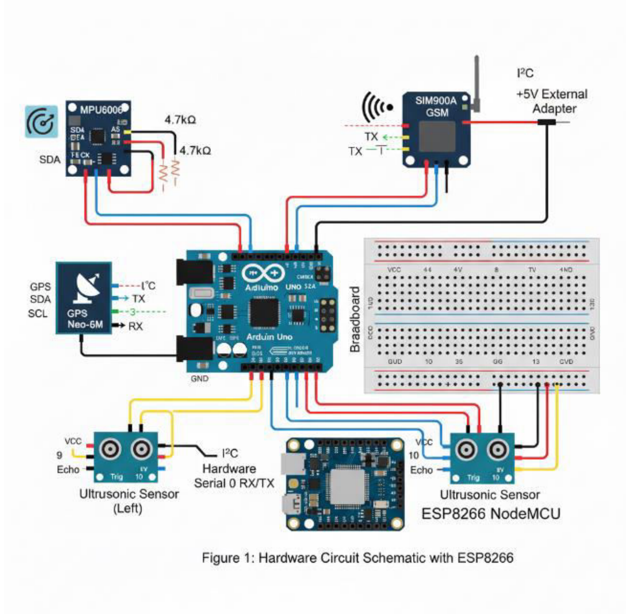


Figure 1: Hardware Circuit Schematic with ESP8266

**Figure 5.1Circuit Diagram**

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## VI. IMPLEMENTATION

The U-Turn Safety and Intelligence Accident Detection System IoT is used to make sure that accidents are detected and safety is maintained on hilly hairpin bends by using a mix of built-in hardware parts, sensor modules, and wireless communication technologies.

The Arduino Uno is the brain of the system. It constantly gets sensor data in real time and makes decisions based on that data. The $I^2C$ communication protocol connects the MPU6050 IMU accelerometer to the Arduino. This sensor can measure acceleration and angular velocity on three different axes. The system can tell when there are sudden impacts, strange tilts, or rollovers by constantly checking these values. Predefined threshold values are used to tell the difference between normal vehicle movement and accident conditions, which cuts down on false alerts.

The Arduino talks to the GPS Neo-6M module through a serial connection. It always gives real-time geographical coordinates, such as latitude and longitude. The Arduino gets the most recent GPS data right away when it detects an accident so it can figure out where it happened. This makes sure that emergency responders get accurate location information, which is very important in hilly areas that are hard to reach.

The Arduino and the SIM900A GSM module work together to make emergency calls. When an accident is confirmed, the GSM module automatically sends an emergency SMS alert with the vehicle's location and accident details to a list of contact numbers. This gets rid of the need for manual reporting and cuts response time by a lot.

Two HC-SR04 ultrasonic sensors are put on opposite sides of the road to make it safer to make blind U-turns and hairpin turns. These sensors keep track of how far away cars are that are coming toward them. The system sees a possible collision risk when it sees a vehicle in a critical range. You can set off local warning lights, and the ESP8266 NodeMCU gets the detection data.

The ESP8266 Wi-Fi module lets IoT devices talk to each other by sending sensor data over Wi-Fi. This makes it possible to monitor things in real time, log data from a distance, and connect to cloud platforms or mobile apps in the future. The ESP8266 makes systems more scalable and works with smart traffic management apps.

A breadboard and jumper wires connect all of the hardware parts, making it easy to test and change things. The Arduino IDE is used to develop the system software, and structured programming guarantees that sensors, communication modules, and alert mechanisms operate in unison. System stability is maintained through the implementation of appropriate delays, interrupt handling, and serial communication management. All things considered, the implemented system effectively combines U-turn safety monitoring, emergency alerting, real-time location tracking, and accident detection into a single intelligent IoT-based solution that can be deployed in hilly and accident-proneareas.

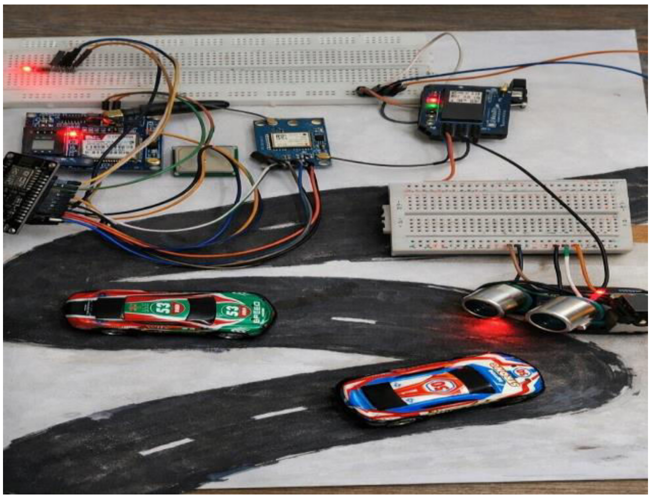

**Figure 6.1 All connections of Arduino and ESP8266 Board**

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## VII. RESULTS

To assess the implemented system's performance in accident detection and U-turn safety, it was tested in a variety of simulated and real-world scenarios.The MPU6050 sensor successfully identified abrupt impacts, sharp tilts, and unusual vibrations that match accident scenarios during testing. Within a few seconds of detection, the system correctly sent out accident alerts. The GSM module consistently sent SMS alerts with accident and location information, while the GPS module supplied exact location coordinates. Even in low visibility situations, the ultrasonic sensors successfully identified approaching cars at blind hairpin bends. The system reduced the chance of head-on collisions at abrupt U-turns by demonstrating accurate distance measurement and prompt warning generation.

Real-time monitoring and future scalability for cloud-based dashboards were made possible by the ESP8266 module's stable wireless communication. Overall, the system demonstrated excellent dependability, quick response times, and precise detection, making it appropriate for use in hilly and accident-prone areas.

The findings demonstrate that the suggested IoT-based system greatly increases road safety by speeding up accident response times, improving driver awareness at blind curves, and offering automated emergency communication—all of which contribute to saving lives in hazardous hilly areas.

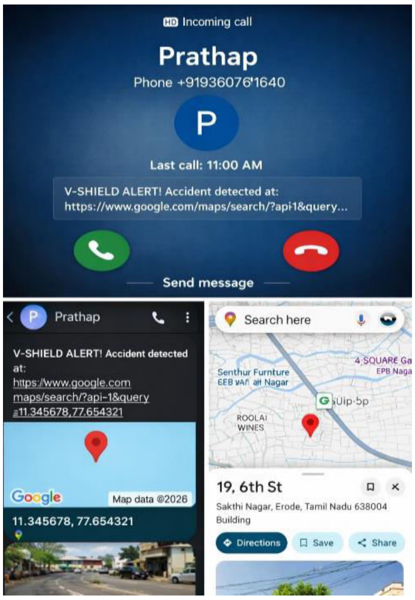


**Figure 7.1 SMS, Call, Alert and GPS Location**

## VIII. CONCLUSION

An integrated approach to improving road safety in hilly and accident-prone areas is successfully demonstrated by this project, Intelligence Accident Detection and U-Turn Safety System Using IoT. The ESP8266 Wi-Fi module, Arduino Uno, MPU6050 accelerometer, ultrasonic sensors (HC-SR04), GPS NEO-6M, and SIM900A GSM module work together to enable the system to automatically detect collisions, recognise vehicle movement close to blind U-turns, and send out timely alerts.

Automatic accident detection without human intervention is made possible by the MPU6050 sensor's ability to detect abrupt impacts or unusual vehicle motion. When an accident is detected, the GPS module precisely locates it, and the GSM module quickly notifies pre-designated contacts via emergency SMS and phone alerts, speeding up response times and possibly saving lives. Additionally, by identifying oncoming cars at blind curves and warning them with buzzers or LED alerts, the ultrasonic sensors improve preventive safety and reduce the likelihood of collisions.

All things considered, the suggested system turns out to be dependable, affordable, and scalable for practical implementation. In addition to enhancing driver awareness, emergency response effectiveness, and general road safety, it emphasizes the useful application of IoT technologies in intelligent transportation systems. For a wider impact, future improvements might include mobile applications, cloud-based data analytics, and integration with intelligent traffic management systems.

## IX. FUTURE SCOPE

There are a number of ways to improve the efficacy and practicality of the suggested Intelligence Accident Detection and U-Turn Safety System Using IoT. For long-term analysis and reporting, cloud integration can be used to store location history, vehicle movement logs, and accident data. Authorities can use this information to plan more effective road safety measures and identify accident-prone areas in hilly regions. areas and develop more effective road safety strategies. To give family members, hospitals, and traffic control centers real-time alerts, live vehicle tracking, and emergency notifications, a specialized mobile application could be created. When approaching high-risk hairpin bends or accident zones, integration with Google Maps or other comparable navigation services can also help alert drivers beforehand. Adding more advanced sensors and AI-based algorithms to the system can make it better by cutting down on false accident detections and making decisions more accurate. Features like detecting when the driver is sleepy, keeping an eye on the weather (fog, rain, landslide risk), and analyzing the speed of the vehicle can make things even safer. In the future, the system can be made completely independent by replacing GSM with LTE/5G modules for faster and more reliable communication. Solar-powered operation could also be looked into for use in remote hilly areas where power is hard to come by. With these changes, the proposed system can become a complete smart transportation safety solution that can be used on a large scale.

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