Transport and Telecommunication, 2024, volume 25, no. 1, 31–42
Transport and Telecommunication Institute, Lomonosova 1, Riga, LV-1019, Latvia
DOI 10.2478/ttj-2024-0004

DATA DISSEMINATION AMONG VEHICLES TO AID IN RENDERING QUICK EMERGENCY SERVICES

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Road traffic in metropolitan cities is increasing at enormous rates resulting in congestion. Vehicles rendering emergency services like ambulances, fire engines, law enforcement vehicles, etc., act as lifelines and should be looked into with the highest priorities on the road. Such emergency vehicles (EmVs / EVs) are seen stuck many times in traffic, especially during peak hours of the day. The vehicles that block the EmVs on the road are unaware of the arrival of the same. Hence this work proposes a system that uses a central server that receives the location of the EmV and shares it with the civilian vehicles around. This is achieved through pinpointed accuracy systems like the Indian Regional Navigation Satellite System (IRNSS), Global Positioning System (GPS), and Global System for Mobile Communication (GSM), etc., The objective here is to help the EmVs reach their target location earlier thus saving lives.

Keywords: Vehicular networks, emergency vehicles, data dissemination, indian regional navigation satellite system, global positioning system

1. Introduction

Human life is of great importance and the preservation of the same through technology is worth working on. Though technology has helped in framing the terms smart cities or smart vehicles, communication among vehicles is not prevalent in many countries. With the challenges prevailing in Indian road traffic, researchers and technologists must create the best impact of the existing resources and technology in public services and reduce fatalities. Hence this work aims at connecting the heterogeneous vehicles on the roads resulting in them helping each other and as a team saving lives. The work proposes to achieve the reduction of fatality through different approaches such as with the help of a Global Positioning System, cellular networks, local servers, etc. so that the service reaches the maximum numbers on the route of EmVs. With this work, the reduction in deaths due to delays in EmVs reaching their destination will considerably be reduced. The decision on the usage of GPS, IRNSS, GSM, etc., in this work, is an outcome of the survey of existing literature as discussed below.

The challenge in device-to-device communication specifically vehicle-to-vehicle communication is the short distance. This can be overcome when it is combined with long-range cellular networks. Obtaining the exact parameters regarding the channel state is very crucial but challenging as the network exhibits a dynamic nature hence an increased end-to-end delay. The simulation in this work considers a highway scenario with five vehicles. The cellular user channel is also used for V2V communication. The statistical and deterministic models have been used for experimentation purposes. When the channel gain has no errors, the performance of information communicated between the vehicles by both models as observed by the base station is the same. When there is a disturbance in the channel, the statistical model shows good robustness. Comparing the statistical and deterministic models, with simulations it is concluded that throughput increases in the statistical model with increasing vehicle density which is not the case with the deterministic model. (Liu *et al.*, 2018).

In Europe, road safety is improved through the design of semi-automated, automated, connected as well self-driving vehicles as discussed by (European Automobile Manufacturer Association, n.d.). Most of the driving tasks like parking, steering, and braking are automated in some vehicles through the Advanced Driver Assistant System (ADAS). Connected vehicles establish communication with their peers as well as with infrastructure which greatly influences in bringing down the number of accidents and casualties.

Independent navigation with a complete 360-degree view is a key feature of self-driving vehicles. These are equipped with cameras, radars, sensors, GPS, etc. Here the general driver-initiated problems like drowsiness, poor vision during night drives, variation in health parameters of the driver, speeding, distraction by phone usage, alcohol consumption, etc., are eliminated. When Europeans see the wide availability of the same in 2030, India will have to wait for long.

Road fatalities in Europe have been reported to be reduced by 50% from 2001 to 2017 with an increase in the number of vehicles. Based on vehicle design, safety systems are termed active and passive. Active systems aim at preventing accidents by introducing autonomous emerging braking, lane departure warning, etc. while passive systems look into methods like airbags, pre-tensioned belts, etc. to protect the passengers of a vehicle involved in an accident and reduce the impact of the same. eCall is also a safety system where emergency services are automatically informed after a serious road traffic accident. According to statistics, all new cars and vans manufactured after March 2018 in Europe are equipped with eCall saving lives every year as the emergency services arrive at the spot in less time than before.

2. Existing work with vehicular communication

The possibility of communication with other vehicles and other devices like road-side unit are discussed and vehicle-to-vehicle communication is experimented by (Vineeth and Guruprasad, 2020).

The main objective of this work- IDRQIS is to reduce the end-to-end delay (E-E-D) encountered in scenarios where intersessions are seen. Intersessions are said to be encountered in environments when two vehicles have data to be exchanged among them. This may suit mobile conferences, safety message exchanges, and entertainment data which are generally disseminated among vehicles in VANETs. The main parameter of consideration in this work is E-E-D.

The focus of this work (Naranjo *et al.*, 2020) is to avoid the vulnerability caused by motorcycles moving among other vehicles by using a mobile application and launching warnings sound and visual types. The challenges encountered on roads due to motorcycles are because of their size, type of movement, and mobility. Use cases such as the ones when the vehicle is in a blind spot, in between vehicles in two adjacent lanes, or in low visibility in sharp bends. The concept of communicating only within the V2V networks may not be very efficient as many vehicles including two vehicles may not be a part of such networks. Hence, an additional mechanism is needed to spot and warn such vehicles to avoid chaos on roads. This is achieved through the MotoWarn application which is specifically designed for iPhones and has been used for such vehicles. With the relative speed of both vehicles being 200km/hr, a warning is given to the driver before 5.5 sec which is good enough to avoid a crash.

Clusters are formed with the cluster head transmitting its details to other members in its cluster (Shah *et al*., 2019). Any emergency information to be broadcasted is not immediately broadcasted by all vehicles to avoid broadcast storms. All vehicles report to the head the details of their distance from the source. The cluster head chooses the farthest node that would broadcast so that the information is disseminated to more nodes with reduced congestion. The authors have compared their work with the existing techniques and claim a reduced delay of 12% with an increased packet delivery ratio. This work bases its results on the increased network connectivity which is in turn based on the vehicles moving with low speed and a better higher vehicle density.

The work proposed by (Rocha *et al*., 2020) shows how relying solely on the wide deployment of WAVE or Wi-Fi Roadside Units (RSUs) can be a bad move as it does not guarantee a continuous V2I connection. Hence, cellular was used to make Cellular-Vehicle-to-Everything (C-V2X). This communication mode decreases the packet loss from over an average of 43% to around an average of 13% and also decreases the delay of data transmission. Hence, cellular communication as a mode of communication between the on-board unit (OBU) and the cloud is the best way to go over OBU and Wi-Fi / WAVE RSU. This will also bring down the cost of infrastructure drastically, as there is no need to deploy RSUs.

This work (Koshimizu *et al*., 2020) on Cellular systems used with vehicular networks shows the efficiency of 5G systems concerning scalability in moving objects. A mechanism has been proposed here based on the scheme affinity propagation which is reliable as it is proven for clustering. The machine learning field is involved in finding and maintaining the life of the formed cluster's size. soft-margin-based Support Vector Machine (SVM) algorithm is applied.

The conclusion of (Bagali and Thangadurai, 2019) was that there was little to no disturbance in IRNSS data when the receiver was moving and in speed. As mentioned by other researchers in the Department of Space, Indian Space Research Organization (DoS, ISRO, 2021) combined GPS-IRNSS gives a much better accuracy even though IRNSS has gotten better on its own. Hence, for critical applications, one should use IRNSS as well as GPS predominantly in India.

Many individual types of research have been done with different approaches to solve this problem, but our problem statement is specific to the ambulances that get stuck in traffic when the main cause of it is the vehicles in its path that obstruct it but are unaware of the whereabouts of the ambulance, resulting in them blocking the ambulance unknowingly.

One of the solutions implemented by the Indian Government is the Green Corridor (GC) which exhibits the importance of time delay for EmVs discussed in (Koushal *et al*., 2018). Organ Donation (OD) and transplantation have resulted in one of the biggest problems – waiting time for organ transplants simply exceeds their viable lifespans. Unless some provision was made for the quick movement of EmVs, this would fail as organs have short lifespans outside a host. GC has been very successful and the organ(s) arrives at its specified destination within the shortest possible time. Although this might seem like a noble solution to our problem, it is not exactly the case as GC is essentially a manual system, and there is a lot of time for preparing for the no-obstruction route, which is not always the case when any EmV has a path to cover. So, there is scope for automation and a more dynamic solution to the problem.

3. Proposed work

3.1. Technical aspects

In (Rocha *et al.*, 2018), it is discussed that a continuous V2I connection cannot be guaranteed if any work solely depends on Wireless Access in Vehicular Environment (WAVE) or Wireless Fidelity (Wi-Fi) Road side Units (RSU). When cellular is used along with the above there was a packet loss reduction of 43% as well as reduced delay. The reduced cost is observed as well as deployment of RSUs is avoided.

3.1.1. Location and positioning system

Global Navigation Satellite Systems (GNSS) include one or many satellite constellations that help determine worldwide position and time. Two popular GNSS constellations are Global Positioning System (GPS) which is American and Globalnaya Navigazionnaya Sputnikovaya Sistema (GLONASS) which is Russian. The Indian version - NavIC (Navigation with Indian Constellation) which is also termed as Indian Regional Navigation Satellite System (IRNSS) has proven better with respect to positioning. The Institute of Electrical and Electronics Engineers (IEEE) has designated 1 to 2 GHz of radio spectrum as the L band. GPS uses radio signals in some reserved spectrum for navigation services. As the L band waves penetrate clouds, fog, etc., GPS receivers can know their positions with an uncertainty of less than 10m. Hence GPS satellites broadcast in carrier frequencies like L1 at 1575.42MHz, L2 at 1227.6MHz, and L5 at 1176MHz. NavIC signals provide standard positioning service at the L1 and L5 bands. Geometric Dilution Of Precision (GDOP) is the measure of satellite-receiver geometry, which relates to the spatial location of the satellites seen by the GNSS receiver. Indian Space Research Organization (ISRO) has published the latest status and stats of IRNSS which contains different GDOP value Ratings – (ISRO-IRNSS-PER-21-02, 2021). It is seen that five out of the seven IRNSS satellites are visible at any given time. This encourages any work in the Indian region to rely on IRNSS.

The Table 1 shows the comparative GDOP values of GPS and various combinations which support the above discussions.

Table 1. Statistics of the GDOP due to different combinations of GPS and IRNSS (Rajasekhar *et. al*., 2016)

Statistical Parameter	**GPS**	**GPS+IRNSS-1C (GEO)**	**GPS+IRNSS-1A (GSO)**	**GPS+IRNSS-1A (GSO) + GPS+IRNSS-1C (GEO)**
Minimum	2.31	1.75	1.58	1.41
Maximum	9.62	9.27	5.93	4.38
Standard deviation	1.25	1.21	092	0.68
Mean	3.57	2.84	2.66	2.31

3.1.2. Description

The proposed work is of great significance as this has a crucial societal impact – saving human lives. As of date, communication among vehicles is not prevalent and hence novel for Indian roads. There is communication between the vehicles and the Roadside Units through the Radio Frequency Identification (RFID) technology used in FASTag observed in toll gates. However, these RFID tags act as only transponders of signals where the antenna in the toll gates receives and processes the information. The RFIDs in vehicles cannot process any dynamic data received by them. In the case of communication among vehicles, we need transceivers that should act as both transmitters and receivers. Hence On-Board Units in vehicles are proposed to be equipped with Raspberry Pi 4s which may act as transceivers that help in the dissemination of information regarding the EmVs.

This challenging task has been proposed in this work as there may be many EmVs on the move and the servers need to register them and prioritize the information from them compared to other vehicles. The other way of communication possible between the vehicles could be broadcasting the local data to nearby vehicles. The method of central point server has been chosen here for the reason that the EmV can be tracked by the hospitals (source/destination) so that arrangements can be made accordingly. Also, this could be the basis for some future extended services like route prediction and suggestions on prioritized routes to decide on the lightly loaded routes. The local server approach mentioned here has been tested in this work. The main objective here is to build a system where the cellular network helps the EmV request a local server to notify the CVs in the path. Here, the current location, path of travel, etc., are appended. The relative location of the EmV will be transmitted to the CVs so that they can take appropriate actions to reduce the obstruction caused by them. This technique is to target CVs that are not in the range of the EmVs. Though such implementations or practices are seen in the developed countries, these are not yet implemented and practiced in most of developing countries.

3.1.3. Methodology

A basic working example showing an EmV which is on its journey is shown in Figure 1. The concept of radius range around the EmV is used here. The vehicles in the range of EmV are alerted based on certain thresholds – inner (100m) and outer threshold (350m). Using the azimuthal angle (angle between the north direction and the targeted object measured clockwise), it is determined if the EmV is moving towards the vehicle or away from it in turn changing the color of the arrow in the compass module, indicating the movement of the EmV.

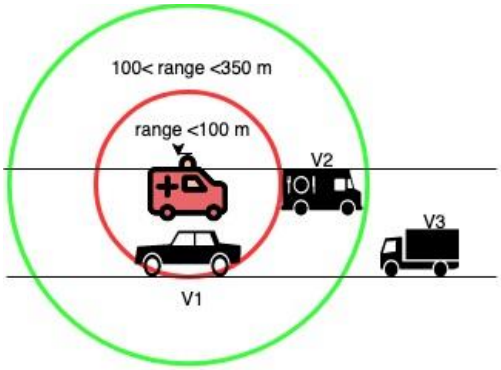

Figure 1. Basic Working example

Color coding of the compass denotes the range information i.e., the distance between the EmV and the vehicle. The static values used here are for experimental purposes. The values can be changed by the program itself once there is some kind of program (say Artificial Intelligence program) that can decide how much should be each threshold.

The presence of the arrow is observed in Figure 2.

Figure 2. When the EmV is not close to and not heading toward the non-EmV

1. The green arrow is shown by the compass if the EmV is either in the [100, 350] meter range or not in the direction of the vehicle. Here, Vehicle [V2] gets the notification indicating the direction of the EmV and its relative position with a green arrow pointer as seen in Figure 2, and the distance as it is far from the EmV but within the external threshold of 350m. Vehicle [V3] gets no notification as it is further away from the EmV's thresholds 100m as well as 350 m range.

2. If the EmV is either in the [0,100] meter range or is moving towards the vehicle, the green arrow will change its color into **red** i.e., a red arrow will be seen. Here, Vehicle [V1] gets the notification indicating the direction of the EmV relative to its position with a red arrow pointer and the distance.
3. When EmV is not in the inner radius threshold of the non-EmV, **no arrow** will be seen.

3.1.4. Flow diagram

Here EmV is the emergency vehicle and non-EmV is the civilian vehicle. Figure 3 shows the flow of functionalities of EmV and Non-EmV.

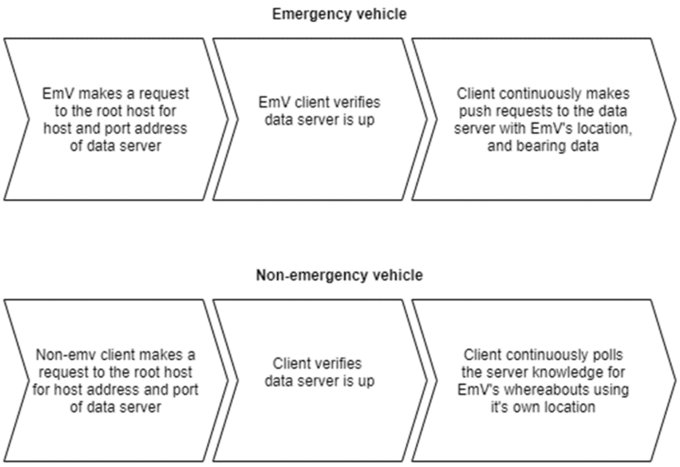

Figure 3. Flow diagram showing functionalities of EmV and Non-EmV

3.1.5. System architecture

The system architecture of the proposed work is mainly based on IoT and Cellular for the communication between the vehicle and the infrastructure. All these subsystems are supported by the underlying hardware components like Raspberry Pi and the used modules.

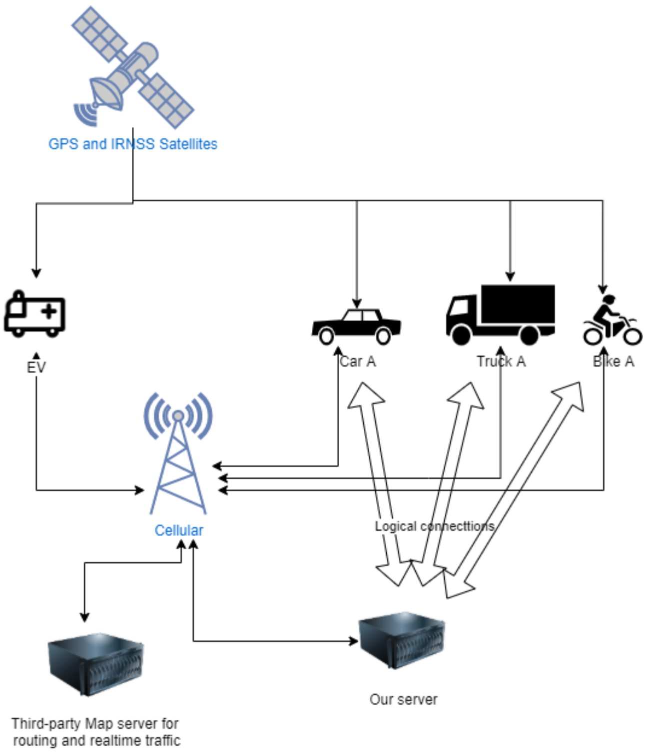

Figure 4. Basic infrastructure diagram

As seen in Figure 4, the infrastructure diagram, the cellular system will be used essentially for communication. The Global navigation satellite system (GNSS) data will be received from a combination of GPS and IRNSS satellite constellations respectively. The routing and dynamic real-time traffic are out of the scope of this work. The data server runs constantly and there is an established connection between every vehicle and the service. Hence, there is a logical connection between the vehicles and the server, and between the EmVs and our server.

3.2. Implementation details

Raspberry Pi 4 has been the component chosen to substitute actual EmV and civilian vehicles. The reason is that it is identified as a low-cost computer that comes with a high-speed processor supporting wireless connectivity with a set of General-Purpose Input Output. Two Raspberry Pi 4s are used where one acts as EmV and the other as a civilian vehicle. As EmV just pushes data, there is no display attached to EmV and as CVs need to receive the location of the EmV, displays are attached to the same. Two servers are used in this, one acting as a primary server and the other as the data server. The usage of the data server is for scalability. As a small authentication procedure for EmV, a secret string is pushed by EmV first to the server to identify itself as an EmV. This first connects to the main server which transmits the IP and the port number of the data server to the EmV. After receiving this, now EmV starts communicating with the data server and shares the parameters like its current location (latitude and longitude), its bearing i.e., the direction towards which it is moving, and its priority (for every emergency vehicle there is a priority set). The civilian vehicles also keep polling the data server with the same procedure as EmV. When EmV is closer to a civilian vehicle, this information is sent by the data server to the CV. EmV always sends data every second. CVs will poll every three seconds when no EmV is around. Once it gets to know about the presence of an EmV within 350m, it starts polling every 1 sec. Python3 modules have been used in communication among servers and vehicles. The compass module is used to know the direction between the two. Proof of concept is demonstrated.

3.2.1. Implementation cases

Case 1: When the EmV is behind the non-EmV vehicle, the distance between EmV and non-EmV is less than the inner threshold (100m), a red arrow is shown.

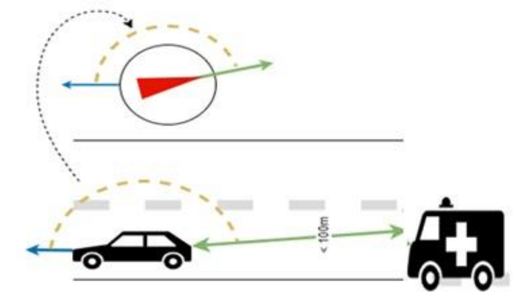

Figure 5. Case 1

Case 2: Direction shown with a different azimuth from non-EmV vehicle to EmV but the distance between the two is less than the inner threshold (100m).

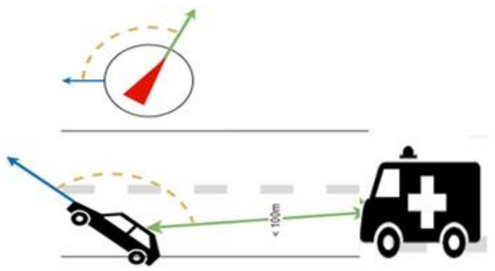

Figure 6. Case 2

Case 3: When the EmV is behind the non-EmV vehicle, the distance between EmV and non-EmV is between the two thresholds (100m<distance<350m), and the azimuth from EmV to the non-EmV vehicle is less than the angle threshold, the RED arrow is shown.

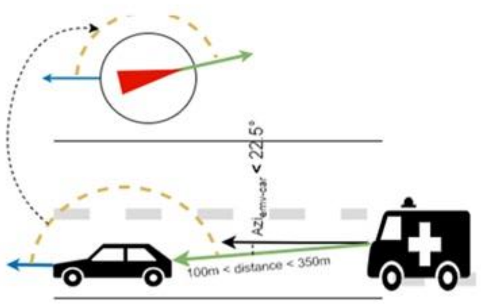

Figure 7. Case 3

Case 4: When the EmV is behind the non-EmV vehicle, the distance between EmV and non-EmV is between the two thresholds (100m<distance<350m), and the azimuth from EmV to the non-EmV vehicle is more than angle threshold, GREEN arrow is shown.

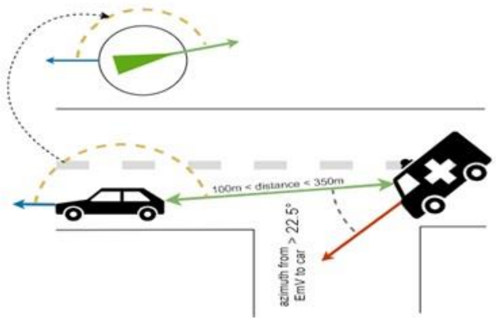

Figure 8. Case 4

Case 5: When the EmV is in front of the non-EmV vehicle, the distance between EmV and non-EmV is between the two thresholds (100m<distance< 350m), and the azimuth from EmV to the non-EmV vehicle is more than the angle threshold, GREEN arrow is shown.

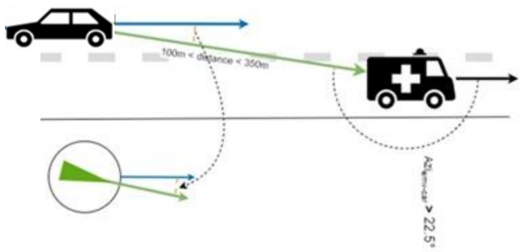

Figure 9. Case 5

Case 6: When the EmV is farther than 350m from the vehicle, the data server will not send the EmV data to the non-EmV vehicle, hence the arrow is not shown.

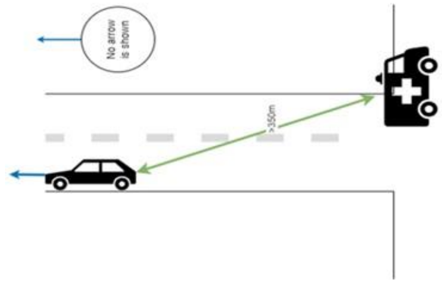

Figure 10. Case 6

3.3. Experimental analysis and results

3.3.1. Unit testing

Two Raspberry Pis kept in two vehicles have been used for testing. The most important module used in this work is the Quectel L89 GNSS receiver. This receiver supports the L5 band of IRNSS and both L1 and L5 bands of GPS hence resulting in very accurate location data using the combination of the two. This module is oriented towards the location of EmV.

Following is a sample 1s output frame of Quectel L89:

```
$PSTMANTENNASTATUS,1,0,1*4D
$GPRMC,070141.000, V,2249.66026, N,11336.95085, E,,,030919,,,N*79
$GPGGA,070141.000,2249.66026,N,11336.95085,E,0,00,99.0,-02.91,M,0.0, M,,*77
$GPVTG,,T,,M,,N,,K,N*2C
$GNGSA,A,1,,,,,,,,,,,,99.0,99.0,99.0*1E
$GNGSA,A,1,,,,,,,,,,,,99.0,99.0,99.0*1E
$GNGSA,A,1,,,,,,,,,,,,99.0,99.0,99.0*1E
$GPGSV,2,1,08,13,79,120,,02,57,087,,15,50,221,,05,46,017,*73
$GPGSV,2,2,08,29,42,304,,06,14,115,,30,13,070,,12,06,211,*7C
$GAGSV,1,1,04,305,68,012,,303,50,241,,309,19,038,,315,14,323,*6C
$IRGSV,1,1,04,805,83,352,,807,57,144,,803,46,236,,804,31,181,*77
$GPGLL,2249.66026,N,11336.95085,E,070141.000,A,N*4C
```

The two vehicles under experimentation moving in Bangalore roads in India are observed using the Teseo-Suite-Pro tool seen in Figure 11 which tracks the communication between IRNSS and Quetel 89. Following is the data recording visualization of the receiver as it is tested while in motion. The receiver is found to be very accurate and has an acceptable delay (<1s).

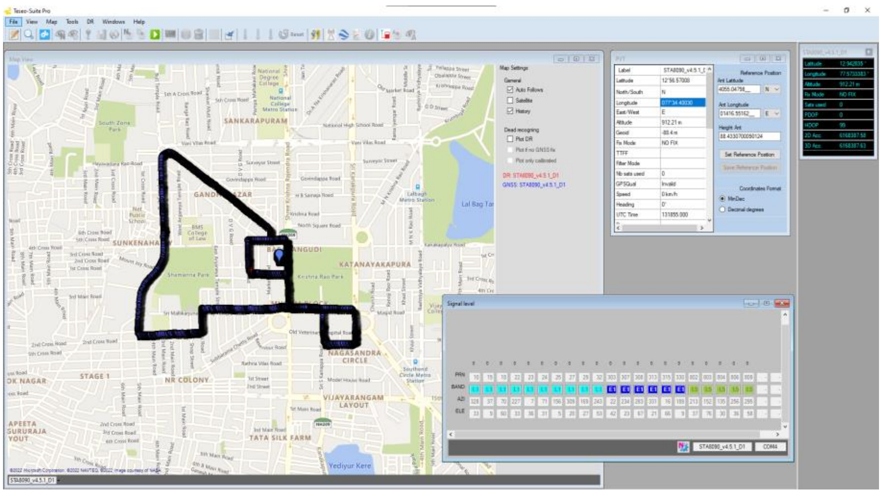

Figure 11. GNSS Data Recording Visualization for testing

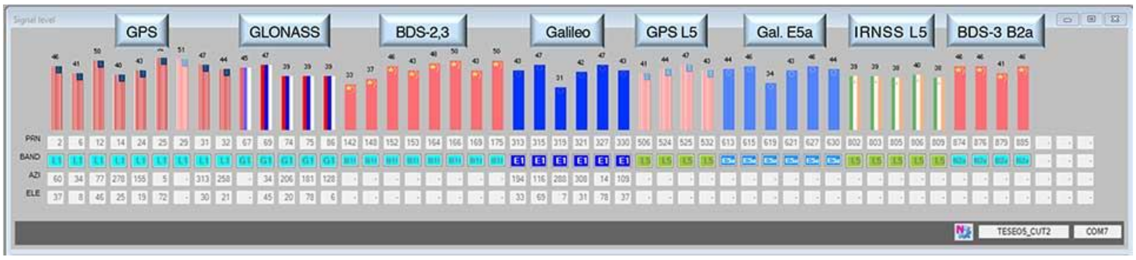

Figure 12. Band coloring (www.gpsworld.com)

The standard coloring of bands in Figure 12 confirms the usage of GPS and IRNSS in this work.

3.3.2. *Integration testing*

Real-time testing of the system has been carried out. The servers were running, with port forwarding enabled in the hosting router's NIC, which makes the two servers accessible from the internet. As can be seen in Figure 13, the EmV client (106.206.8.167) made the first request, and then the non-EmV client (157.45.234.231) requested server 1 to get the IP and port address of the data server. Then continuous requests are made to server 2 (Data server). Figure 14 shows the compass module being tested and being nearer and Figure 15 shows the red arrow in the monitor display of CV which indicates that the EmV is closer. The EmV client calls the /evPushData with appropriate parameters, and the non-EmV client calls the /evGetData with its longitude and latitude as request parameters. Figure 16 and Figure 17 demonstrate that when they are close to each other, a red arrow is shown.

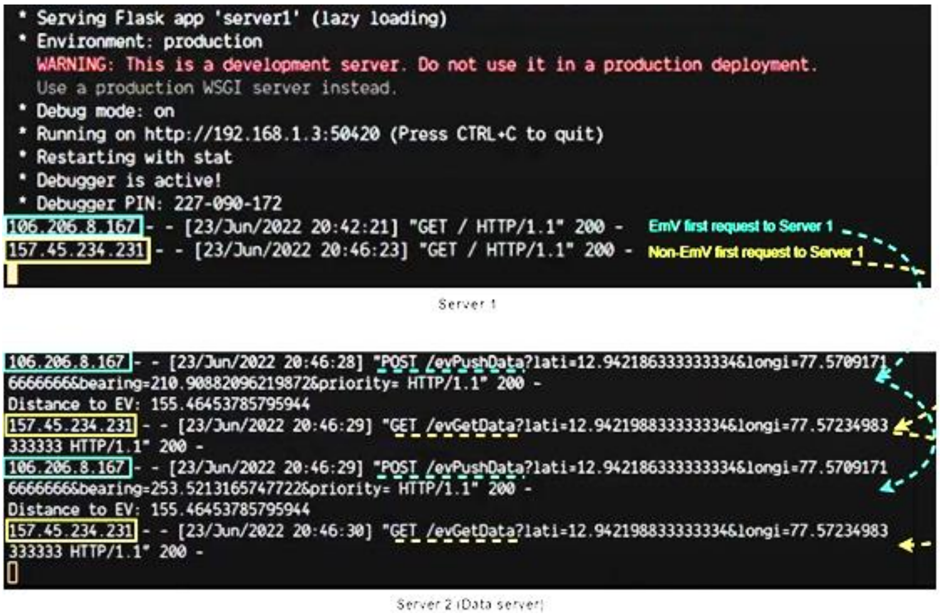

Figure 13. Server calls

Figure 16 and Figure 17 show the distance is 155.4645 which is between 100 and 350 m. Hence the arrow color now shown in the civilian vehicle depends on the bearing of the EmV. The color is green as the absolute difference between two bearing values (269.4905, which is the azimuthal angle from EmV to the CV using their longitude and latitude, and 74.9767, which is the bearing of the EmV) is more than 22.5 degrees and hence the arrow is green. The green arrow indicates that though there may be an EmV in its outer threshold, it is not approaching the CV.

Figure 18 and Figure 19 show the distance is 155.4645 which is between 100 and 350 m. Hence the arrow color now shown in the civilian vehicle depends on the bearing of the EmV. The color is red as the absolute difference between two bearing values (269.4905, which is the azimuthal angle from EmV to the CV using their longitude and latitude, and 253.5213, which is the bearing of the EmV) is less than 22.5 degrees and hence the arrow is red. The red arrow indicates that there is an EmV in its outer threshold and it is approaching the CV.

Figure 20 shows the distance to EV as 380m in the data server and hence no arrow is shown in the CV. The CV starts polling every three seconds, instead of every one second when it comes to knowing that there is no EmV nearby, and this can be seen clearly as the server gets three pushData requests from EmV for every getData request from CV i.e., the civilian vehicle polls for every three seconds whereas the emergency vehicle updates every second.

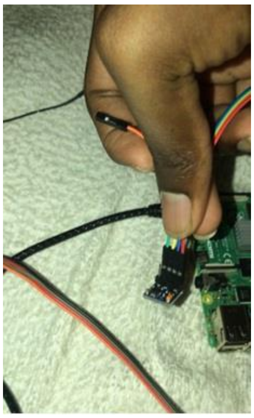

Figure 14. Compass module being held while execution to ensure correct bearing

Figure 15. The compass in the monitor shows a red arrow indicating the EmV is closer

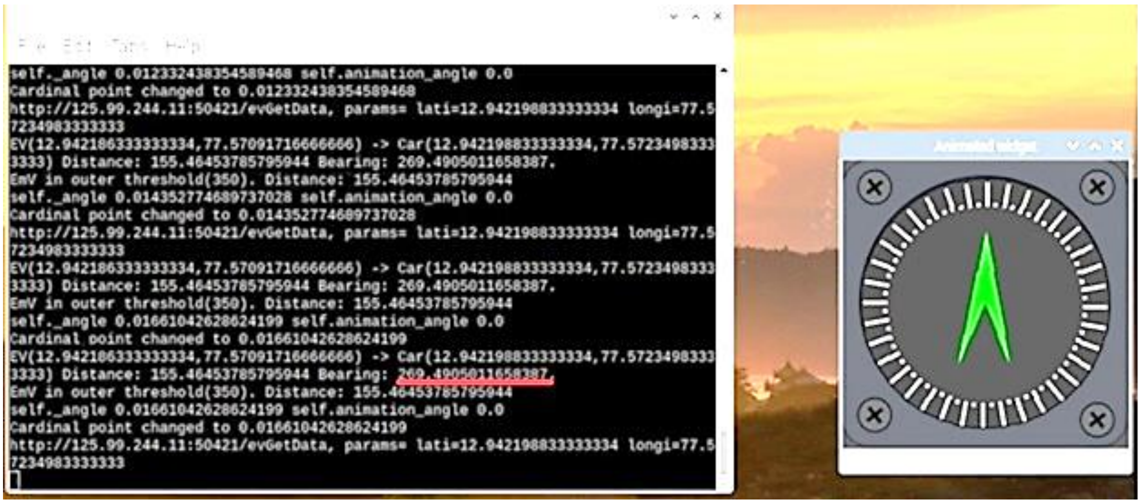

Figure 16. Screen as displayed in the civilian vehicle - a green arrow shown

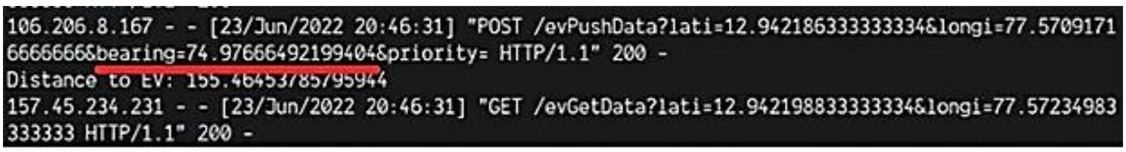

Figure 17. Screen as displayed in the server during the time green arrow is seen in CV

Figure 21 shows that bear1 is the azimuthal angle of the CV, and bear2 is the azimuthal angle of the EmV. The angle bear3 gives the azimuthal angle from EV to CV, which means that if a straight line is drawn from EmV to CV on the map, the angle which the line makes for the North direction. Hence, the absolute difference between bear3 and bear2 decides the color of the arrow displayed in the CV, when the absolute difference is more than the angle threshold (22.5 degrees in the project) the arrow is green-colored, or else it is red-colored. The difference between bear3 and bear1 is the angle that is shown on the CV's display. In the shown image, it is assumed that the EmV is outside the inner threshold(100m) and inside the outer threshold (350m) of the CV, and the difference between bear3 and bear2 is more than the angle threshold of 22.5 degrees, hence the arrow is green as the EmV is not approaching the CV.

Figure 18. Screen as displayed in the civilian vehicle - a red arrow seen

Figure 19. Screen, as displayed in the server during the time red arrow, is seen in CV

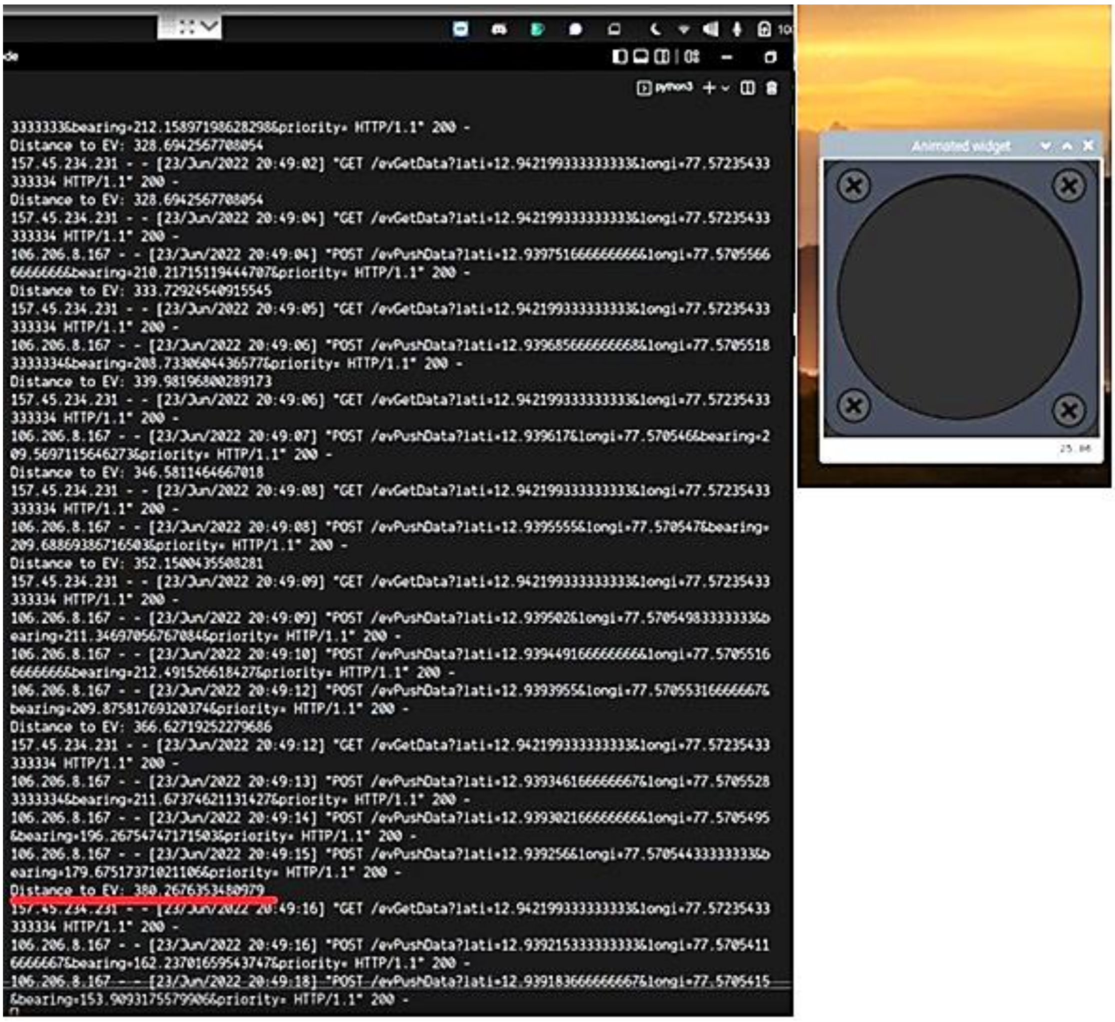

Figure 20. Screen as displayed in the server during the time no arrow is seen in CV

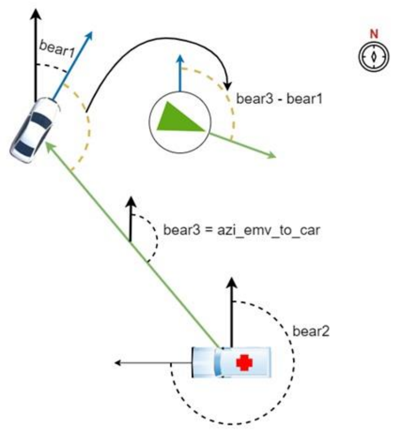

Figure 21. Consolidation of all the bearing angles

3.4. Challenges encountered and strategies used to tackle the same

While carrying out the work, challenges were faced. These have been discussed here as these are the hidden information that would be helpful in similar implementations.

3.4.1. Sourcing of components

While ideating the work and coming up with better approaches, IRNSS was found to be the best choice for location data. IRNSS is very accurate in the Indian sub-region and is a fairly new technology, and not many works have taken place that use it. So, finding and sourcing the IRNSS GNSS module was a challenge. The list was narrowed down to two items – Mikroe GNSS Click 8, and Quectel L89 EVB kit. Mikroe Click 8 comes with more support, and connections are specifically made for Raspberry Pi. As this had to be imported from Russia, Quectel L89 EVB has been used in this work as a first step.

3.4.2. Working module drivers for Raspberry Pi 4

The magnetic compass that was a choice was QMC5883L. This is a less expensive alternative to HMC5883L. The register addresses were different in QMC5883L, compared to the HMC5883L. So, the drivers for HMC5883L would not work for QMC5883L. Fortunately, an open-source driver written in Python 3 that worked well has been explored and used.

3.4.3. Public servers with open ports

The work's architecture is such that it requires two servers. The first server replies with the IP and port address of the second server. The second server is the data server. It stores the location and bearing data of the EmV in real-time, and sends that data to the non-EmV when requested, and when the EmV is in the outer threshold radius of the non-EmV. The servers then need a public IP and port address each, that are accessible from the internet. One option for this is a paid public cloud provider. This would be challenging as cloud providers have many rules and regulations for port forwarding and port locating. It also needs more capital and man hours. Hence local servers were used and port forwarding has been enabled on the router's NIC page.

4. Conclusion

Recognizing that human life is of paramount importance and involving technology in its preservation can bring significant results is the main motive behind this work. Reduction of fatalities due to additional delay in the EmVs reaching their destinations being the objective, a system has been proposed that establishes communication between civilians and EmVs when on the road, as well as a central server. This is intended to reduce the confusion that occurs during the transit of EmVs. Because the problem is time-consuming, it is intended to optimize the efficiency of this system, potentially averting disaster. Some of the most recent advancements in positioning technology have been used to achieve pinpoint accuracy. The future enhancements of this work could be the usage of RFID in traffic light poles equipped with the capability of precisely locating the EmV (along with our own GPS/IRNSS details). This can also be used to determine if the EmV has passed a junction, allowing users of the system to achieve greater accuracy in location. This system can be added to existing WAVE and IEEE Wi-Fi infrastructure to reduce communication packet loss even further.

Conflict of interest

The authors declare that they have no conflict of interest.

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