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Health Perspective Of Emergency Accident Evacuation System: A Cloud, Iot, And Mobile Based Conceptual Framework

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Abstract — Road accidents have been touching the alarming level due to the rapid growth of world population, life in congested city area and equally the usage of motor vehicles around the globe.According to the World Health Organization, around 1.35 billion deaths are being reported annually due to road accidents, where the most of the deaths happen in the urban areas due to poor infrastructure where the emergency evacuation services can not be carriedout appropriately. An emergency evacuation plan must have an exact route without traffic, available services from a nearby hospital, emergency services during the evacuation process, and on-time services.This study introduces an emergency services layer on top of accident avoidance layer which was proposed in our previous study.Pulse and heart rate of the human being enters the cloud via a wireless sensor network. Wireless nodes and poles are used to transfer the data to the cloud. An aggregator node collects all data and sends it to the clouds. A Data Lake acts as a cloud server, and petabytes of data from the vehicles will store in the data lake. The data lake supports all the data from websites, IoT devices and mobile applications. According to the severity of the accident, the data lake will be notified. If the case is falling minor injuries the driver will be notified to consult a doctor. If the case is major then the data lake sends notification to emergency response service to find the shortest path to reach hospital; traffic system to clear shortest path traffic route; available doctors nearby hospital to study the patient's history and when the patient is reached, then to start the treatment; and hospital system to inform the nearest police station. The health information data is very crusial part and the health information must be protected multi security layer.When the proposed solution is implemented with our previous study's accident avoidance layer, the complete system delivers the best protection to human lives.

Key words: data lake, new sql, wireless sensor network, short path algorithm, health info

1. INTRODUCTION

Traffic problems and accidents are becoming the most critical problems with an ever-growing number of people and vehicles in a busy city.People in the current era do not like to travel with slow-motion vehicles, and they like to travel quickly with fast-paced times. Busy and fast-moving schedules made people do everything quicker.

The most unexpected thing to happen to a road user is a road accident, although they occur very frequently. Road accidents happen due to many reasons. High speed, disturbance while

driving, avoiding safety measures, population, and vehicle crowding are identified as valid reasons for significant accidents. Fatalities, injuries, and destruction are the main consequences of accidents. World Health Organization (WHO) stated that 1.35 billion deaths are reported yearly by road accidents. Furthermore, it stated that emerging countries' death rates are very high compared with developed countries[1].

Accidents cause many issues. Sometimes it takes human lives from us. However, reaching the hospital on time helps to protect human lives from danger. Most of the time, we could hear a phrase from doctors that "If they reach the hospital a little bit early, we could save a life". Unfortunately, urban town infrastructure not appropriate for emergency evacuation services, and it must improve with proper techniques. This situation must be handle with a better system, which must work as smart and intelligent based on the type of accident or incident.

Nowadays, machine learning techniques with a cloud platform provides massive services to users. Recently the medical sector used machine learning techniques for many purposes. Forecast and manage outbreak infections [2], find new medicine and pharmaceuticals[3] and predict deaths [4] are a few examples. Different machine learning model with a cloud environment provides its best services to the different domains. In an emergency evacuation system, the system must not overreact meanwhile must not be underreacted. For example, when the user gets a minor injury, there is no need for emergency services. However, if it is an impactable incident, they need to focus on emergency services. In that respect, works with machine learning and cloud platform, always perfect and best solutions in current trends—besides, mobile services connected with those services robust the system in technological site.

The emergency evacuation process must have an exact route without traffic, available services from a nearby hospital, emergency services during the evacuation process, and on-time services. This study aims to provide all services with the help of mobile, cloud, and machine learning environment as a concept.

2. LITERATURE REVIEW

Abdullahi Chowdhury[5]proposed a system regarding the emergency vehicle to minimize injuries. This study entirely focused on IoT and traffic control systems. Whenever any accident happens, it will inform the Emergency control room, which passes the emergency codes to the central traffic control (CTC). CTC transfer the messages to the traffic signal and emergency vehicle; hence, emergency vehicles follow the traffic route from a traffic signal to an emergency evacuation. Bilal Khalid Dar et al. [6]proposed a system with simulation regarding accident detection and avoidance. This system is divided into two layers, namely, the layer of collision avoidance and the emergency response. The collision avoidance layer identifies the accidents and delivers the alarm based on the violations. In comparison, the emergency response layer provides emergency evacuation services to minimize human lives' effects. The backbone of the emergency layer is a smartphone. An android phone needs to carry out by the driver for this layer. GPS of the driver pointed out by the smartphone. It will share with the hospital, emergency vehicle, and family members if in case of emergency. When the drivers get into an accident, this protocol helps to do an evacuation as soon as they collied. Fog computing helps to store all necessary data into the cloud database and servers.

As several studies have pointed out, it is imperative to consider the route, the individuals, and the resources during the emergency rescue operation. If they fail, all the effort would be

pointless[6]–[8].F. Montori et al. [9]stated that data is a crucial factor of any emergency response system. Data will deliver from the human, vehicle, and other materials used in the system. Therefore the collector of all data in the central device must be robust. If the data obtained process failed, the system would fail. In conclusion, they have suggested IoT as a central device to collect data. Harish Kumar N and Dr. Deepak G [10]developed a system for accident detection and emergency evacuation with IoT technique. In this system, Raspberry pi act as a central device. When it identifies the accidents, it notifies the hospital and emergency ambulance services. Based on the traffic control system, evacuation will be done expeditious manner.The location of the system will share from the specific android app developed for this system.Arif Shaik et al. [11]proposed a smart car system to detect and avoid accidents. The microcontroller governs the system to detect the accidents. Whenever an accident happens, data will pass to the cloud server. From the cloud, necessary information and notifications will be shared with ambulance service, hospital, and family members. Data will pass the cloud by the Wi-Fi module placed in the microcontroller.

A. John and P. R. Nishanth [12] proposed a system to reduce the accident's injuries. The user of this system needs to wear a device given by the hospital. The device monitors the body condition of the user in real-time. Whenever an accident happens, body conditions vary. The hospital sends the ambulance to emergency evacuations—this system not only for an accident but also for some unwilling patients. Yeong-Lin Lai et al. [13]developed an emergency ambulance service to minimize the accidents' injuries. RFID plays a crucial role in this system. When an accident happens, a notification will send to the ambulance services. Based on the GPS location of the incident ambulance is moving on. RFID transceiver placed in the top of the ambulance notifies whether an emergency vehicle is coming. The road poles place with an RFID reader, which reads the notification and information to the traffic lights. Based on the notification, the traffic signal blocks other vehicles and give priority to the emergency vehicle. The evacuation process will happen quickly, and it will reduce the danger of human life considerably. D. Deva Hema et al.[14] developed a system to avoid accidents and provide emergency services. In this system, the microcontroller act as a hub. Whenever an accident happens, the microcontroller informs the GPS location to the physical database via the GSM module. The database then sends notifications to the hospital, emergency services, and emergency contact. From that, evacuation happens as soon as the rescue team reaches the spot.

3. METHODOLOGY

This study aims to propose a conceptual solutionfor emergency evacuation services. This study is an extensive solution to previous studies of "Cloud, IoT and Mobile based conceptual framework on accident avoidance system"published in "*Journal of Solid State Technology, volume 63 issues 06*". We have a layer in a previous study is called the "accident avoidance layer". In addition to that, this study is proposed that a new layer is called the "Emergency services layer"—the accident avoidance layer deal with the preventions of unnecessary accidents. In comparison,the emergency services layer provides immediate care to someone who gets an injury from anaccident avoidance security breach.

Emergency services layer

Accident Avoidance Layer[15]mostly helps drivers to prevent accidents through all techniques and technology in several ways. If any accident happens other than in the way of accident avoidance layer, as a complete system, prompt and required response is vital to the saving of human life. This layer entirely focuses on those aspects.

Whenever any accident happens, the Emergency services layer identifies that with the help of pulse and heart rate of the human by placed in the RFID reader as a wearable device and SparkFun sensor, respectively. The pulse and heart rate of the human being enters the cloud via a wireless sensor network. Wireless nodes and poles are used to transfer the data to the cloud. RFID reader initially reads the plus of the human by place in the RFID tag as a wearable device and transfer it to the pole via wireless nodes placed everywhere. Which lately transfers the cloud via 4G or 5G network. An aggregator node collects all data and sends it to the clouds. Heart rate reading also following the same structure. Figure 1 shows the way of data transfer from the vehicle to a cloud environment.

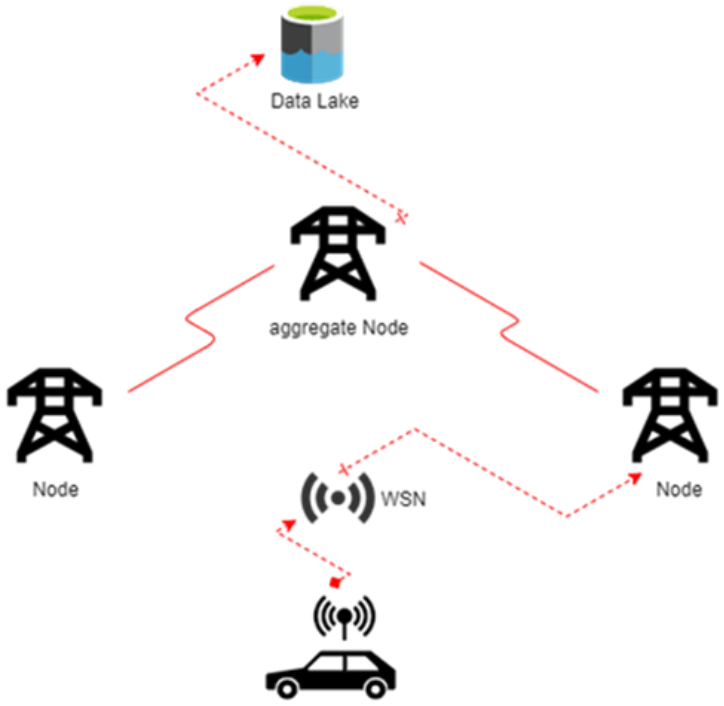

Figure 1:Data transfer from vehicle to cloud Data Lake via WSN

Here a Data Lake acts as a cloud server, and petabytes of data from the vehicles will store in the data lake in a cloud environment. The data lake is a perfect solution when compared with the data warehouse. Because data warehouse only dealing with a relational database but the data lake supports both relational and non-relational databases. Additionally, the data lake is faster and cheap compared with a data warehouse. The data lake supports all the data from websites, IoT devices, mobile applications, and social networking.

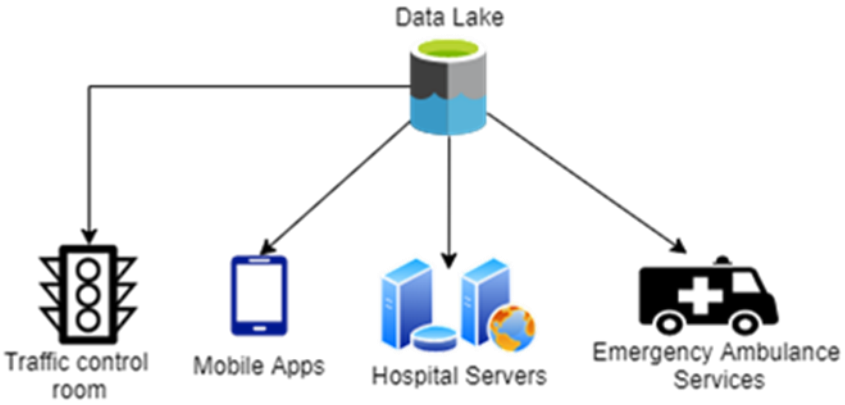

Figure 2 Sharing the emergency data to different domains

When the system obtains data to the data lake, it could be shared among responsible domains, includinga nearby hospital server, an available doctor at the time, a traffic control room, and nearby available emergency ambulance services. One essential and fascinating fact about the data lake is that data scientists are usually involved in this field and are using machine learning techniques to foresee the future. Thus, based on the machine learning model, when data scientists train data from the data lake, the data lake will warn the appropriate services based on priority. If the accident is a small issue, there is no need to submit excessive resources. So the data lake helps to do it by the data scientist.

When the data lake delivers an alert to the available doctor, the doctor will read the patient's history from the hospital server's data or the android app before the emergency response reaches the hospital. Patient name, age, history can be acquired from the RFID tag placed as a wearable device.

When nearby emergency ambulance services and traffic control room obtain the warning from the data lake, ambulance services identify the short path to reach the spot. The traffic control room identifies the accident spot and ambulance spot and clears the traffic route by control the traffic lights. This technique utilizes the GPS location of both the ambulance and the vehicle to bypass the traffic. This traffic control unit often uses the same short-distance approaches to determine the path to clear the traffic.There is also no hurdle to the emergency team to rescue patients, and evacuation takes place smoothly, ensuring saving people from risk.

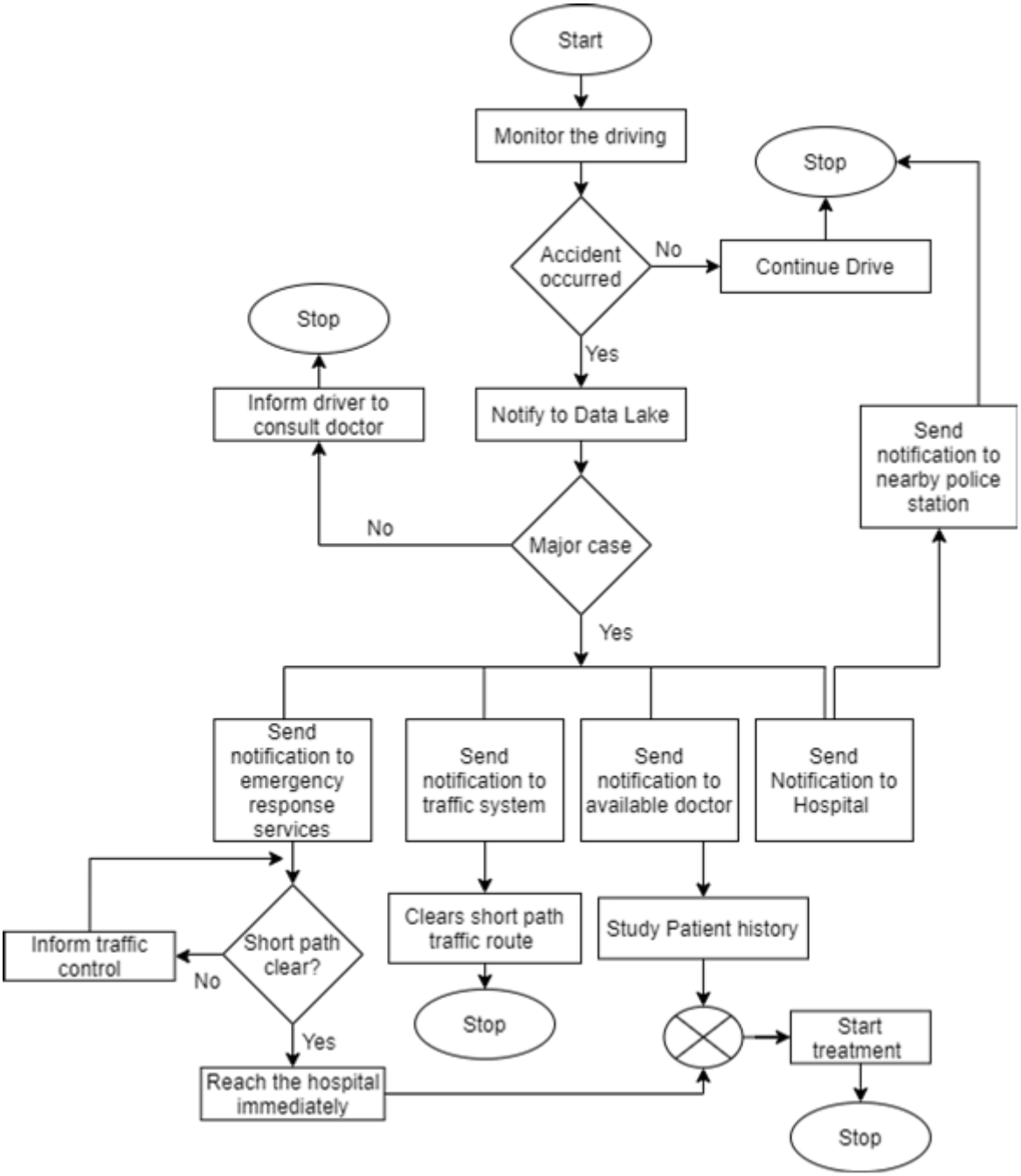

Figure 3: Flowchart of emergency evacuation layer

4. RESULT AND DISCUSSION

System components and applications

A. Wireless sensor network (WSN)

WSN is a way to track and respond to changes in the environment with the assistance of sensor nodes. Sensor nodes play a significant role in WSN. Memories, power source, Radiofrequency transceiver and receiver, controller, and sensors are the main components of a sensor node. Usually, the sensor nodes are made up of a microcontroller, and the necessary sensors are connected to the controller. Enabled sensors track the surroundings and store data

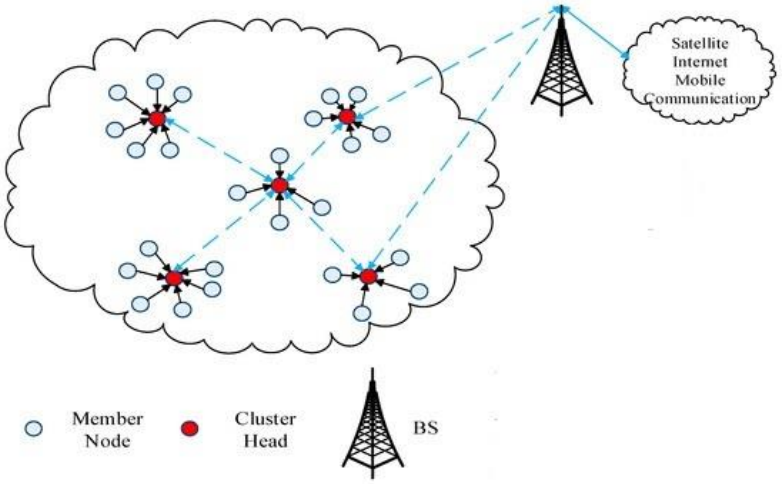

Figure 4: WSN Technology [98]

in the sd card. The RF transceiver transmits the stored data to the next sensor node. The next node collects data from the previous one using the RF receiver technology. This pattern continued until the data is processed in the cloud data lake. Data transfer from one node to another using 4G or 5G technology[16]–[18].

From figure 4, we can identify that the sensor node passes the data to another node and which passes the data to the cloud via the Base station. This process is called the "Wireless sensor network".

B. Data Lake

Data Lake is a compendium that maintains organize and unstructured data in a cloud background. It can store the data at any scale[19], [20]. The data coming from the vehicle in this system are very high due to the extensive volume of available vehicles. Hence we need a solution in a scalable and manageable manner. So the only better solution in the current era is a Data lake. The famous and identified data lakes are Hadoop, Kafka, and Azure data lake. After the data is processed in the data lake, it will be exchanged to the data warehouse and Firestorefor further progress. In the data lake, all data will be cleaned and trained with a proper machine learning model to identify the critical objectives. In the accident system, the system must understand whether the accident is severe or typical for emergency response. If the accident is a typical type, there is no need for emergency services. The necessary model will train this based on the pulse, heart rate, and image coming from the RFID reader, SparkFun, and camera module, respectively.

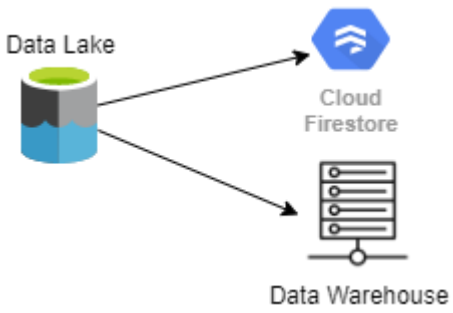

Figure 5: Data lake, warehouse and firestore

C. Data warehouse

Data warehouses allow users to make queries or analysis the structure of the data. Famous data warehouse tools are; Google Big Query[21]–[23], Amazon Redshift[24]–[26], and Amazon Athena[27]. In this system, All trained data from the data lake will pass to the data warehouse via Google Big Query for the decision-making process[28]–[30]. The data warehouse also a repository where it uses for making a final decision based on the system. Here all the information regarding the accident will send to the data warehouse for immediate response.

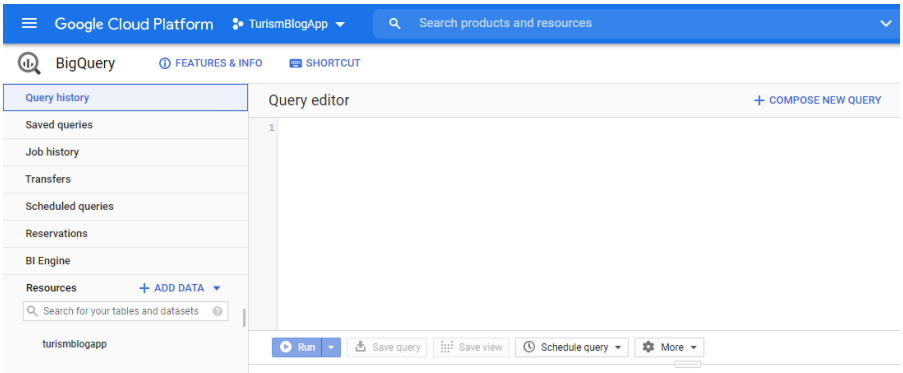

Figure 6: Google Big Query Interface

Figure 6 and 7 shows the sample interface of loaded accident data of Google big query. Based on the necessary data, the system analyst can set the queries and obtain the data for necessary areas. Once the query is done, the information will send to the mobile app, emergency ambulance services, traffic system, and hospital server.

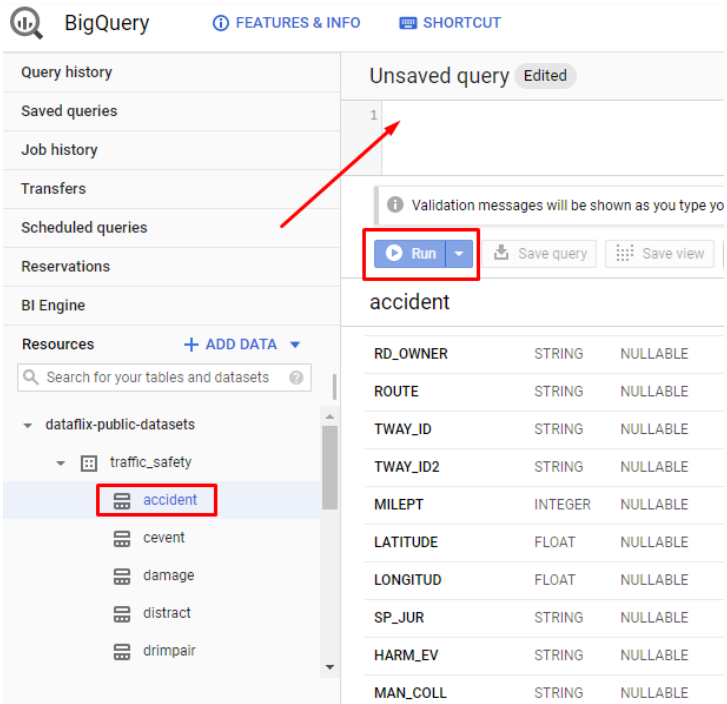

Figure 7: Query interface with accident data

D. Short path Algorithm and ambulance services

When the required data hit the emergency services, the ambulance and the transport system must pursue the shortest route for rapid response. Hence the system must follow a short path algorithm to obtain that services. This study proposed an existing short path algorithm called the "Dijkstra" algorithm[31], [32]. Consider figure 8 below.

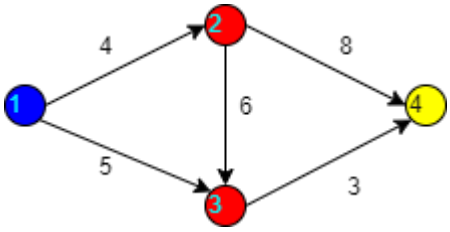

Figure 8: Dijkstra example

Blue – Start Node, Yellow – End node, Red – Other nodes, Numbers – weights

Let us consider the possibilities of the path and the weight,

Table 01. Dijkstra possible paths

Routes	**Distance**
1-2-4	12 (4+8)
1-2-3-4	13 (4+6+3)
1-3-4	8 (5+3)

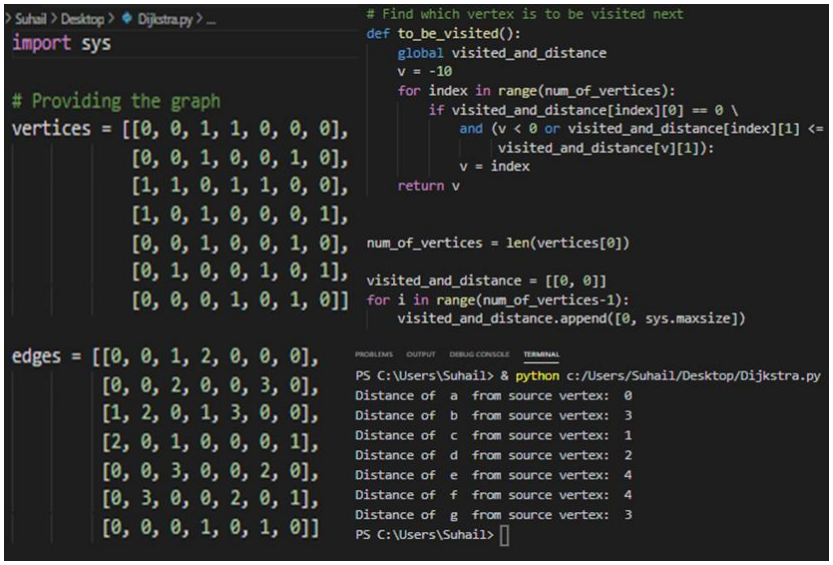

Figure 9: Sample python code for Dijkstra and output

Figure 10: Emergency services of ambulance

The shortest path is 1-3-4, and this is how a Dijkstra algorithm works.

Figure 10 shows all necessary equipment and services which must be taken in the evacuationprocess. There isa high possibility for patients who died during the evacuation process due to human mistakes. So it is the responsibility of persons who are doing the evacuation process.

E. Hospital server (NewSql)

There are several data stored on the hospital server, such as routine patient information, staff details, medical records, instruments, and so much more. The vehicle owner's data is continuously uploaded; hence, we need a server containing high scalable storage space with accurate and reliable transactions. Mysql database server typically deals with the relational form, and this database guarantees transactions through the provision of "acid" properties, although it does not have scalable data storage. While NoSqllittle bit unorganized, it allows us to store information on distributed databases, which means when data get bigger, we can have a NoSql database on different machines. Hence it scales up with our data; it still misses the reliable transaction. Newsql databases like vault DB, Cockroach DB are having the distributed nature of NoSql databases; thus, we can scale up and have some guarantees of a relational database. So the Newsql is the best option for the hospital database even when it new[33]–[44].

```
> CREATE TABLE animals (id INT PRIMARY KEY DEFAULT unique_rowid(), name STRING);
> INSERT INTO animals (name) VALUES ('bobcat'), ('🦡'), ('barn owl');

> SELECT * FROM animals;
```

id	name
148899952591994881	bobcat
148899952592060417	🦡
148899952592093185	barn owl

Figure 11: Sample CockroachDBcode and the output

When looking at the sample code in figure 11, we can observe and can be identified that it is very similar to the relational databases. Working with Newsql is more comfortable. It provides high flexibility to the accident system rather than working with Mysql and Nosql individually.

When the data reach the server, it will send the notification to the police station. Typically, most of the country has a procedure that accident cases do not proceed before police verification. This is worse and worrisome, and most of the deaths happen due to the late visits of police. Therefore the hospital server is connected with the police for provides instant notification and reduce the unnecessary deaths from that.

```
Step 1: Start
Step 2: declare variables injury, minor, available and operation_theater;
Step 3: If injury equals minor
            Display Consult a doctor
        Else
            If operation_theater equals available
                Display Evacuate immidiatley
            Else
                Display Find another nearby hospital
Step 4: Stop
```

Figure 12: Algorithm for hospital availability

In some cases, nearby hospitals may not be free, and they can even do some emergency services. At that moment, the hospital server must identify the notification and reply as soon as it gets a message. Figure 12 shows the algorithm of the hospital server based on availability.

F. Firestore and Android apps

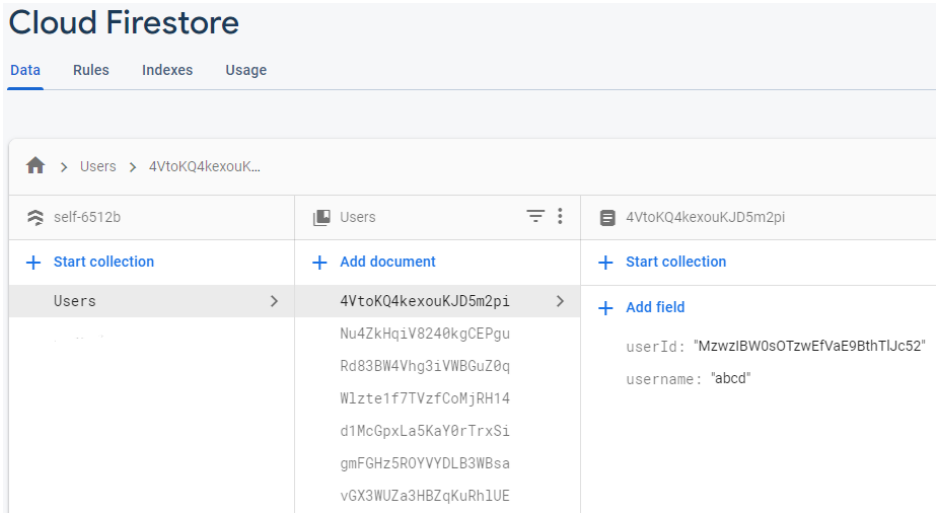

Figure 13: Sample Firestore cloud database

Firstore[45], [46] is a NoSql Cloud database for Android applications. All data from the android apps will be queried in this storage. From the firestore, we can share the data with the phone and other web-based applications. This storage is used to deliver an emergency alert to the emergency services and the doctors present in the hospitals. Also, we can share the previous history of the patients via a specific app created for this system.

G. Security

Data is a crucial factor in the study of accident protection systems. In other terms, the data is the back-born component of the proposed scheme. Without such data, no services or potential benefits can be acquired from the user through this conceptualization. In this study, data obtained from drivers is transmitted to the cloud and the server through a wireless sensor network. Hence we must have a better protection framework to achieve a betteroutcome. This study discusses the possible attack of a wireless sensor network and solution studies as a compilation.

Table 02.Compilation of possible attack and relevant studies

Possible attack	**Layer**	**Studies and authors regarding attacks**
1. Jamming Attack	Physical	Ashraf Al Sharah[47], W. Xu et al. [48], K. Pelechrinis et al. [49], N. Ahmed et al. [50], M. Li et al. [51]
2. Physical Tampering Attack		A. Becher et al. [52], J. Sen and A. Ukil[53]
3. Exhaustion Attack	Data Link	X. Wang and M. Reiter [54], D. Nash et al. [55], J. Antunes et al. [56]

4. Sinkhole Attack	Network	E. Ngai et al. [57], S.A. Salehi et al. [58], M. Kaur and A. Singh [59], I. Raju and P. Parwekar[60], A. Rehman et al. [61], H. Shafiei[62], F. Zhang [63]
5. Sybil Attack		J. Douceur [64], J. Newsome et al. [65], M. Demirbas, Y. Song [66], A. Vasudeva and M. Sood[67], K. Ssu et al. [68], U. Dhamodharan and R. Vayanaperumal[69]
6. Wormhole Attack		Y. Hu and A. Perrig[70], M. Patel and M. Patel [71], H. Chen at al. [72], F.Nait-Abdesselam et al. [73], R. Singh [74], M. Sookhak et al. [75], R. Poovendran and L. Lazos[76], J. Eriksson et al. [77]
7. Hello Flood attack		V. Singh et al. [78], V.PalSingh et al. [79], R. Singh et al. [80], R. Gill and M. Sachdeva [81],
8. Selective Forwarding Attack		L. Bysani and A. Turuk[82], Q. Yaseen et al. [83], Z. Wazir et al. [84], A. Mathur [85], J. Ren et al. [86], P. Sharma [87], H. sun et al. [88]
9. Acknowledgment Spoof Attack		P.U. Maheswari et al. [89], U. Sabeel et al. [90]
10. Flooding Attack	Transport	T. K. Krishnan et al. [91], A. Sana et al. [92], H.N. Lakshmi et al. [93], A. Moon et al. [94], S. Jindal and R. Maini [95]
11. Desynchronization Attack		A.D. Silva et al. [96], J. Degesys et al. [97]

5. CONCLUSION

A robust, sophisticated emergency accident evacuation system is proposed from this whole study. In road accidents, most of the time, people died due to carelessness though they could survive. When users and the government follow the proposed solution, the injury rate can be mitigated considerably and efficiently. A traffic control system, an emergency vehicle system, a nearby hospital with available doctors, and police play a significant role in the emergency evacuation system. Most of the studies concentrate on accident prevention, and only a handful focus on emergency care. When the proposed solution is implemented with

our previous study's accident avoidance layer, the complete system delivers the best protection to human lives.

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