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REVOLUTIONIZING EMERGENCY RESPONSE: 5G AND IOT ENABLED ADR SYSTEM FOR UAV DELIVERY OF AID IN A CATASTROPHE

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ABSTRACT

Intelligent transportation systems (ITSs) are being enabled by the Internet of Things (IoT) and 5G. ITSs have the potential to enhance roadway security in smart cities. As a result, ITSs are gaining traction in both the industry and academia. Vehicle numbers are increasing due to the fast growth in population. As a result, the frequency of traffic accidents is growing. The majority of the moment, accidents aren't identified or communicated to nearby hospitals and family in an appropriate manner. This absence of prompt medical attention and first assistance. In a matter of minutes, you might lose your life. To handle all of these issues, an intelligent system is required. Although numerous ICT-based solutions for identifying accidents and rescue efforts have been offered, these systems are not interoperable with every vehicle and are also expensive. As a result, we presented a smart city accident detection and reporting system (ADR) that is less costly and compatible with any vehicle. Our plan strives to enhance the quality of transportation while keeping costs reasonable. In this context, we created a simulation that gathers information from the sensors about pressure, acceleration, captures moment, location of the occurrence, and force of the accident. The measure of speed contributes to the accuracy of accident recognition. The information gathered is then analysed for accident identification. A GPS system should also alert relatives, the police, and the closest medical center. The hospital sends a UAV (drone) along with a first aid kit and a motor ambulance to accident location. The road transport and roads accident repository's real dataset are used to produce simulation results. The proposed plan shows promise when measured against current approaches in terms of accuracy and response time.

Keywords: *Accident Detection, Accident Prevention, 5G, IoT, ADR*

1. INTRODUCTION

Road accidents are getting more widespread these days, as indicated by the observation that the incidence of accidents is growing on every single day. As the population grows, so does the count of vehicles on the roadways, increasing the probability of an accident occurring.

The World Health Organization (WHO) reports an annual rise in traffic fatalities. Accidents cause over fifty million injuries as well as 1.35 million deaths [1]. Accidents in which Vehicles are currently the eighth leading cause of mortality, having risen at ninth in 2015. If no precautions are taken, this ranking might fall from ninth to fourth in a few years In accordance to the Association for Safe International Road Travel (ASIRT), the future is bright.

Even in affluent nations with perfect road safety legislation, traffic fatalities have been on upward trend in recent years [3]. One of the leading causes of mortality in a traffic collision is a lack of prompt assistance to preserve a life.

Using new technology with various tactics in our everyday lives may be saved in this contemporary world that is always growing with new technologies. In today's world, the concept of 5G and the Internet of Things (IoT) can allow previously unimagined applications such as automated healthcare, smart cities,(ITS) intelligent transportation system, and a lot more [4]. Several technologies serve these applications and satisfy requirements[5]. These programs gather data from the surroundings each minute and then share it across one another using a range of sensors.

Further action is made based on this information. Accident monitoring and reporting to necessary authorities and registered domestic members is critical in today's world. Accident detection, as well as rapid reporting of accidents to the emergency medical facility This will end up in the saving of lives and the rescue of injured people. As a consequence of this research, an affordable 5G technology and internet of things surveillance and accident detection system is presented[5]. The suggested technique is divided into two stages: accident identification and accident reporting. the Global Positioning System accelerometer, a microphone, as well as pressure sensors are among the smartphone sensors used to detect an accident. A smartphone or module utilised to collect sensor data and deliver it to an edgecloud for processing. Threshold analysis is performed to figure out what caused an accident. When an accident is discovered, the closest medical center, the police department, and domestic members are alerted. The IT research contribution of the work as follows

- The creation of a simulation that obtains data from sensors;
- The change of different values from sensor that is linked to an edge computer to track down the accident using boundary analysis;
- Determining and identifying acceptable thresholds for accident identification; and
- Detect and reporting to the nearby hospital, police department, and concerned domestic person.

2. PAPER STRUCTURE

The remaining portion of the paper is divided into the following sections. Related work is included in Section 2. The proposed structure is shown in the Segment 3. The mechanism for detecting accidents is presented in Section 4. The Section 5 contains the simulation Comparisons and results. Section 6 follows with the conclusion and forthcoming tasks.

3. BACKGROUND STUDY

The escalating number of automobile accidents is creating a severe challenge for our society, necessitating prompt action. The most of intriguing technologies in the field of intelligent transportation is the Internet of Things (IoT). IoT was used by several researchers to support intelligent transport. Additionally, UAVs play an essential part in many applications due to their wide range of mobility in any direction [6]. UAVs can glide at subordinate heights in any orientation, permitting them to reach locations where people are unable to access [7]. Because of these qualities of UAVs, providing a firstaid package to the accident occurrence site rapidly is advantageous [8].

The researchers provide a paradigm with two stages in article [9]. In the initial stage, the device senses an accident and offers a notification system, while in the second phase, it provides an ambulance management system. The routing method advises the ambulance on the most effective path. The provided approach is appropriate for road intersections with traffic signals. The approach however isn't relevant to traffic lights.

The researchers provided an accident control framework in article [10] to determine the trade-off while taking into account various criteria such as erroneous delivery, excessive rate, and nonprobability. The proposed approach is unsuitable for limiting available resources. To assess the severity of an accident, the approach employed a severity scale.

The authors of paper [11] proposed a technique for detecting an accident at both high and low speeds by considering several circumstances. In a fast scenario, if the acceleration value exceeds 4G, an accident is declared using a smartphone application. However, in a few circumstances, it activates false alert messages when mobiles are being used. In article [12], the researchers presented a call-based notification system using several components like Seeduino, Xbee shield, Wi-Fi module and GPS technology. The sensors are utilized to identify an accident, resulting in less reliable findings.

The researchers evaluate the driver's behavior in paper [14] by employing IRsensors to monitor eye blinking. The driver's head gesture is recorded using an accelerometer. To measure the angles produced by head movement, an accelerometer sensor is installed on the driver's forehead. The procedure would be inconvenient if the accelerometer was attached to the forehead every time. Furthermore, merely the driver's actions in detecting the crash may be wrong.

The authors of article [15] conferred a system intended for accident detection employing hardware with several sensor. The level of seriousness of a crash is determined using generated findings in this manner. In article [16], the researchers employ a fitted device in the automobile to detect an accident. This gadget is outfitted with a button push switches that detect any triggers and impediments. By following any obstacles, the microcontroller (AT8952) assists in turning on the beeper. Nevertheless, the plan could go wrong if the vehicle driver stops to turn on the switch.

The investigators proposed a system in article[17] that identifies an accident by evaluating the state of the vehicle's engine and informs the user of any flame or smoke noticed in the automobile engine. The device can efficiently screen all the aberrant circumstances that happen in the automobile; nevertheless, the provided system is not place a high priority on collision detection.

In article [18], the researchers provided a crash warning system that alerts the appropriate number in the event of an accident. Instead of calling 911, the system reports to the appropriate number in this approach. The system, however, is unrefined because of limited resources and implementation.

In article [19], the researchers suggested a technology with the ability to automatically identify accidents using a motion sensor and transmit the information to rescuers through GSM connection. However, as the approach just uses one sensor, the results might not be reliable. In the publication [20], the authors demonstrated a system for detecting and tracking automobile accidents using GPS and GSM. Push button turns on controls identify an accident and monitor the location using GPS and notify through GSM service.

[21] introduces EARVE, an architectural framework for V2E applications. The solution takes benefit of edge servers' minimal latency to provide immediate disaster identification and reporting. The layered design of EARVE enables servers at the local, neighbourhood, and metropolitan phases, allowing for a variety of usage at different spatial scsles and time. When contrasted to cloud alternatives, the data show that EARVE lowers the response time of augmented reality applications in automobile networks. [22] proposes a unique vehicle-to-multiple-edges (V2Es) model for increasing the computing and communication capacity of vehicular networks. A multi-agent RL method is used to learn current communication state of automobiles and numerous edge nodes in order to reach appropriate work outsourcing and edges caching decisions.

[23] provides an in-depth review of decentralized vehicle computing infrastructures, which includes centralized cloud computing, automobiles cloud computing, and automobiles edge computing, in order to carry out investigation on various transport technology structures, also future data analytics methods and how they interact with transport computing infrastructures.

4. PROPOSED ARCHITECTURE

Hold conscious of the aforesaid restriction in accident recognition systems. We describe a distinctive accident detection and reporting (ADR) system. To save costs, our solution is built on a smartphone, which does not require any specific hardware.

The layers underlying the ADR framework are depicted in Figure 1.

The ADR framework is divided into five layers: applications, databases, clouds, networks, and perception. In the proposed ADR architecture, the perception layer is in charge of interfacing with the smartphone's sensors. The primary job of the perception layer is to collect information from the sensors. The data gathered is based on vibrations, acceleration, the pressure, a gravitational and automobile position. Information is collected and sent to the communication layer for processing. The role of a network layer is to link the edge to the perception layer. To transport the sensor surface to the cloud, the network layer uses 4G, 5G, or Wi-Fi. All the provided technique is implemented in the edge layer and detects accidents and analyses them based on a predefined threshold. When a vehicle crash occurs, the closest medical centre and emergency vechicles are notified, and data is sent to a database layer. Finally, the data stored in the database. With the use of handsets and online communication systems that connect the driver and hospital, the information gathered is subsequently transferred to the application level for further processing.

Every automobile equipped with a smartphone will be included in the proposed concept. Every smartphone is built around four sensors: a sound sensor (microphone), a pressure sensor, an acceleration sensor, and an accelerometer. A mobile phone with the aforementioned sensors is constantly utilized for data collecting in order to do experiment assessment. To identify an accident, the smartphone sends data to the cloud, from where it is evaluated by the edge, which assesses whether or not a collision happened. This value has been preset; if the sensor information obtained exceeds this value, a crash has happened. When the specified circumstances are met, an alarm is triggered, and the driver receives an alert notice.

To prevent fraudulent coverage, when the driver rejects the alarm before it sounds, the medical facility will not consider it. If the motorist does not act within 10 seconds, a nearby clinic and Unmanned ambulances are notified and edge service assistance is provided. The edge service notifies the closest ambulance of the accident site for the rescuing operation. Cloud service manages the computerized records of medical centres, automobiles, and ambulances. The planned project is divided into two stages. (1) accident detection phase. (2) Notification phase.

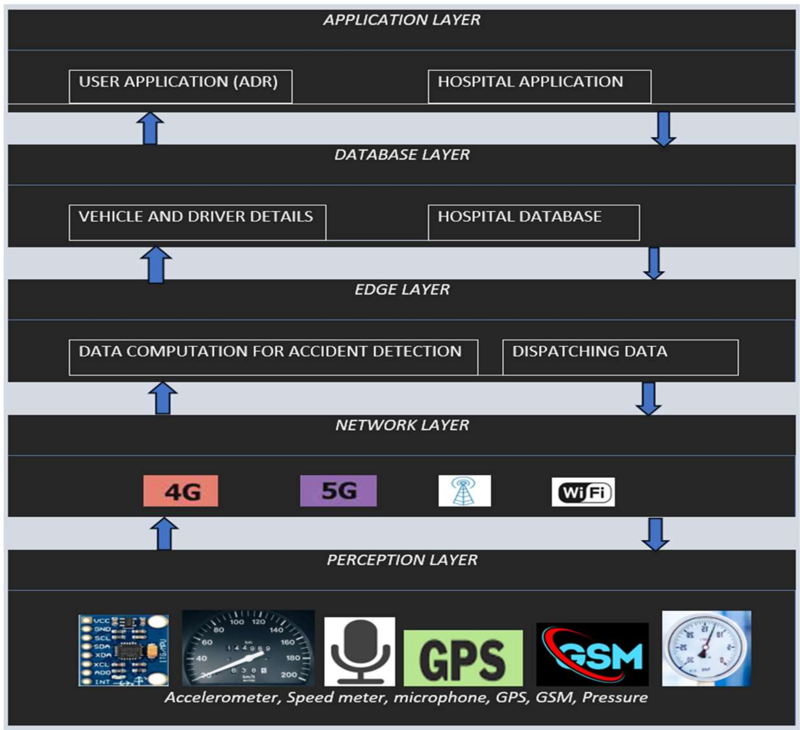

Figure 1: Accident Detection and reporting Framework

The selection criteria of critique model's primary purpose are to establish a framework that permits and transports on the goals outlined below.

- ✓ To provide a direct vehicle-to-infrastructure association.
- ✓ To create an economical system.
- ✓ To increase the reliability of accident detection;
- ✓ To reduce the number of fraudulent reports.

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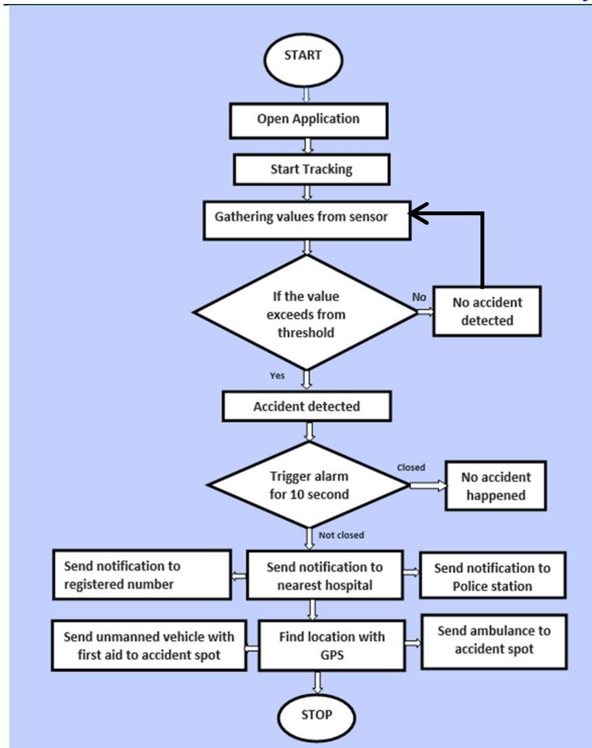

Figure 2: Workflow of Proposed System

4.1 Segment of Accident Detection:

Accident detection seeks to prevent unexpected occurrences while driving that result in harm or damage, as well as to reduce the fatality rates in crashes while driving. During this step, several components such as a microphone, a force sensors, accelerometer, and GPS are employed to determine the location of the accident. All of these elements are described in further depth below.

4.1.1 GPS Navigation Technology:

GPS technology (global positioning satellite system) seeks to derive positioning data. GPS assists in determining the vehicle's location and transmitting that information through the network. The data supplied can be used to compute the velocity of the vehicle. The speed of an automobile aids in precisely identifying the collision.

4.1.2 GSM Technology:

It is employed to send mobile data (e.g., messages to police stations, hospitals, and concerned individuals). The message's objective is to transmit an accident notice for further confirmation.

4.1.3 Microphone:

This element is used to detect sound. When an amount of sound deviates from the set threshold value (140 dB), an accident alert is triggered. As a result, we Utilize a pressure sensor with an accelerometer in order to better recognize an accident, yielding to improved outcomes. A mobile device with a microphone built-in improves accuracy by lowering the the likelihood of erroneous results.

4.1.4 Accelerometer

The mobile device's accelerometer sensor may be used to measure velocity force. This accelerometer is a vital tool for detecting accidents. Once the acceleration force exceeds 4G, the accident indicator is raised [28]. It could be noted that G-force statistics alone are insufficient to correctly identify an accident. Furthermore, the 4G threshold level is determined by trial as well as secondary research.

4.1.5 Sensor of Altitude

The pressure sensors continually capture data regarding the vehicle's pressure before and after the accident. When a pressure reading reaches a predetermined threshold (i.e., 350 Pa), an accident alert is raised. As a result, pressure information assists us in identifying the happening of a collision and reducing erroneous reports of an accident.

4.2 Notification Phase

Timely notification of an accident's occurrence is critical, and messages are instantly relayed to hospitals and immediate rescue services for action to be taken. After an accident, the system uses mobile GPS to determine the position. With the use of 4G/5G, information about the accident, including speed, heaviness, noise, and position, is transmitted to the edge. The edge server contains the database of hospitals and uses a planning service to identify the nearest medical center. The accident is reported to the nearest hospital, along with the owner's details and the exact spot of the accident. An accident is added to the current database.

4.2.1 Vehicle Database

Motor vehicles are described in this database. For instance, proprietor name, proprietor ID, vehicle name, vehicle ID. The vehicle database is seen in Figure 3.

5. PROPOSED WORK IMPLEMENTATION

The suggested system paradigm is described in this segment. The suggested system is built on two major processes. A handset for communication and IoT-enabled gadgets. Using the speed sensor and cellphone microphone, the Android application collects data such

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as pressure and noise. An accident is predicted based on these standards.

The operator installs the module and activates it with internet connectivity (e.g., Wi-Fi/4G/5G). The smartphone captures data from the pressure sensor, GPS, Camera, accelerometer, and microphone using the application.

5.1 Accident detection Phase:

The crash detection criterion is taken from [40]. Where AD stands for accident occurring flag pointer.

On formula:

CA is an acceleration value that may be measured using a handheld device.

Noise is an amount of noise detected using an audio sensor on a smartphone.

SVP is a fluctuation in speed after a defined duration that can be utilized to recognize accidents at low speeds.

Accident Target (AT) refers to the defined rate (i.e., 1.5) at which an accident is identified.

Target for low speeds (TLS) is a number given (i.e., 3) the collision is recognized at low speed; Speed (S) and SG-Force is used to measure amount of speed;

MT is the maximum time allowed to examine an accident at a slow pace.

By analysing the acquired data, the cloud determines the accident using Equation (1). When an accident is recognized, the alarm goes off. To prevent fake accident reports, the user has 10 seconds to silence the alert. If the alarm is not disabled before 10 seconds, a critical notification is sent to the nearest medical facility for action to be taken. Accident detection is described in Algorithm 1.

Alerts Whenever an accident has been verified, the precise spot of the accident is determined using GPS. Google Map is employed in the proposed method to locate the site of accident. The technology used 4G/5G/Wi-Fi to send vehicle, location, and information about passengers to the closest hospital for quick care.

$$AD = \{1, \quad if\left(\frac{noise}{140} + \frac{CA}{4G} + \frac{pressure}{350}\right) \geq (1)(Speed) \geq 24km/h,$$

$$1, \quad if\left(\frac{noise}{140} + \frac{CA}{4G} + \frac{pressure}{350}\right) \geq (TLS),$$

$$1, \quad if\left(\frac{noise}{140} + \frac{CA}{4G} + \frac{pressure}{350}\right) \geq (AT) \wedge (ET < MT),$$

$$0, \quad Otherwise\} \qquad (1)$$

5.2 Accident detection algorithm

DATA: Gather information from sensors.

Outcome: The acquired data was used to detect accidents.

Table1: Accident Detection Algorithm

Initialization
if($\frac{noise}{140} + \frac{sg-force}{4} + \frac{pressure}{350}$)≥ (1)(Speed) ≥ 24 then
∣T← 1;
else if ($\frac{noise}{140} + \frac{sg-force}{4} + \frac{SVP}{2.06} + \frac{pressure}{350}$)≥ (1) (Speed) ≥ 3 then
∣T← 1;
else if ($\frac{noise}{140} + \frac{sg-force}{4} + \frac{pressure}{350}$)≥ (1)∧ (ET) < (MT) then
∣T← 1;
Else
∣T← 0;
End
If T=1 then
Set An alarm;
Timer=10 seconds;
If(timer)≤10 seconds then
∣ condition=Detection of an accident;
Else
∣ condition= No Detection of accidents;
End

Table 2: Location Analysis Algorithm

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Use GPS to determine the exact spot of an accident;

Get automobile description from the db;

Get an emergency contact (i.e., the registered number of the individual in question) from the database;

Alert Message =Owner information, location, and emergency phone number;

Wi-Fi accessible in 5G/4G;

Locate the nearest hospital;

Notify the closest medical facility and police station, as well as the site of the accident;

The hospital despatched a drone and an ambulance equipped with a first-aid kit.

else

Criteria = No Accident Occurred

End

6. SYSTEM IMPLEMENTATION

As previously stated, the system that is proposed is divided into two phases: Install the physical module that detects an accident, whereas the internet-connected system will notify the medical centre. The Arduino IDE is utilized for coding, while the Android Studio's IDE is employed for design during the accident detection phase. After installing a module on a car, the user must register with various details. After completing the registration procedure, applicants may log in to the system using their login credentials. When the user engages the vehicle tracking button, data is transmitted and recorded. The program continually gathered information from the device sensors and sent it over the edge. If the amount reaches the set the limit, the edge detects the error and sounds an alert for ten seconds.

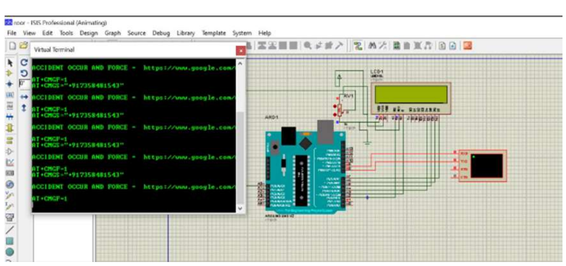

Figure 3: System Implementation Module using Proteus

6.1. Deployment of Notification Phase

By the use of edge, an accident is reported to the nearest hospital when it has been identified. This program is used by hospitals to identify emergency situations. In the case of a crash, the internet portal is contacted and gets accident information. The website displays accident details such as driver identity, vehicle details, and incident spot. The accident scene is located on a map using google map for the purpose of location tracking.

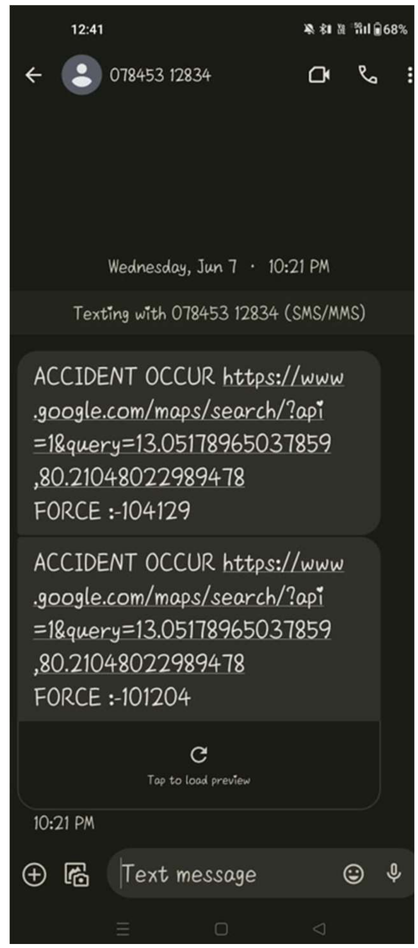

Figure 4: Accident Notification to Registered User

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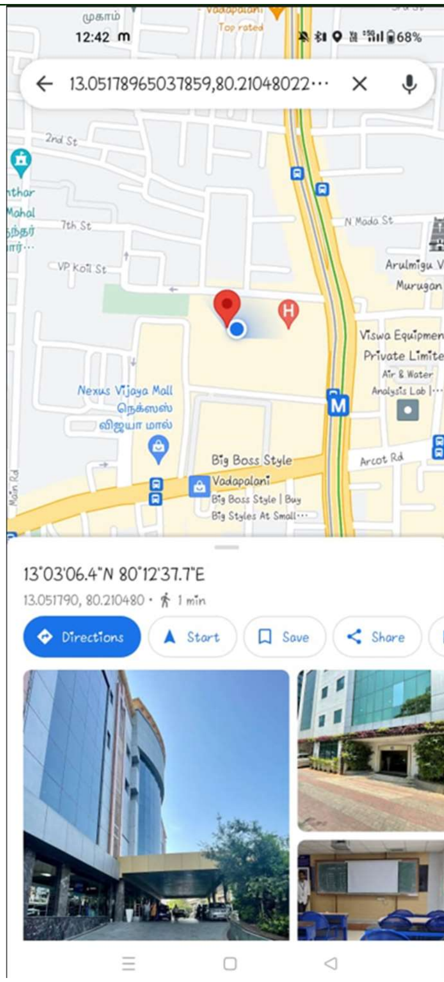

Figure 5: Accident Location to Track

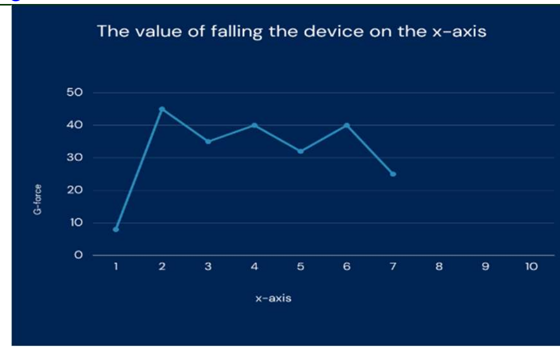

Figure 6: The rate of falling the object across X-axis

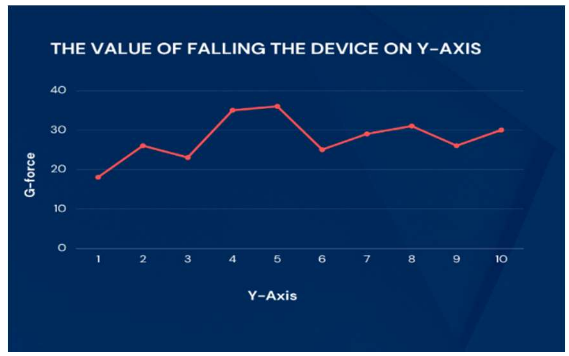

Figure 7: The rate of falling the object across Y-axis

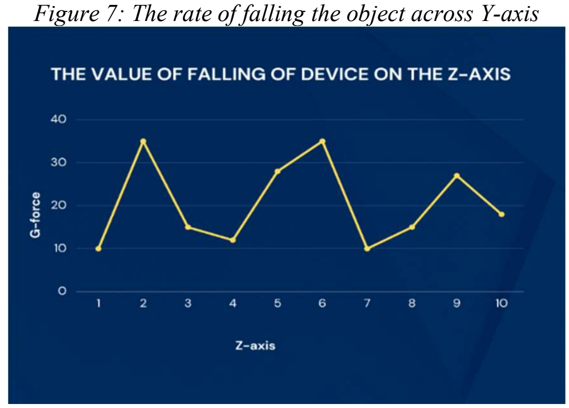

Figure 8: The rate of falling the object across Z-axis

7. SIMULATION RESULT:

The suggested technique is unable to be utilized in a real-world setting due to damage concerns, safety concerns, and economic considerations. We were able to simulate the suggested framework in a monitored environment. The suggested system archives acceleration at a high rate depending on the values of noise, pressure, and speed. The gathered data is sent to the edge for accident detection.

7.1. Threshold Assessment:

We compute the sg-force values displayed in Figure 6 for criterion determination. wherever numerous speeds are driven at by actual drivers in real cars. The claim has been made that the ultimate force experienced is 3.3 G.

To evaluate a program for Android, other variables like G-force, acceleration, and force are also computed.

7.2. Standard CADANS

The reliability and quickness of response of app are illustrated in this section as the outcomes of our simulation. Accuracy and response time are computed using ACC simulator. The outcomes are contrasted with those of the care accident detection and notification system (CADANS)[32], which bases accident detection

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on mobile device sensors. We took into account all four sensors that the ARD system suggested, and we used three sensors to assess CADANS behavior. The findings demonstrate that RAD performs better than CADANS in terms of accuracy. Accidents occasionally go undetected by CADANS while they are still happening. We deployed Sim, threads, and a mobile ad hoc network in the simulator to manage numerous automobiles. Each one of the sensors has its own get and a particular set of methods that produce outputs every second. For the duration of five minutes, we ran a simulation to get the data and examine them. In Table 2, the simulation variables are listed. To determine the accident, an accident equation is run with various sensor data.

TABLE 3: ADSim data

Constraints	Distortion	sg-Force	High Pressure	Speed.
Threshold level	145 dB	5.00 G	355 P	23-24km
At Start	Zero	Zero	Zero	Zero
Scale	131- 155 dB	0 - 100	300-415 P	1-10G

Five minutes were spent running the scenario. The 16 accidents that occurred during this time were all accurately recognized by the suggested ADR; only 37 incidents were precisely identified by CADANS. Comparatively to RAD, CADANS also produced incorrect reports. Accidents with a G-value of less than 3 G (i.e., those brought on by a smartphone falling) are detected by CADAN. 11 of the 16 accidents that CADANS records were false accidents. A pressure sensor's outcome aided the ADR system in precisely detecting accidents and lowering the likelihood of false reports. The simulation results are depicted in Figure 7a–c.

7.3. The OnStar System as a Model

Regarding a comparison with the planned system ADR, the OnStar method [41] is employed.

General Motors (GM) created the OnStar system to provide roadside assistance. The technology is built on implanted sensors in vehicle that identify an accident then notify to rescue crew. The OnStar system is a hardware-based system with embedded with the vehicle sensor. The technology is only available in GM vehicles and cannot be installed in other automobiles. The results of the simulation are shown in Figure 7d.

7.4. RADS as a benchmark

In the context of turnaround time, the RADS device [40] is chosen for comparison. The RADS employs similar sensors as the ADR system. RADS operates with cloud computing, which is remote from physical, resulting in excessive latency. Because an automobile collision is a serious situation, real-time recognition is critical. The ADR system is built on edge computing, that analyses data close to its core and optimizes network traffic. It reduces data flow to and from the principal network, resulting in minimal latency and high speed overall. The simulation results are shown in Figure 7e.

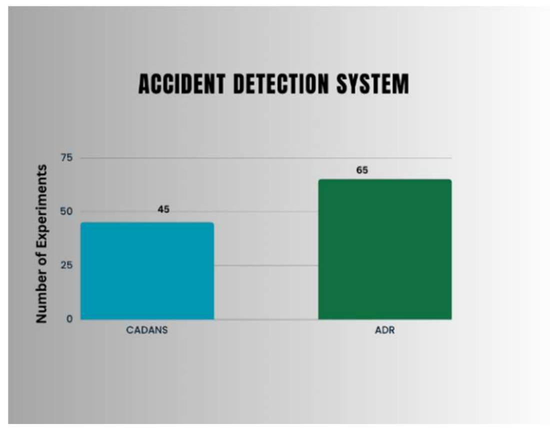

Figure 9: Accident detection Comparison

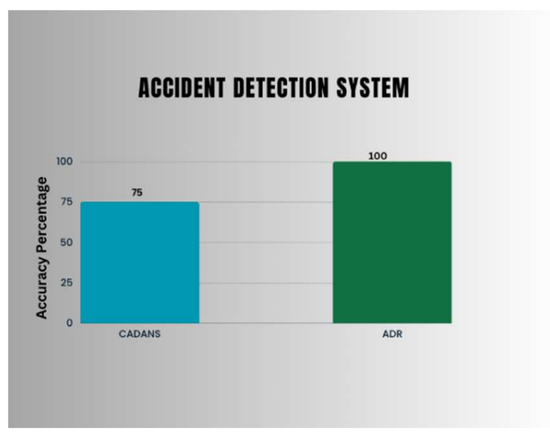

Figure 10: Experiments accuracy percentage

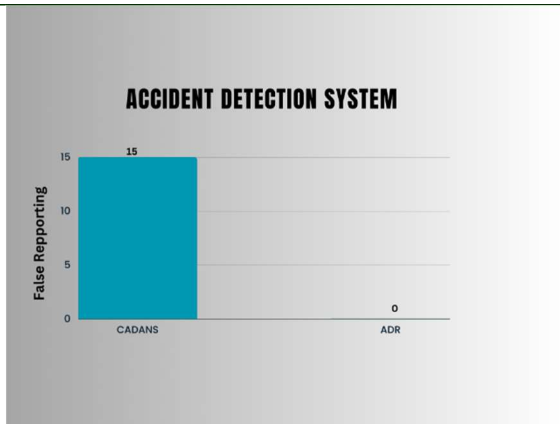

Figure 11: False reporting experiments

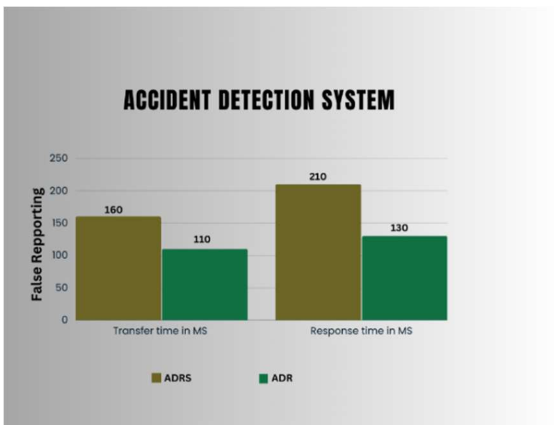

Figure 12: Comparison based on parameters

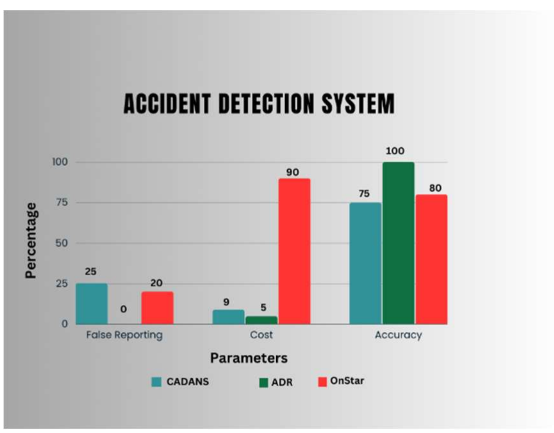

Figure 13: Transfer and response time comparison

7.5. Evaluating Making Use of the FODR Dataset

For additional studies, we utilized the FODR dataset to identify a crash.

The Finding open-source information portal may be found at https://morth.nic.in/ as of 2022-2023. Actual accidents provide the numbers for speed and loudness. We tried with three separate situations while taking into account numerous sensors.

Scenario 1: The true obtained speed value is equivalent to the system with only one sensor [42]. At speeds less than 24 km/h, the technology has no ability to identify an accident.

Scenario 2: The device with two sensors is thinking about [32], The charge of velocity and loudness are taken into account. At slower speeds, the technology is unable to detect the accident. When the velocity is greater than or equal to 24 km/h, the technology may have identified an incident when there was none. In another example, if the variation in the noise rate above the specified threshold, may fail to identify an collision even when one has occurred.

Scenario 3: To detect an accident, numerous sensors with speed, accelerometer, pressure, and noise are employed. Integrating several sensors enhances accident identification precision while decreasing the likelihood of false positives and false negatives. It may also aid in detecting an accident that other systems might miss at a slower pace.

The Scenario-1 detects just three mishaps out of five. In Instance 2, only four out of five instances are discovered. Finally, in Option 3, all five mishaps out of five are recognized. In Scenario 3, the suggested system has a 90% accuracy. Figure 8 depicts the correctness and falsification of all three situations.

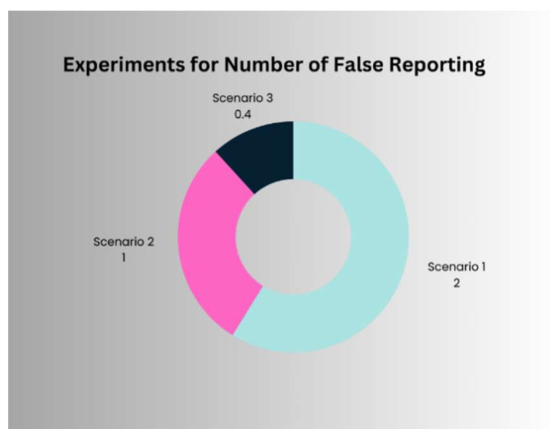

Figure 14: Comparison of Accident detection

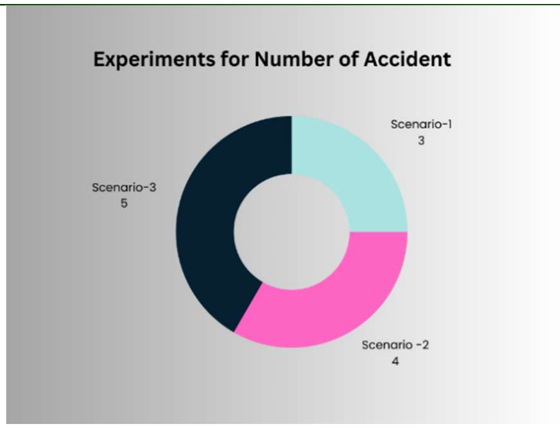

Figure15: Comparison of False reporting

8. CONCLUSION AND FUTURE WORK

In today's culture, the number of automobiles on the road is rapidly rising. As an outcome, the total amount of accidents is on the rise. Despite the availability of several technology for accident identification, the mortality toll continues to rise. Accident detection inaccuracy and inadequate communication techniques are liable for the slow reaction to catastrophic incidents. The problem is exacerbated by an absence of access to feasible retrofitting options, Aswell as economic concerns. The strength of this paper as it has been discovered that using many sensors improves the reliability of recognizing accidents. In real time, the technology detects an accident and locates the closest hospital. Then it quickly notifies an emergency alert to a local hospital as well as a domestic member or acquaintance. An accident can be detected and reported using the smartphone's sensors. Our suggested approach has been shown to reduce the amount of incorrect positive accident detection reports. Our system must be linked to the internet in order to function. In future, we prefer to test our innovation in all the vehicle in real-world situation. Therefore, the security and privacy of the drone communication are crucial. We look for to discover solutions to privacy and security-related problems since the system needs total confidentiality and safety.

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