Research Reports on Computer Science
https://ojs.wiserpub.com/index.php/RRCS/

UNIVERSAL WISER PUBLISHER

Research Article

Witness System of Vehicle Accidents Based on the Internet of Things

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Received: 26 June 2023; **Revised:** 25 September 2023; **Accepted:** 27 October 2023

Abstract: Road traffic accidents become more of a problem as there are more automobiles on the road. Accidents are impossible to completely prevent, but there are techniques to lessen their impact and manage their aftereffects to limit harm. One of the biggest issues is exchanging car accident alerts with other vehicles on the road. A number of technologies are in use to prevent traffic collisions. It is planned to develop a system for detecting collisions between vehicles based on the vehicular ad-hoc network (VANET) concept. Additionally, it immediately alerts the neighborhood hospital and social media about the incident. The proposed technique uses a warning system supported by collision potential and is implemented on OpenStreetMaps and at locations of interest. We assess our system's performance using the simulation of urban mobility (SUMO) software tool, which employs OpenStreetMap data to simulate vehicle-to-vehicle communication and accident detection. SUMO generates traffic on the road for our evaluation. To gauge the effectiveness of our system, we measure the size of messages exchanged within the VANET and demonstrate its feasibility. Furthermore, we compare our results with previously published works in the same field of study for reference.

***Keywords*:** vehicle detection, Internet of Things, accident

1. Introduction

The number of fatalities and injuries resulting from accidents rises exponentially as more people drive cars and other vehicles. Accidents can have many different causes, but the ones that concern us the most include excessive speeding, intoxicated driving, careless behavior, a driver's disorientation, and not being aware that an accident has occurred. There are post-accident events that lead to an increase in the number of injuries, vehicle damage, and casualties. Other cars on the road are often impacted by inefficient handling of post-accident events and occurrences. Such post-accident duties include providing basic initial assistance, notifying oncoming traffic when it is hazy or smoky outside, and telling emergency medical officials the causes of the collision.

We might be able to lessen post-accident effects if these post-accident occurrences are handled appropriately. For instance, when a collision bet ween two cars happens on a highway in a foggy environment, many other approaching automobiles happen to collide with them as the incoming vehicles are unaware of the collision owing to low visibility

DOI: https://doi.org/10.37256/rrcs.2220233275

and a lack of communication. Particularly when accidents occur on highways during foggy and polluted seasons because of poor visibility between vehicles. If we immediately alert approaching oncoming traffic to an accident by flashing a warning message on on-board units (OBUs) installed in their vehicles, this will undoubtedly save many priceless lives.

With a network of more than a million kilometers of roads, Pakistan is one of the top nations in the world. While these roads make a significant economic contribution to Pakistan, the facilities for drivers do not appear to be up to par, which increases the danger of fatalities. These recent fatalities and traffic accidents have prompted a number of questions about the security of transport. It is crucial to have a collision warning system that is able to stop accidents even in unexpected circumstances.

Mobile incidental networks (MANET) is one of the vehicular ad-hoc networks (VANET) that has been considered due to all the attention it gained over the recent years being a potential collision warning system. Usually, collision warning systems (CWSs) are employed to avert probable crashes [1, 2]. By 2020, there will be 25 billion items connected to the internet, with vehicles accounting for a sizable portion of those. The growth in the number of vehicles may lead to traffic-related problems, which the internet of items may easily resolve [3]. These vehicles create a type of "Internet of Automobiles," a network of automobiles that communicate with one another to transfer data. This is because they are gradually becoming connected to the Internet of Things (IoT). Internet of Vehicles (IoV) thus represents the fusion of the mobile network and IoT. It is a growing sector of the automobile industry and is laying the foundation for smart cities [4]. It is clear that the VANET may evolve into the IoV as more vehicles become a part of the IoT [5].

With the aid of roadside devices known as roadside units (RSUs) and onboard transceivers, knowledge, and significant data are shared across the vehicles in an integrated vehicular system to enhance driving and traveling. By connecting many technologies, the internet has developed into a platform for their progress in the current day. Many technologies are becoming web-responsive, such as traffic management, which makes transportation easier with the aid of the internet. Aside from numerous problems with traffic management, there is currently no way to detect a collision between two vehicles; however, if such a collision were to occur, information about the coordinates of the accident site could be sent to the web server and to the OBU mounted inside the vehicles, alerting them of the collision [6].

In the proposed study, we will be able to identify accidents, record the accident data to an online cloud server, and instantly notify the unit room of the accident, including its geographic coordinates, the angle at which it collided, and any other on-road vehicles involved. Hospitals and related friends and family will also be promptly informed of the accident.

There is currently no method in place to completely eliminate accidents. Although alerting automobiles will help to reduce accidents through the accident awareness process and prompt notification of the disaster management authorities. Precautionary measures and increased awareness will help to reduce the number of accidents that occur every day. A vehicle accident witness system (VAWS) will be simulated using IoT technology. The cloud, a measurement device, inaudible sensors, RSUs, a global system for mobile communication (GSM) module, and OBUs are used to operate this simulated system.

Through a microcontroller, many parts, including global positioning system (GPS), GSM, accelerometer, and ultrasonic sensor, are interconnected. When an accident occurs, the alarm may send you a warning message. When an accident occurs, the accelerometer is used to locate the crash or vehicle tilting, and then it sends signals to the microcontroller. The ultrasonic sensor determines whether or not an obstruction caused the mishap. Vehicles are tracked and navigated using GPS modules. Without the driver's intervention, tracking systems allow us to locate automobiles, while navigation systems enable moving vehicles to get to their destination. With the aid of a camera, which is activated when it receives a signal from an accelerometer and an ultrasonic sensor, the job of accident witnessing may be completed. The camera will then record several characteristics, including the accident scene, the location's coordinates, and the speed of the vehicle.

There is currently no technology that allows automobiles to communicate with hospitals and other on-road vehicles or alert oncoming vehicles and emergency control centers about vehicle collisions that have occurred. Road and traffic safety can be increased if a driver develops the ability to see farther down the road and detects a collision. In this way, he or she can prevent any catastrophe. If drivers and vehicles communicate with each other, then this will be possible. If drivers, police, and other responsible parties are informed immediately after an accident, the road will become safer and travel will be far more cost-effective.

1.1 *Research contribution*

- Development of a collision detection and alert system using VANETs.
- Utilizes vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication for collision detection.
- Relies on sensors like accelerometers and ultrasonic sensors.
- Alerts nearby vehicles, hospitals, and control centers.
- Presented state-of-the-art algorithms for transmitting accident information in VANETs.
- Compression of messages for efficient transmission.
- Utilized simulation of urban mobility (SUMO) for simulation.
- Demonstrated real-world implementation using an Android app.
- Integrated Google Firebase as a real-time No-SQL (Not only-Structured Query Language) database server.
- Highlighted the potential of the IoV for improving traffic safety and communication.

2. Related work

An overview of the literature and a thematic taxonomy of current accident detection methods are included in this part.

2.1 *Literature survey*

The literature contains some related work that is connected to safety applications for the automotive industry [7]. Many of these works, such as forms and collision detection programs, do not make use of any mobile network infrastructure. Particularly, [8] emphasizes pedestrian-vehicle collisions in industrial settings. Using a mix of Micro Electronic Mechanical Systems (MEMS), GPS, and other relevant sensors, coordinates are obtained in this case, but the required goals are not met. In order to reduce the delay between an accident and the arrival of first responders, [9] suggests using a smartphone's accelerometer to physically observe a collision after it has happened.

In order to inform other on-road cars of accidents and to keep data on our cloud repository for additional analysis and statistics, our research suggests a collision detection system that can build an Inter Vehicle Communications (IVC) with them. While [10] describes an approach based on V2V, [11] presents a top-down and specification-focused type of associate degree reconciling accident alert system. However, this research only offers very weak simulation results.

According to [12], these various types of evolutions aid motorists in overcoming a variety of problems and making driving easier, such as managing a heart attack while behind the wheel by quickly alerting medical facilities to administer first aid as soon as possible. The IoT makes it easier to alert the local police station when an accident happens. IoT also contributes to the introduction of the automated toll tax payment process.

A cluster system that is being developed for intersection collision detection is somewhat different from Dedicated Short Range Communications (DSRC). Cluster creation is facilitated via Wi-Fi through peer-to-channels, but cooperative awareness messages must be transmitted over LTE channel. Additionally, a channel allocation algorithmic program is implemented amongst various clusters to aid in lowering wireless local area network channel interference. When compared to other methods, the heterogeneous architecture does not perform much better in terms of delivery rate. However, a standard system which includes communication between machines (machine to machine, M2M), IoT, and IoV has yet to be developed as the development requires a broad and open-ended review of the current information [13].

This [14] device was created with the goal of detecting accidents. The continuous transfer of vehicle data to the control room with the aid of a Wi-Fi module allows for the detection of car accidents. The "Arduino IDE" is taken into mind when writing data transmission code. The cloud is used with "Thingspeak", which is essentially an open IoT platform. Using encryption libraries, data sent to the internet cloud is shielded from prying eyes. To determine if an accident has occurred or not, threshold values are established for the accident on the controller, after which the accelerometer is used to measure the data that was sent to the cloud.

Radio control (RC) was used to assess the procedure with real-time parameters. That technique is unsuccessful because it puts additional strain on the network and is not very practical because it adds constant data transfer to the cloud server, which requires a continual connection. This method is less useful because it requires a lot of bandwidth to communicate continuously with the server. IoT and distributed computing technology are bringing about innovation and improvement in the field of automotive services. The four main "parameters" to measure and analyze the development are the innovativeness of the product, the innovativeness of the process, the innovativeness of the process, and the paradigm that is used, as mentioned by [15]. For each of these parameters, the goal is to "improve" it as much as is humanly possible. The administrative sector has to adopt new ideas to make it easier to use IoT and distribute computing in cars [16]. For instance, the drivers' data should be saved on the cloud server to make the communication route flexible between the VANET and cloud storage. Following the drivers' enrollment, the created framework provides a means to determine whether they are using a seatbelt or not. It can also be used to determine whether they have consumed alcohol. This is how they are able to update the data on the cloud.

A system for the remote monitoring of the vehicles was implemented using GSM. The software and hardware combination are specifically planned with the system structure in mind. In this work, the GSM network is utilized as a communication medium for the delivery of remote signals to the distant server. The two modules in this system are a distant observation station and a module for directing attention. The coordination module and PC utilized in the observation center are GSM-compatible. This technology is used to keep an eye on and manage remote communication. A drawback of GSM communication technology is that users share the same bandwidth. As the number of users rises, several types of unmanaged interference enter the communication channel. So, using faster technologies, like 4G, is a better option than that in order to get over such bandwidth restrictions [14].

A system that offers vehicle tracking is made out of a cloud computing architecture. To monitor the fuel level and speed of the vehicle, various sensors are employed. With the aid of an implanted GSM device, all the data will be stored on a cloud database server. To determine their location, every car has a GPS antenna integrated into it. The alcohol sensor is used to track the driver's blood alcohol content. The suggested structure can considerably lower highway accident rates [17]. The employment of intelligent systems helps to prevent collisions between cars. This smart system includes a wireless module that connects every automobile to every other car. The vehicles are connected using a communication module called NodeMCU which makes use of GPS to track the vehicle's position. When two vehicles are very close to one another, a warning is issued by an ultrasonic sensor to remind the drivers of both vehicles to keep a safe space between them [18].

The amount of traffic is directly correlated with a significant rise in automobile collisions. In both urban and rural areas, traffic congestion is a major problem. These problems are resolved by [19] using a technique known as the social vehicular network (SVN). The term "social vehicular network" refers to a combination of the terms "vehicular cloud" (VC) and "roadside units" (RSU). RSU is used by the VC to share data with the internet cloud. If an accident occurs or there is traffic congestion, RSU is utilized to upload vehicle information to the internet cloud. Accidentally transmitted information may take the form of audio, video, and graphics that may be shared via Twitter and display the current state of the road. The use of SVN provides the most up-to-date real-time traffic scenario for any driver who needs to monitor the current traffic status on a street or road.

Road accidents are rising as a result of the exponential rise in car numbers around the world, which leads to other problems. The bulk of collisions take place where two roadways intersect. Modern transportation uses M2M communication system to link different communication components, such as vehicle sensors, automobiles, wireless networks, and roadside infrastructures [20]. Handling post-accident conditions skillfully is an efficient technique to deal with accidents. Because prompt assistance is frequently unavailable, many injuries result in fatalities. The system is divided into two phases: the first is for accident detection, and the second is for notification [21].

Outside of urban areas, multilane highways are a relatively popular form of road infrastructure in many industrialized, growing, and underdeveloped nations around the world. The median divider, a center area between the opposing lines of traffic, is often absent from these highways, with one lane of passage for traffic moving in either direction. Unless otherwise stated, overtaking is permitted, but drivers must make wise decisions and usually weigh the risk of doing so against what they perceive to be a possible opportunity. There has been an immediate correlation between driver age, attitude, frustration, vehicle type, and speed [22, 23]. Regardless of the cause, crashes always have disastrous consequences.

2.2 *Thematic taxonomy of existing accident detection techniques*

The currently used methods make use of many methods for detecting accidents. This section emphasizes the vehicle accident witnessing topic taxonomy displayed in Figure 1. Dynamic and static variations are the two most popular types. Existing methods employ a variety of sensors. Various sources of data gathering, which include VANET, 3G, 2G, and 4G/LTE. Intelligent transportation, device-to-device (D2D) [24], and the VANET cloud are some of the channels that are used for communication [25].

3. Proposed framework

Even when drivers take numerous safety precautions, accidents are bound to happen on the street. This is the most undesirable thing that may happen to drivers. The worst part is that our stumbles on the road did not result in victory. The majority of motorists are completely aware of the norms and safety precautions that apply to driving on public roads. Even though only a small percentage of road users are careless, it still leads to accidents and fatalities. Human error is primarily to blame for accidents. Preventing accidents is important because failure simply leads to mistakes or additional damage. However, from the perspective of road failures, we have overlooked this case of poor management, and we must develop a framework to develop a strategy model to lower accidents as well as the aftereffects of accidents. Contextual analysis and foundational research were necessary before work could begin, and numerous sensors that are adequate for the framework's robustness and cost-effectiveness are needed. Figure 1 shows the thematic taxonomy of current techniques for accident detection.

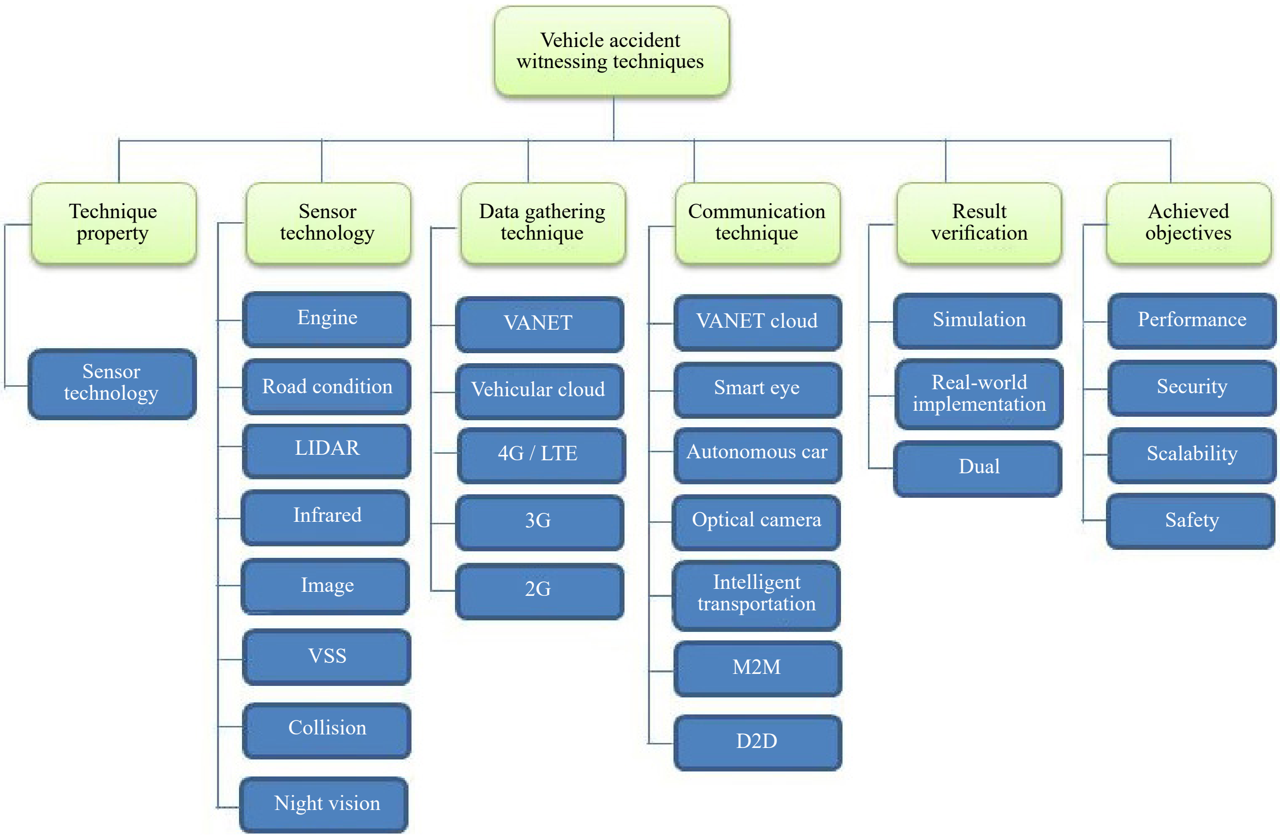

Figure 1. Thematic taxonomy of current techniques for accident detection

To access and transfer data to and from cloud servers, we created an Android application. To build the system, we used a simulation environment in a simulation program called SUMO. The following is a list of the implementation steps:

i. Figure 2 shows how each car is assigned a unique ID on a cloud server, where information on vehicle crashes is logged against each ID together with other data, such as the coordinates of the accident site.

ii. When two cars collide, a message is created. The message structure is shown in Figures 7 and 8, and this message is delivered to the VC to be sent to all of the other vehicles in the VANET.

iii. The RSU gets the collision notification in the interim and transmits it to the nearby hospital or control center. Additionally, RSU sends collision data, including coordinates and vehicle identity, to a secure cloud server.

iv. Overspeeding is detected by an accelerometer, while collisions and vehicle rolls are detected by an ultrasonic sensor. The accelerometer and ultrasonic sensor will both be connected to the online server. We will collect unintentional position coordinates and other information with the aid of RSUs and OBUs.

v. As a result, other motorists passing by the accident coordinates are alerted to the fact that an accident occurred there, and they should proceed with caution. The saved record can also be used to analyze the accident's underlying causes. The mechanism for collision detection and reporting is shown in Figure 3.

vi. When Vehicle V transmits a collision message C to a faraway Vehicle D, it is important to properly convey the data packet across the VANET, even to those remote cars.

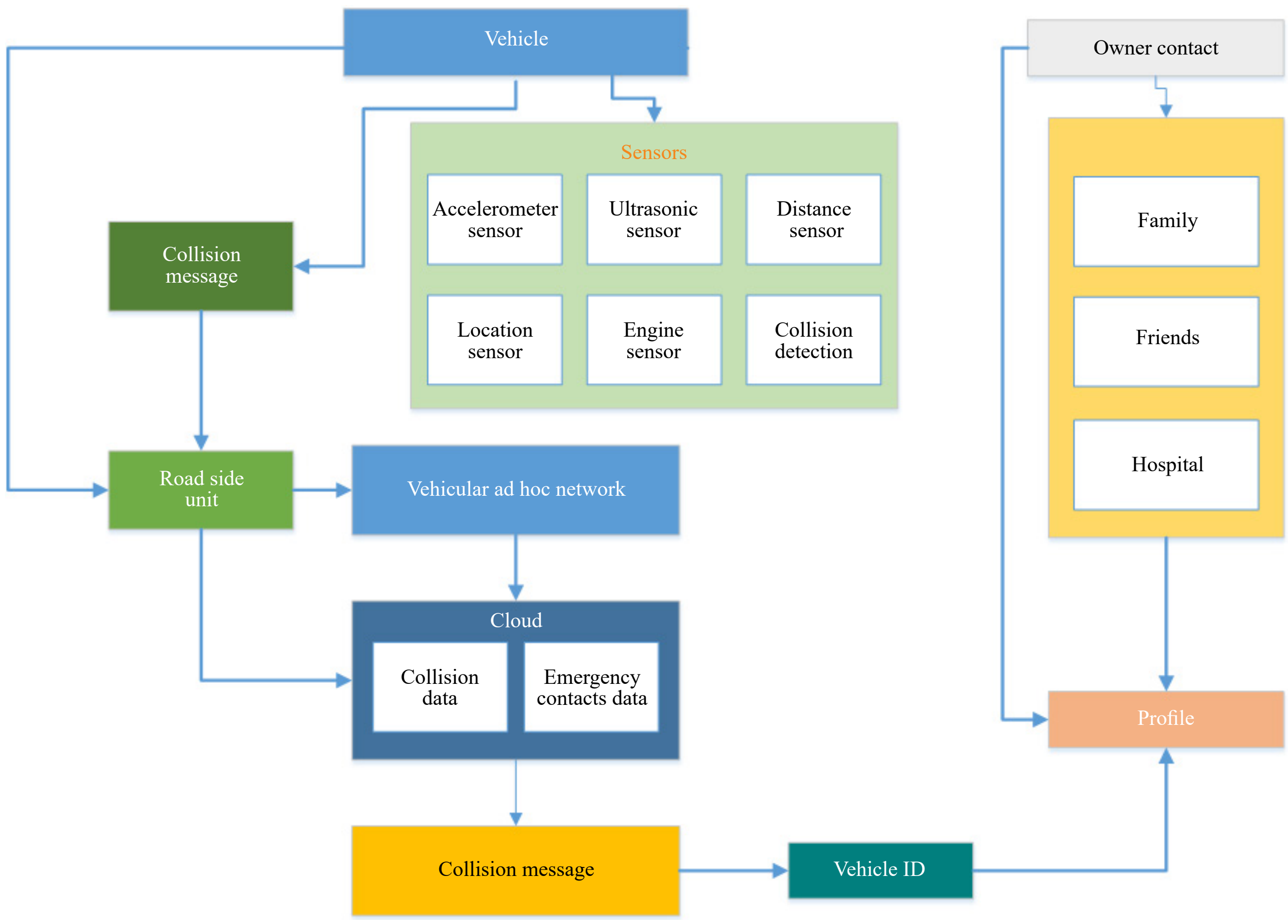

Figure 2. Research framework and working mechanism

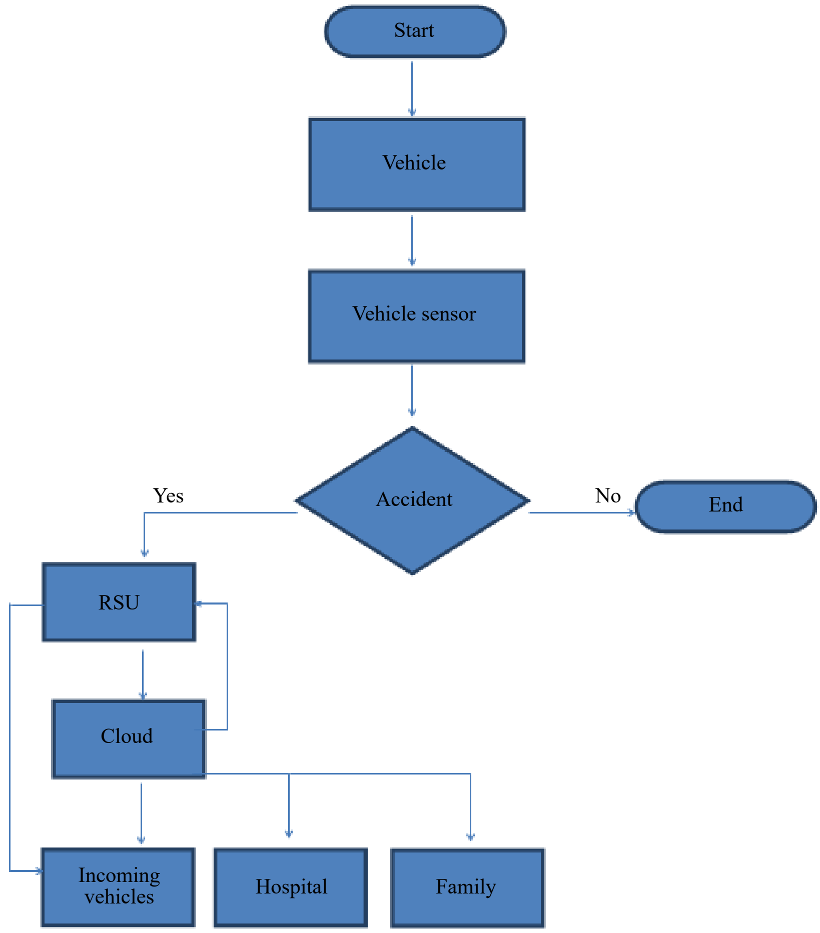

Figure 3. Process of collision detection and reporting

3.1 *Proposed network model of communication*

An VANET, which is essentially a sub-type of an ad-hoc mobile network used to ensure communications between nearby vehicles and nearby infrastructure and equipment that are commonly referred to as roadside equipment or simply RSU for communication, is included in the network model that is being proposed. VANET's main objective is to ensure your comfort and safety. An OBU, a specialized electronic gadget that has wireless connection capabilities and will enable passengers with ad hoc network connectivity, will be used for this purpose and placed inside each vehicle. Two methods of vehicle communication are produced by the aforementioned proposed communication paradigm. V2I communication involving RSUs allows for direct communication between vehicles without the interference of RSUs, while V2V communication in the form of a VC allows for direct communication between vehicles so they can obtain information directly from the RSUs. So, V2V or V2I can be used by cars to communicate with one another. In general, this system will function without base or client-server communications. Each prepared car equipped with the VANET device will serve as a hub for the specifically designated system and be able to receive and relay various communications via the distant system. The aforementioned suggested communication architecture is shown in Figure 4.

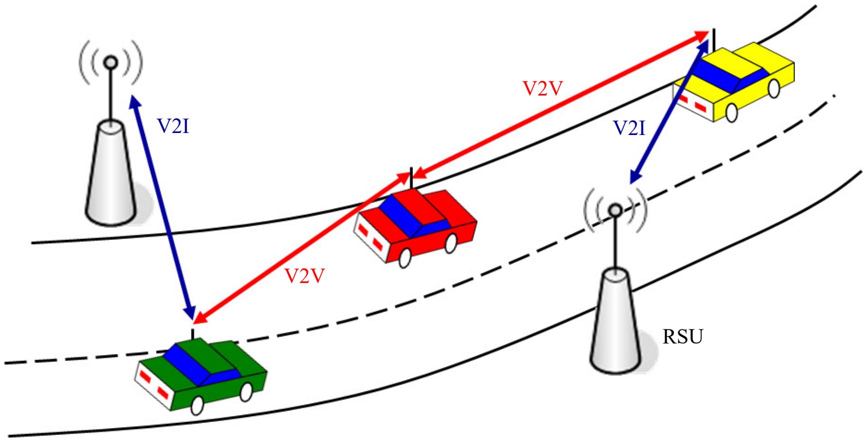

Figure 4. V2V and V2I communication

The cars will communicate with one another linked by this passing message, forming a VANET, or vehicular ad hoc cloud. As demonstrated in Figure 5, even though a vehicle is far from the VANET, it may still interact with other cars utilizing RSU. After connecting to RSU, it will receive alert messages from RSU. In order to increase efficiency, it is proposed that cars have both direct and indirect communication channels.

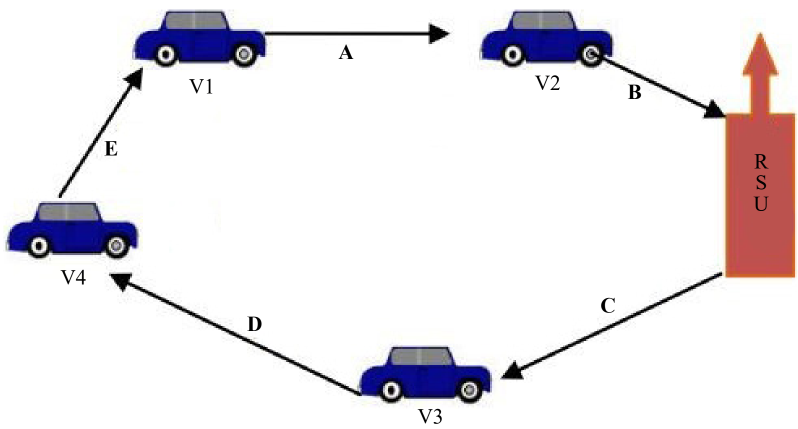

Figure 5. Packet moving across vehicles and RSU

To ensure message propagation to the greatest number of vehicles, the proposed method of communication combines V2V and V2I. With the use of roadside infrastructure, vehicles can immediately connect, or the farthest vehicle may communicate with other vehicles while utilizing the multi-hop property.

4. Implementation and results evaluation

In this section, we analyzed the prototype system's simulation-based results and presented them. We also provided a quick overview of the main evaluation strategy used to support the suggested system. Additionally, we demonstrated the simulation of the suggested methodology using the SUMO simulation of urban transportation. For real-time evaluation, we have created an Android application.

4.1 *Algorithms for transmission of accidental information*

Due to the two distinct communication scenarios that are adhered to here, we must effectively route the unintentional collision message over the VANET. Here, the first scenario is one in which the transmitter and receiver are at a great distance apart, and the second scenario is one in which they are quite close to one another. When Vehicle V transmits a collision message C to a faraway Vehicle D, it is important to properly convey the data packet across the VANET, even to those remote cars.

For the challenges listed below, there are provided algorithms.

i. Vehicle-to-RSU dispatch algorithm packet P (input) layout
ii. Data packet delivery algorithm from an RSU to a vehicle
iii. An RSU and a vehicle data packet delivery algorithm to a neighbour

4.1.1 *Algorithm for layout for dispatch of packet P (input) from a vehicle to an RSU*

An algorithm is provided for the purpose of developing a way to send an accidental message containing coordinates of an accidental location to a roadside unit so that this may be stored on the cloud server for upcoming transmission.

A packet P created by the vehicle and meant to be transmitted to the roadside unit for that purpose immediately continues and is delivered end-to-end if R is within the defined range. If it is outside of the permitted range, the source vehicle investigates all possible paths to the R. And after reaching its neighbors, the message keeps moving till it reaches the RSU. Each automobile has a unique ID that is stored on a cloud server, as was already mentioned. Each vehicle's ID is used to identify it and to send communications.

Before sending the message to the next car, which then transmits it to the following vehicle in the chain, and so on, until the message is relayed to the RSU, the transmitting vehicle first forms the communication chain with its surrounding vehicles, K. The communication may also be easily sent between cars and from that RSU to the cloud server.

Algorithm 1. Algorithm for layout for dispatch of packet P (input) from a vehicle to an RSU

```
Result: Transmission of Packet(P) from Vehicle S to RSU(Destination)
Vehicle S (Source);
RSU R (Destination);
Packet P (Collision Message);
if R is within S range then
   S sends directly to R;
   Go to end;
else
   S defines total path between itself and R;
   S determined the set of Sn of neighbours that are nearer from it to
      R;
   if Sn = 0 then
        Go to delay routine;
   else
        S sends P to K neighbours in Sn;
        S drops P;
   end
end
```

4.1.2 *Algorithm for the deliverance of a data packet from an RSU to a vehicle*

The technique below shows an optimal method for transmitting a data packet from the RSU to other vehicles. We chose to send packet P to approaching vehicles, who then kept the list L, which contains numerous properties such as the vehicle's coordinates, speed information, direction, and timestamp. This is how we opted to convey packet P from RSU R to vehicle S. Before being transferred to the RSU, these packets are shared back and forth between the surrounding automobiles. The purpose of sending those packets to the RSU is to enable communication between cars that are remote from one another and the speedy receipt of collision notification alerts. The roadside infrastructure R's integrated communication infrastructure also enables the storage of the collision message. These packets are sluggishly moving between the cars and the RSU.

As an alternative, a packet P may occasionally be sent from an RSU R to a target location, in this case, a vehicle. The message is sent to the neighbouring cars to the RSU. Each vehicle has a unique vehicle ID, which is also kept with the message. The key is sent in this way after being matched to each vehicle ID. The transmission from R is received by the nearby automobiles in that particular domain, K. Due to the relatively small size of these communication packets, the network does not suffer from any additional bandwidth loss.

Algorithm 2. Algorithm for the deliverance of a data packet from an RSU to a vehicle

Result: Deliverance of a data packet from an RSU to a vehicle
Vehicle S (Destination);
RSU R (Source);
Packet P (Collision Message);
while *START condition* **do**
  instructions;
  Stepl. R calculates the estimated distance travelled by D from the instance it sent its last until it receives P
  Step2. R determines estimated location of D at the time it receives P
    Step2.1. R determines whether the location should be calculated using CASEl or CASE2
    Step2.2. R calculates the center and radius of the estimated area (Ag)
    Step2.3. R adds the center and radius of Ag to P
  Step3. R sends to K vehicles
    Step3.1. R determines the best candidate roads
    Step3.2. R forwards P to the farthest K vehicles moving on the candidate on the candidate roads
end

4.1.3 *Algorithm for deliverance of a data packet from an RSU and vehicle to neighbor*

Routes are not set in stone. By automatically transferring messages to the closest vehicle node, as well as to other vehicles and RSU, this device speeds up message transport. Therefore, packets are sent to the closest nearby cars, from which point they identify the next closest node. This process continues until the message is delivered to the intended recipients. However, because of their extremely small size, these message packets do not use network bandwidth. For instance, there is a vehicle that needs to send a message to the RSU, and in order to do so, it uses a coordinate sensor to determine the quickest route from its current location. The distance from its current location is then calculated by adding together the distances of all the on-road approaching cars.

This procedure continues until the RSU transmits the packet to the vehicle. When Vehicle V receives a packet P, it first checks to see if D is its next neighbor; if so, it transmits the packet to D. Otherwise, it is broadcast to all of their nearby neighbors inside their community.

Algorithm 3. Algorithm for deliverance of a data packet from an RSU and vehicle to neighbor

```
RSU R (SOURCE);
Packet P (INPUT);
vehicle D(Destination);
vehicle N (Intermediate vehicle carrying P);
while START condition do
    instructions;
  Stepl. if(D is a neighbor of N)
    Stepl.l. N sends P directly to D
    Step1.2. Go to end
  Step2. N updates the estimated area(Ag)
  Step3. if (N has one or more neighbor within Ag)
    Step3.1. N sends P to these neighbors.
    Step3.2. N drops P
  Step4. if (D is neighbor of N)
    Step4.1. N send P directly to D
    Step4.2. Go to end
    Step4.3. ELSE
      Step4.3.1. if(N has one or more neighbors)
      Step4.3.2. N broadcast P to all its neighbors else N stores P to queue
end
```

4.2 *Simulation environment*

The machine on which the simulation environment was created and tested contained an i5 7th generation microprocessor core, with 8 GB RAM and 256 GB hard disk. We employed SUMO, an open-source simulation program, for the simulation process. It can be used to easily imitate network traffic. OpenStreetMap (OSM) is a free, editable, open source map of the world for use by the general public. Users can easily import or export the necessary maps from OpenStreetMap. It has more than 2 million registered users, and these people gather information on GPS and other free resources regarding travel and places [25]. Figure 6 displays the main Kashmir Highway in the OSM-downloaded version of Pakistan's capital city.

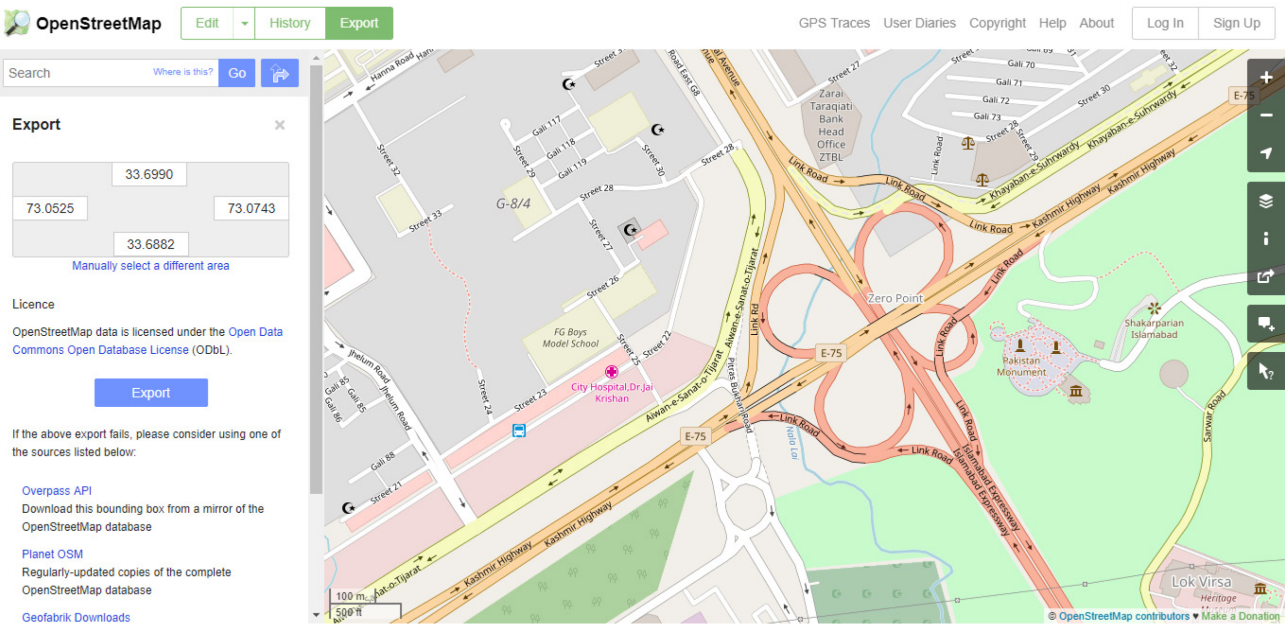

Figure 6. Kashmir highway OpenStreetMap of Islamabad, Pakistan

4.3 *Simulation environment*

i. The SUMO tool is used to simulate the proposed technique. Following the download of an OpenStreetMap of Islamabad, traffic is produced.

ii. Along with the completely accessible traffic, a tiny portion of the automobiles also have the capability to spread messages for simulations.

iii. SUMO will produce an output trace in the form of an .xml file that contains information about coordinates, a message about a vehicle accident, and other things.

iv. Figure 8 displays the output of the simulation, which is an XML file including coordinates and other data.

v. Reduce the size of the message by supplying information from the SUMO in the form of Extensible Markup Language, which is then delivered to the RSU's and again communicated to the cloud, the hospital, other cars, and friends (family, coworkers, and relatives). Figure 7 depicts a collision between two vehicles.

vi. A collision message and an XML trace are sent to a cloud storage system for distribution to the intended location.

vii. Figure 8 displays the data produced by various sets of vehicles.

viii. Data is transmitted to the cloud storage approximately every 3-5 seconds.

ix. Using the OpenStreetMap's V2V communication architecture, this data is sent to the other vehicles.

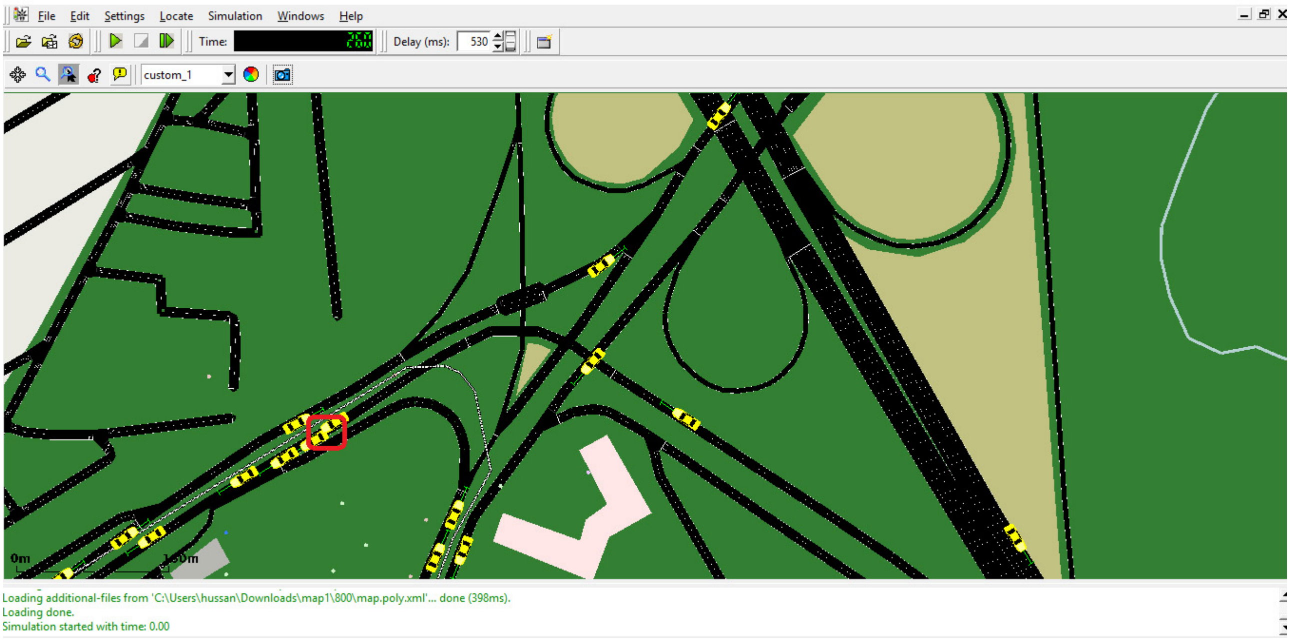

Figure 7. Vehicle collision simulation

Time	ID	x	Y	Angle	Type	Speed	POS	Lane	Slope
0	0	5391.23	6518.36	239.64	DEFAULT_VEHTYPE	0	5.1	477974809#0_0	0
1	0	5389.99	6518.36	239.64	DEFAULT_VEHTYPE	1.44	6.54	237974098#0_0	0
1	1	7648.8	5160.16	56.43	DEFAULT_VEHTYPE	0	5.1	889186809#0_0	0
2	0	5386.55	4696.62	239.64	DEFAULT_VEHTYPE	3.98	10.52	237974098#0_0	0
2	1	7650.19	64696.74	328.97	DEFAULT_VEHTYPE	1.67	6.77	24313309#0_0	0
2	2	5776.66	5165.65	239.64	DEFAULT_VEHTYPE	0	5.1	477974098#0_0	0
3	0	5381.53	4700.54	56.43	DEFAULT_VEHTYPE	5.82	16.43	488918648#0_0	0
3	1	5673.22	5688.71	56.43	DEFAULT_VEHTYPE	3.63	10.42	363274098#0_0	0
3	2	5775.35	7553.62	239.78	DEFAULT_VEHTYPE	2.54	7.64	88916865#0_0	0
3	3	5134.7	6497.47	328.97	DEFAULT_VEHTYPE	0	5.1	20901853#0_0	0
4	0	5374.54	6518.36	149.45	DEFAULT_VEHTYPE	8.09	24.43	23489532#0_0	0
4	1	7657.61	6518.36	59.57	DEFAULT_VEHTYPE	5.27	15.68	23489539#0_0	0
4	2	5773.06	6518.36	263.6	DEFAULT_VEHTYPE	4.43	12.08	88918541#0_0	0
4	3	5133.31	6518.36	239.86	DEFAULT_VEHTYPE	1.63	6.73	57974098#0_0	0
4	0	5796.63	6518.36	149.35	DEFAULT_VEHTYPE	0	5.1	904404809#0_0	0
5	1	5366.05	6518.36	263.6	DEFAULT_VEHTYPE	9.82	34.52	49848098#0_0	0
5	2	7664.55	6518.36	62.93	DEFAULT_VEHTYPE	7.86	23.54	12387623#0_0	0
5	3	5130.9	6518.36	238.75	DEFAULT_VEHTYPE	6.43	18.51	90000123#0_0	0
5	4	7673.31	6518.36	56.43	DEFAULT_VEHTYPE	3.64	10.37	23987632#0_0	0
5	5	2312.22	6518.36	149.45	DEFAULT_VEHTYPE	1.86	6.96	34223665#0_0	0
5	0	9081.43	6518.36	238.75	DEFAULT_VEHTYPE	0	5.1	124431124#0_0	0
6	1	5355.38	6518.36	238.97	DEFAULT_VEHTYPE	12.34	46.59	96495867#0_0	0
6	2	6362.92	6518.36	328.97	DEFAULT_VEHTYPE	10.12	33.66	54586863#0_0	0
6	3	5125.21	6518.36	238.75	DEFAULT_VEHTYPE	7.89	26.4	66534593#0_0	0
6	0	6497.24	6518.36	45.66	DEFAULT_VEHTYPE	5.83	16.2	78657443#0_0	0

Figure 8. Output from SUMO in the form of XML

4.4 *Results of simulation*

We have taken into account factors like data storage and message transmission reaction time to the cloud and to other vehicles in the OpenStreetMap in order to evaluate the findings.

4.4.1 *Data storage and response time*

Figure 9 shows how long it takes for a message to go through the cloud and how long it takes for the cloud server to respond. Additionally, it displays how long it takes for vehicles to transmit and receive what is known as a response from the cloud.

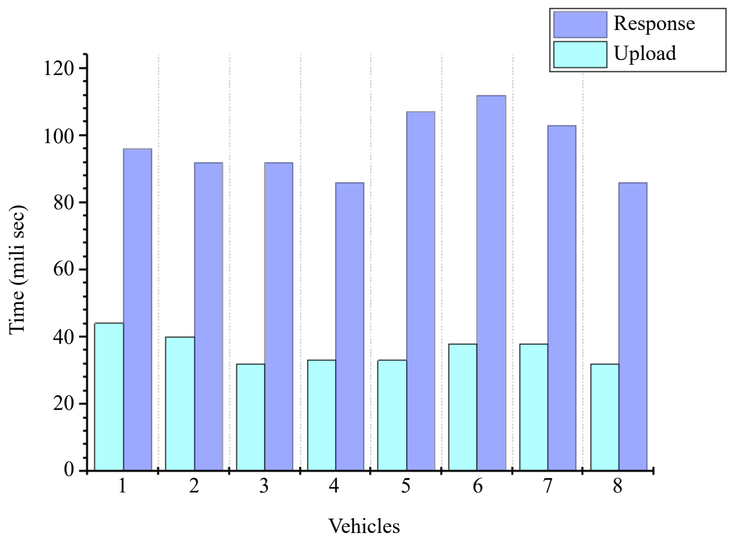

Figure 9. Message response and upload time graph

4.4.2 *Average response and data upload time*

The milisecond (ms) is used to represent the typical reaction time for data uploading to or downloading from the cloud. Figure 10 shows a trend over time for the Firebase.

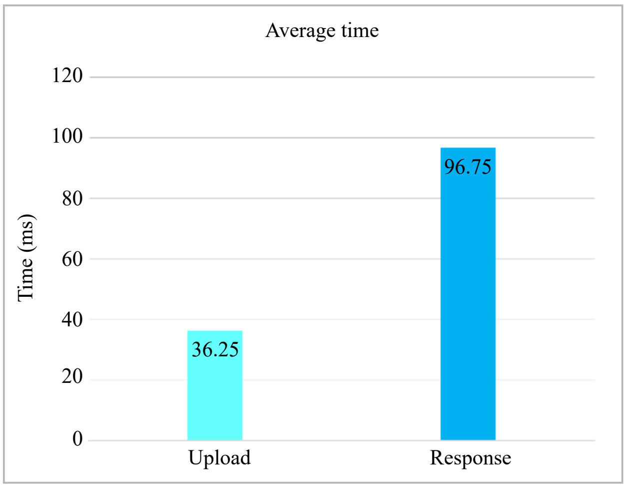

Figure 10. Depiction of average response and data upload time

4.5 *Real-world implementation*

We created an Android app for real-world implementation and evaluation; it will be mounted over the RSUs. It will get erroneous coordinates and send them to the cloud database. The cloud database will then share this erroneous message with approaching vehicles, hospitals, and friends. It should be mentioned that since Google Firebase is the fastest real-time No-SQL database server, we will be using it as our cloud database. In the cloud database, each car will have a unique identification. Additionally, every record will be kept to be used in statistics and analysis in the future. Figure 11 depicts the created Android app.

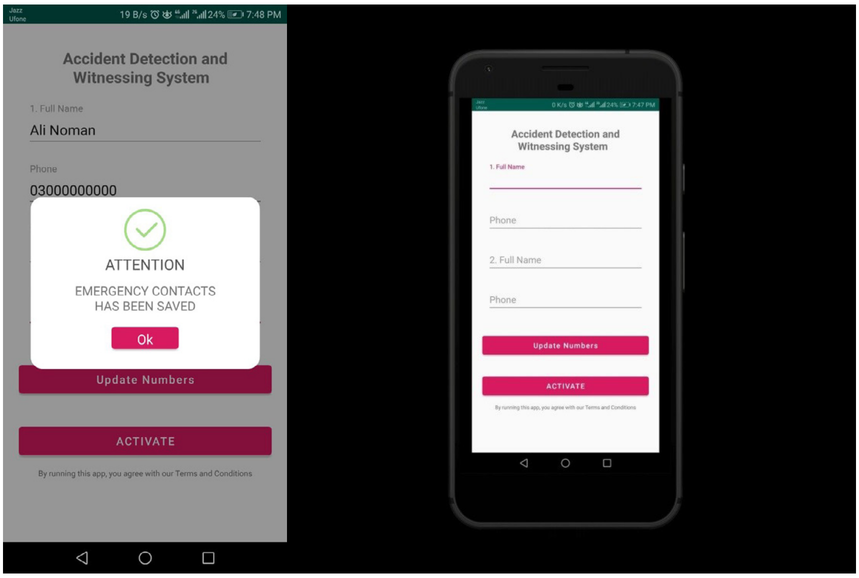

Figure 11. Accident detection system

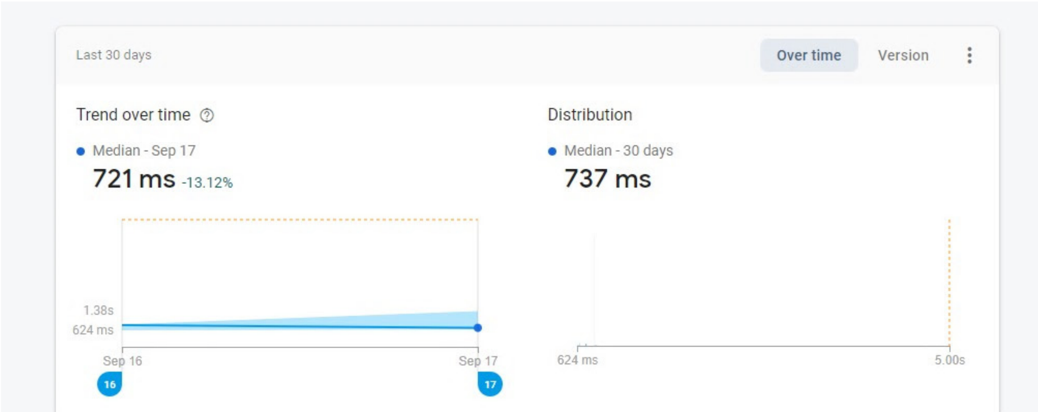

Figure 12. Depicts the trend over time from the Firebase

5. Conclusion

By fitting automobiles with network connections, technological advancements have assisted science and technology in making them smarter and more intelligent. The internet is a global village with its own culture and infrastructure. Traffic management becomes a critical problem that needs to be tackled as soon as more technologies, like vehicles, are integrated into this global community. IoV significantly enhances vehicle communication and safety. The proposed methodology can be used to convert the detected accident into the format of a message and encode it to reduce its size. It can be used to transmit the encoded message to the network of vehicles, friends, and hospitals.

The message is sent to RSUs that have an Android application which transmits data to the cloud, friends, and hospitals. Message transmission across the network of vehicles can be made directly or indirectly with the help of the RSUs, which act as mediator. The proposed system uses the machine on which the simulation environment was created and tested, which contains the core i5 7th generation microprocessor, 8 GB of RAM, and a 256 GB hard disk. The SUMO tool is used for the simulation of the environment. This method would undoubtedly pave a significant way in the field of automotive internet. Vehicle collisions can be significantly reduced. Car accidents may be easily tracked thanks to the network's ability to automatically gather and transmit data about them.

6. Limitations of the research

The study's focus is on accident prevention as well as exchanging accident data among a network of cars, including car owners' acquaintances and hospitals. Vehicle motor departments can use this saved data to track accident-prone cars and analyze the data set of these collisions in order to better formulate policies to prevent future collisions by better understanding the causes and consequences of accidents. However, it also has significant drawbacks, one of which is that it is unable to record accidents as they happen in real-time.

7. Future work

In the future, it may be possible to place a real-time accident camera on the RSUs, which would enable users to more thoroughly and precisely analyze accidents by recording them as they happen in real-time. For better functioning and accuracy, more sensors can be added.

Conflict of interest

The authors declare that they have no conflicts of interest.

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