Advancements in IoT Technology: A Comprehensive Approach to Accident Detection and Emergency Response

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Abstract. Infrastructure and also technological advancements have actually made life less complex for individuals, causing huge demand for vehicles. This results in an increase in road mishaps. An accident is a vulnerable and unintended occasion, as well as it can additionally occur because of the carelessness of the vehicle drivers. With the increasing number of road accidents and the high mortality rate associated with them, there is a growing need for a system that can detect accidents and provide timely assistance to the victims. In this project, we propose an IoT based Accident Detection and Rescue System that leverages various sensors, GSM, GPS, fire sensor, IR sensor, MQ135 Gas sensor, I2C LCD, DC Motor modules, to detect an accident and alert the concerned authorities. The proposed system has the potential to reduce the response time in the event of an accident, thereby improving the chances of survival for the victim. The project combines the latest advancements in IoT technology and Thingspeak to store the data.

1 Introduction

One of the most cutting-edge technologies is IoT, or the internet of things. It is a network of non-human physical objects that are connected by a network and communicate with one another. In this paper, we use the Internet of Things to organize the chaos. One of the main reasons for trouble making is accidents. Thus, it is crucial to appropriately monitor these disorders caused by accidents. This method can be used to prevent accidents and can also lower the risk to human life. Wireless sensor networks (WSNs) have found usage in a variety of current applications, including weather monitoring, military operations, home automation, health care monitoring, security, and safety. In summary, it can be said that WSN can be used to most fields. Accident detection technology is not yet available. Because of the delay in the ambulance's arrival at the accident scene and the high traffic between it and the hospital, the chance that a victim would die is further raised. It is necessary to implement a strategy to reduce the number of fatal accidents and the time it

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takes an ambulance to arrive at the hospital. The Internet of Things (IoT) is the network of personally identifiable embedded computing devices that connects to the current Internet infrastructure. The Internet of Things (IoT) frequently offers complex device, system, and service connection that goes beyond machine-to-machine (M2M) interactions and encompasses a variety of protocols, domains, and applications. Modern applications like a Smart Grid are made possible by the interconnection of these embedded devices (including smart objects), which is used in nearly all automation domains. The term "things" refers to a broad range of devices, such as heart-monitoring implants, biochip transponders on farm animals, electric mussels in coastal waters, cars with built-in sensors, or field operation tools that assist firemen with search and rescue. Thermostats and Wi-Fi-enabled washers and dryers are two examples that are currently on the market for remote monitoring. This message will be retrieved utilizing the circuit's internet connection. Longitude and latitude values will be included in the message. These values can be used to approximate the vehicle's position. The modulation process is carried out by the modem both during transmission and during reception.

The center medians are neglected by cars for a variety of reasons, which results in numerous accidents.

There are numerous potential reasons, such as: Before the median opposite light glare to the driver, there are no reflector indicator plates, making objects invisible. The divisions were not well planned. erroneous or abrupt lane keeping when making a sudden lane change with a car in front, the co-driver side area is invisible - And a number of others.

This will cut down on how long it takes the ambulance to get to the hospital. A patient monitoring gadget in the ambulance will transmit the patient's vital signs to the pertinent hospital. Due to the systems complete automation, it can locate the accident site and aid in a timely arrival at the hospital. Both battery and solar power are used to power these sensors. They have the ability to draw solar energy, allowing them to operate during the day with sunshine and at night or in overcast or foggy conditions with battery power. The two primary types of sensors used in wireless sensor networks for traffic signal systems are: There are two types: intrusive and non-intrusive. I Obtrusive sensor types are stored beneath the road and detect traffic that is stopped at a signal. The operation of this kind of sensor is similar to that of a metal detector. ii) Non-Intrusive sensor kinds are installed on the roadway. As there is no need to cut the road, installing this kind of sensor is simple. Acoustic sensors or video image processors are examples of non-intrusive sensors that can be used to identify the presence of automobiles at traffic intersections. Although though intrusive sensors are quite effective, non intrusive sensors are still favoured because they are less expensive, simpler to install, and resistant to corrosion and deterioration caused by the environment.

2 Literature Survey

Accident detection system based on Pranto Karmokar[1] in which information is submitted to the web server as soon as an accident occurs and an instant SMS is sent to the patient's friends and neighbouring ambulance services. The likelihood that patients will die, however, may increase due to the heavy traffic between the scene of the accident and the hospital.

A method that uses vibration, acceleration, and heart-rate monitoring to identify accidents has been forwarded by Karthikeyan M[2]. It makes use of an app that locates the accident's scene and alerts the surrounding medical facilities and ambulance services. The accident detection system and the driver's mobile device are connected via a Bluetooth module. It requires the victim to constantly pair his phone with the accident detection system's Bluetooth, which might not always be practicable.Frahim Wadud Taj[4] proposed a system

that recognises accidents and alerts the rescue crew to save the victim's life. When an accident occurs, the system uses the GSM module to send an SMS to the local police station and rescue crew. In response, a rescue crew uses GPS to find the accident's location and locate the victim. Due to the single vibration sensor that is used in the proposed system, there is a high likelihood that detection system errors would arise.S. L. V. Prasad[5] put forth a solution that addresses the idea of accident detection without utilising a human rescue crew. An inexpensive sensor that is built inside the car is used to detect accidents. The sensor notifies an ambulance where the accident is when it happens. An ambulance is dispatched right away to the scene of the collision after getting the location.

Several researchers have investigated accident detection systems. Aishwarya S.R explained an IoT-based method for detecting and preventing automobile accidents for nighttime drivers. The Eye Blink Monitoring System (EBM) in this paper warns the subject when they are feeling sleepy. [6] Sadhana B has described how a smart helmet with open CV and a raspberry pi can increase motorcycle riders' safety. The idea originated from the realisation that there have been more fatal road accidents in recent years. The objective of this project is to put safety measures in place that will enable motorcycle riders to wear helmets correctly.[7]

The sophisticated Embedded System of Automobile Sarika R. Gujar gave a description of the accident detection and tracking system. The main objective of this system is to find the accident and then notify the emergency services. Vehicle accidents can be located thanks to sensors. A GPS and GSM module allows for the tracking of the vehicle. Shailesh Bhavthankar provided a description of the Wireless System for Automobile Accident Detection and Reporting Using Accelerometer and GPS[8]. Both an accident detection accelerometer sensor and a GPS-based vehicle location are utilised in this study. The technology uses GSM to automatically contact the reprogrammed number, such as a family member or emergency medical services, in the event of an accident. [9] Jagdish A.Patel described a smart home powered by a Raspberry Pi. The goal of this paper is to design a simple home automation application for the Raspberry Pi using a camera interface for security purposes. The methodology for this application is written in the Python environment, which is the default programming environment offered by the Raspberry Pi.

3 Existing Methodology

Narayana,K.Lakshmi and Ram[10] introduced the accident Discovery and Insurance Claiming System(ISADICS) In this system the GPS is connected to the Raspberry Pi vibration detector is used to descry the accident once the vibration value crosses the threshold limit and i t cautions the jeer Pi. The Fig.1 shows the ISADICS architecture.

The processor receives the position and speed details from GPS to family members during the mean time the processor sends accident details to pall garçon through the wifi module. Garçon quests for near hospitals, police stations, and insurance company figures from the database and updates regarding the information about vehicle and position details. Shubham, Suraj Pratap and Kumar[11] introduced A check on IoT- grounded automatic road accident discovery in this paper it tells about Injuries and crashes are caused due to neglagence some of the most common mortal actions that lead to mishaps, over Speeding, Drunken Driving, Distractions to motorist, Red Light Jumping, Avoiding Safety Gear like Seat belts and Helmets. Choi, Jae Gyeong, and Kong[12] presented a method for auto crash discovery for an emergency road call service that automatically recognises business accidents and permits prompt deliverance after transmission to emergency recovery agencies.
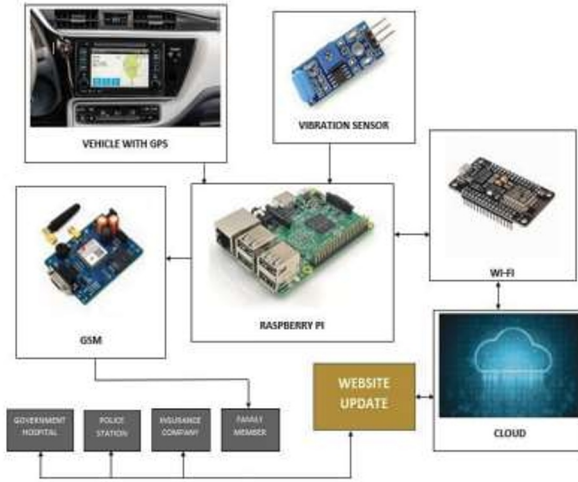
Fig. 1. ISADICS Architecture

This system is based on ensemble deep literacy and multimodal data from dashboard cams.The proposed exploration is comprised of four main way. First, data accession and data preprocessing using videotape data, audio features of audio data, and spectrogram images of audio data from the dashboard camera are conductedOn the foundation of GRU and CNN, auto crash discovery classifiers using videotape data, audio characteristics of audio data, and spectrogram images of audio data are also produced. The three distinct classifiers are combined in an ensemble form using a weighted average ensemble. In the end, the proposed auto crash discovery system's performance bracket, which makes use of three different data kinds.

4 Proposed Methodology

We have created a smart gadget prototype that can be attached to any person's vehicle. The device will begin transmitting the present latitudinal and longitudinal coordinates once it is implemented. This system's goal is to be able to recognize when an accident occurs, send the victim's emergency contacts a message with the victim's GPS location, and simultaneously alert the ambulance and hospital services.

I'll present the ideal answer to this problem in this project. According to this paper The NODEMCU ESP-8266 sends an alarm signal through Wifi MODEM to the police control room, the rescue team, and the family. Thereafter, the relevant actions will be performed in accordance with the situation. The gadgets send all of their data to cloud storage services. For instance, ThingSpeak IoT makes use of a Wi-Fi model-connected internet connection to make each vehicle's data easily accessible to family, law enforcement, and hospitals. The Fig.2 shows block diagram.
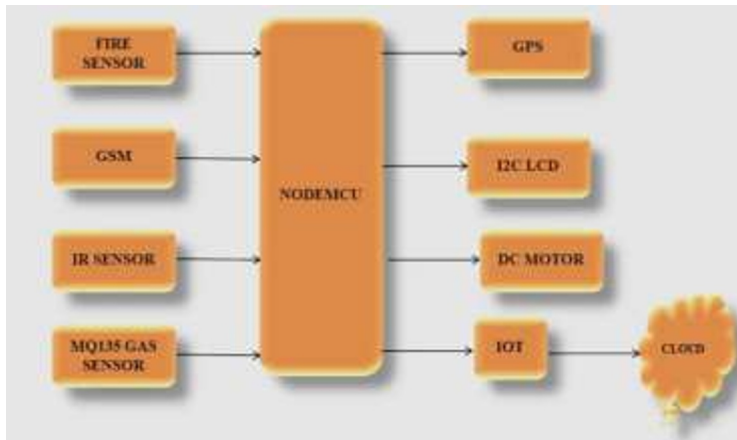
Fig. 2. Block Diagram

4.1 NODMCEU

An open-source development board called NodeMCU is built around the ESP8266 Wi-Fi module. It's intended to give developers a simple approach to begin exploring with connected devices and the Internet of Things (IoT). The popularity of NodeMCU can be attributed to its ease of use, low cost, and the availability of a wide range of libraries and tutorials online. It is also highly customizable and can be easily modified to suit specific project requirements

4.2 Fire Sensor

A fire sensor can be a valuable component in an accident detection system, particularly in situations where there is a risk of fire, such as in car accidents. When a fire sensor detects the presence of fire or smoke, it can trigger an alarm or alert the appropriate authorities, which can help to reduce the risk of injury or damage to property.

4.3 GSM

The GSM module enables the system to send SMS (Short Message Service) messages to a designated phone number or to a remote server, allowing for quick notification in the event of an accident. The integration of a GSM module into an accident detection system can greatly improve the speed and effectiveness of emergency response, potentially saving lives and reducing the severity of injuries in the event of an accident.

4.4 IR Sensor

IR sensors can detect the presence of objects by emitting and receiving infrared radiation, making them well-suited for detecting the proximity of other vehicles, pedestrians, or obstacles. IR sensor into an accident detection system can provide an additional layer of safety and help to reduce the risk of accidents caused by collisions or obstacles.

4.5 Gas sensor

The MQ135 sensor is a gas sensor that is commonly used to detect air quality and pollution levels. While it may not be directly applicable to accident detection, it could be used as a supplementary sensor in a broader accident detection system. it can be a useful addition to a broader accident detection system or in other applications where air quality monitoring is important. The gas sensor is shown in Fig.3.

4.6 GPS

A GPS (Global Positioning System) sensor can be an essential component in an accident detection system. It allows the system to accurately determine the location of the accident, which can be crucial in getting emergency services to the scene as quickly as possible. The integration of a GPS sensor into an accident detection system can greatly improve the speed and effectiveness of emergency response, potentially saving lives and reducing the severity of injuries in the event of an accident.

4.7 I2C LCD

The I2C LCD can display information such as the status of various sensors, the location and severity of an accident, and the status of any emergency responses that have been triggered. This information can be particularly useful for emergency responders, allowing them to quickly assess the situation and take appropriate action. The integration of an I2C LCD into an accident detection system can greatly improve the usability and effectiveness of the system, providing important real-time feedback on the status of the system and the situation at hand.

4.8 DC motor

A DC (Direct Current) motor sensor can be a useful component in an accident detection system, particularly for detecting the impact of a collision. When a collision occurs, the DC motor sensor can detect changes in the motor's speed, which can indicate that an accident has occurred.In an accident detection system, the DC motor sensor can be integrated with other sensors, such as accelerometers or gyroscopes, to detect when an accident has occurred. Once an accident is detected, the system can then use the DC motor sensor to determine the severity of the collision. the integration of a DC motor sensor into an accident detection system can provide an additional layer of safety, particularly for detecting the impact of collisions and determining the severity of accidents.

4.9 IoT cloud (thingspeak server)

ThingSpeak is an open-source IoT (Internet of Things) platform that allows developers to collect, store, and analyze data from connected devices. The platform provides a web-based user interface for visualizing and analyzing data, as well as an API (Application Programming Interface) for developers to build custom applications.ThingSpeak also provides a range of APIs that allow developers to integrate the platform with other services, such as social media or email, or to build custom applications. For example, a developer could build an application that uses ThingSpeak to monitor and control smart home devices, or to analyze data from environmental sensors.ThingSpeak is a powerful and flexible platform for managing and analyzing data from IoT devices. Its open-source nature

and extensive documentation make it a popular choice among developers looking to build connected applications and services.

5 RESULTS AND DISCUSSION

The mq135 gas sensor is used to detect an intoxicated person, and we utilize ultrasonic sensors to calculate distances between objects using sound waves. The Ir sensor is used to detect obstacles, and whenever a speed breaker is identified, it will sound a buzzer alert and automatically stop the car. All of these sensors gather data, send it to the nodemcu controller, which displays the data on an i2c LCD and uploads it to the cloud so that we can automatically track it.
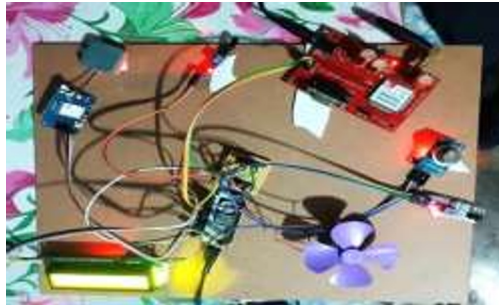
Fig. 3. Circuit diagram for Gas sensor

It maintains an eye on the vehicle to collect information about the distance between two vehicles. The capacity to measure distance is a feature of ultrasonic sensors. This measurement is updated every second. In an automobile, a number of system components must be installed properly. ThingSpeak allows you to keep an eye on the value.
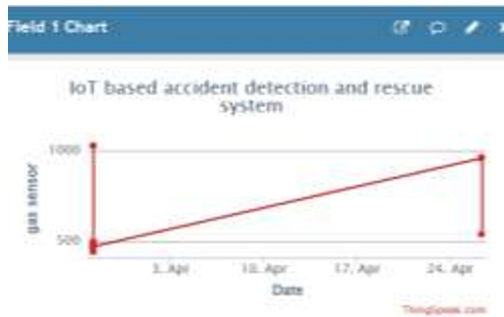

Fig. 4. Graphical representation of Gas sensor

The above graph as shown in Fig.4 represents the gases present around the car
In order to determine where the accident occurred, the GPS module collects the latitude and longitude coordinates of the car from a satellite. Once the data has been encoded, it is transferred to the wifi modem. NodeMCU transmits the signal to the wifi modem for the purpose of sending an accident message to pre-programmed phone numbers.as shown in the below figure 5. It collects location information using a GPS receiver module, sends the information to the

Cell phone via text message, and also uploads longitude and latitude data along with other information to the cloud. GPS receivers that can be installed in various devices such as smartphones, vehicles, and fitness trackers. Each satellite broadcasts a signal containing its location and the current time, which is received by the GPS receiver The GPS receiver, can determine its precise location, speed, and direction of motion by analyzing the signals from several satellites.

GPS technology has numerous practical applications in fields such as transportation, aviation, marine navigation, surveying, and outdoor recreation. It can be used to provide turn-by-turn directions, track vehicle and send the exact location.
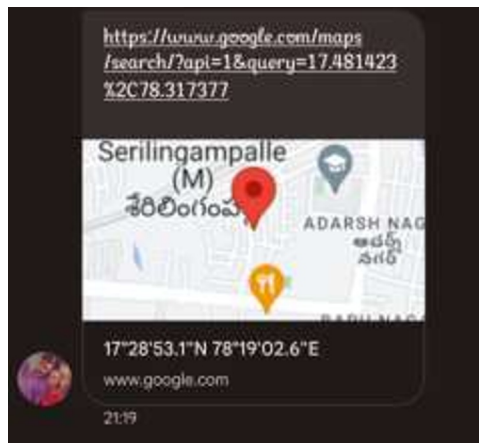
Fig. 5. Location alert sent to emergency number

The circuit as shown in Fig.6 is designed such that it can even identify the fire using fire sensor and the obstacles using IR sensor. As shown in the below figures and the values can be stored and can be monitored in thingspeak.
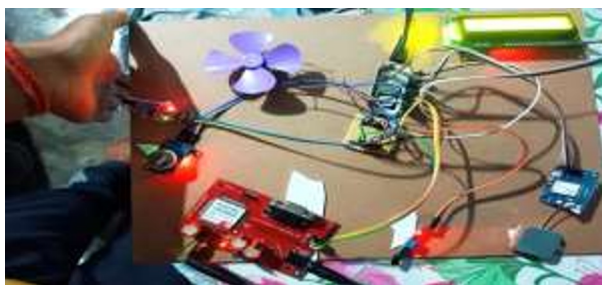

Fig. 6. Circuit Diagram for IR sensor

IR sensors typically operate by producing a beam of infrared radiation and then calculating the amount of that energy that is reflected back to the sensor. Some of the radiation will be reflected back to the sensor if an object or person is in the path of the beam, which will allow the sensor to sound an alarm or take other safety precautions if an accident is present.
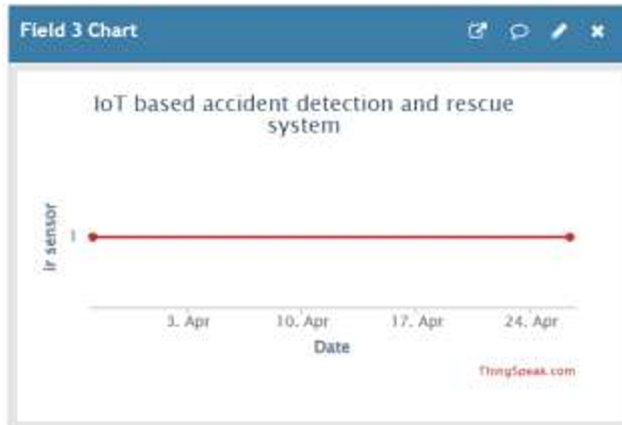
Fig. 7. Graphical representation of IR sensor

The above figure represents the graphical representation of IR sensors. Fire sensor detects the presence of fire or smoke and signals an alarm or alerts the concerned authorities. In the context of accident detection, fire sensors can be used to detect fires that may have started as a result of the accident and give alert message

Fig. 8. Circuit Diagram for Fire sensor

Fire sensors are mainly used in EV battery cars as they are catching fire even due to sunlight. fire sensors play an important role in accident detection by providing an early warning of potential fires or smoke, which can help prevent or minimize damage and injuries. Graphical representation is shown in below figure.
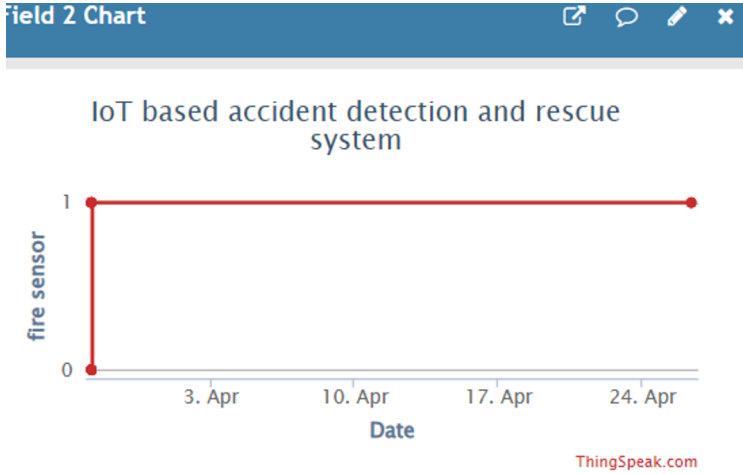
Fig. 9. Graphical representation of fire sensor

ThingSpeak provides a web-based interface that allows users to create and manage their IoT devices and applications. Users can create channels to collect data from various sources, including sensors, social media, web services, and mobile devices.

Fig. 10. Data stored in excel sheet

The collected data can be analyzed and visualized using built-in tools, or users can create their own custom analysis and visualization tools using MATLAB, a programming language widely used in scientific computing. ThingSpeak has the ability to support real-time data processing and visualization. Users can set up alerts and notifications based on specific data thresholds, which can be sent via email, SMS, or other means ThingSpeak provides an easy-to-use and flexible platform for IoT data collection, analysis, and visualization, making it a popular choice for hobbyists, researchers, and businesses alike. and can be accessed from any location with a strong internet connection and the data is

secured storing the data in cloud is more secured because most cloud service providers encrypt data and take other security precautions to keep it safe.

Table 1. Comparison table for different technology

Tittle	Used technology	Accident detection	Send alert message through location	Passing accident information to			
				Rescue system	Ambulance	Police station	Family member
IoT based Smart Accident Detection & Insurance Claiming System	IoT (rasberypi)	✔	✘	✘	✔	✔	✔
Automatic Alert for Accident Detection and rescue based on Wireless Technology	Wireless (Bluetooth ,wifi)	✔	✘	✘	✔	✘	✔
Arduino Based Vehicle Accident Alert System Using GPS, GSM and MEMS Accelerometer	Wireless (Gsm, Gps)	✔	✘	✘	✘	✘	✔
Development of smart accident identification and detection system	IoT (wifi)	✔	✘	✘	✔	✔	✘
An IoT based accident detection and rescue system	Iot	✔	✔	✔	✔	✔	✔

The above table 1 has the comparison of parameters of accident detection system and sending the alert messages through location and passing the information to different places and family members.

	A	B	C
1		accident detection	alerting msgs dealy time
2	reference paper 1	4.5	5
3	reference paper 2	4.7	6
4	reference paper 3	4.4	4
5	reference paper 4	4.3	5.5
6	proposed paper	4	3

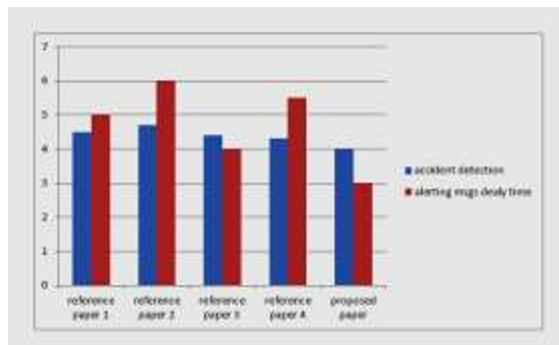**Fig. 11.** Comparative analysis -statistics

Fig. 12. Comparative analysis - bar graph

6 Conclusion

The system offers a design that benefits from being inexpensive, portable, and compact. It has a vibration sensor, GPS, and IOT connectivity, all of which help to cut down on accidents. It also solves many issues with automated systems for locating accidents. As a

result, it takes less time to find the place so that the individual can receive treatment right away, which helps to save many lives. The accident system project's primary goal is to reduce the likelihood of fatalities in such accidents. Accidents that happen at night or in deserted areas benefit more from the invention of this technology. In the future, this system will be crucial to daily living.

7 Referances

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