Socio-IoT Enabled Smart Drive System for Smart Cities

[1]Syed Saqib Raza Rizvi[1], [2]Sagheer Abbass[2], [3]Atiq Ur Rehman[3], [4]Tariq Javed Zia[4], [4]Muhammad Younas[5], [1]Muhammad AsadUllah[6]

[1, 6] Department of Computer Science, The University of Lahore, Lahore, Pakistan.
[2] Computer Science Department, National College of Business Administration & Economics, Lahore, Pakistan.
[3] Department of Natural and Social Sciences, Sharif College of Engineering & Technology, Lahore, Pakistan.
[4, 5] Department of Mathematics, COMSATS University Islamabad, Lahore Campus, Lahore Pakistan.

Abstract

Internet of Things and Future Internet aims that daily life objects which surround us enable to communicate over the internet with the unique identification. IoT is an emerging field which completely changed the dilemma of conventional computing. The major application of IoT includes intelligent security systems, home and industrial automation, smart buildings, energy management and smart city etc. By the dramatic growth of urban population future cities require to be designed in an efficient and sustainable manner by taking full advantage of modern day technology. Smart city increase transparency, availability, and efficiency in services offered to citizens. Application of smart city includes waste management, energy management, and smart traffic management system etc. The Social Internet of Things (SIoT) is a network of intelligent objects that have social interactions. The Social Internet of Vehicles (SIoV) is an example of a SIoT where the objects are smart vehicles. In this study, a Socio-IoT based Smart Drive system is proposed to reduce traffic congestion by sharing real-time and dynamic information of other travelers and route condition like weather change, traffic saturation, accidents etc. to users. The aim of the proposed system is to provide an economical solution that will increase the comfort level of travelers and enable them to make smart and better transportation decision.

Keywords

Internet of Things (IoT), Future Internet (FI), Social Network Analysis (SNA), Smart City, Smart Traffic Management System (STMS), Social Internet of Vehicles (SIoV).

1. Introduction

Internet of Things is an emerging field that deals with the study of interconnected computing and smart devices like microcontrollers, sensors etc. which have the ability to send data over the network might be internet with suitable communication protocols [7], without or very less human to machine or machine to human interaction. In IoT paradigm, many daily life objects that surround us will be part of the internet. IoT vision is successfully emerging computing paradigm beyond conventional mobile, desktop computing and focus on connecting everyday existing objects and implementing intelligence in the environment. IoT has emerged to transform the current static internet into the fully integrated future internet. IoT is defined as a worldwide network of interconnected devices uniquely addressed based on traditional communication protocol [10]. IoT had brought technological revolution in future of computing and communication. In future traditional communication between human to human would be less but the machine to machine communication would be excessive, where the machine would communicate on behalf of humans [13]. According to recent studies number of active devices over the internet used by 7 billion people will grow up to 24 billion in 2020 [10]. With the growth of IoT, we are already short of IP addresses within IPV4 due to use of personal computing, the new longer-range addresses under IPV6 was launched on 2012 to increase the capacity of unique IP addresses [13]. In this scenario different active groups like 6LoWPAN, ROLL and CoRE etc. are participating but even after great efforts implementation of IP-based IoT solutions are still challenging [17]. Internet of Things involves the collaboration of wireless communication technology, electromechanical systems, electronic and internet technology. Applications of IoT includes intelligent security systems, smart and autonomous vehicles, communication and interconnectivity of electronic devices like sensors, self-operated intelligent software systems, home and industrial automation, energy management, smart gadgets etc. One of the major key application of IoT is planning and development of smart cities.

According to United Nations alarming statistics, cities occupy 2% of earth's land but consume 75% of world's energy. Urban population will grow over 2.3 billion over next 40 years, while 70% of world's population will reside in cities till 2050. Such exponential growth of population in cities brought focus to develop and design cities in a sustainable and efficient manner. Smart city and the future internet have been widely adopted all around the world in order to bring high potential to overcome many big cities problems [8]. The smart city is a novel concept of designing smart and better urban lifestyle by adopting modern technological advents. Smart city incorporates IoT and communication technologies for better utilization of public resources, increase quality and reducing the operational cost of services offered to citizens. Smart city phenomenon provides simple, unified, and economical access to public services for citizens. This concept brought number of advantages in management and optimization of public services as well as brought availability, efficiency,

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transparency to the service offered by local government like security and surveillance, maintaining public property and cultural heritage, waste management, smart traffic management system etc. The primary characteristic of urban IoT infrastructure is to integrate different technologies with existing communication system to provide novel and progressive functionalities and services to citizens. According to research conducted by Pike on smart cities, smart city market is estimated of hundreds of billion dollars by 2020, with an annual expenditure of about 16 billion. Smart city market connects major industries like smart governance, smart building, smart utilities, smart environment and smart transportation etc. Despite great advantages smart city market has not really elevated yet because of political, technical and financial hurdles and barriers [7]. It has been predicted that Internet of Things would take 5-10 years for market adoption according to Gartner's IT hype Cycle [10].

The smart transportation system is a prime concern of smart city development. Efficient transportation systems are lifelines of country's economics. People travel less or more for their work, education, and business purposes etc. Every government takes keen interest to develop proper and efficient transportation infrastructure, but by the exponential growth in urban population, enormous export of vehicles, poor planning and construction infrastructure of roads traffic system framework is becoming miserable for personal and commercial use. Damage to property like vehicles, even lives loss is common observation nowadays. According to ASIRT (Association for Safe International Road Travel), almost 1.3 million people lose their lives every year in road accidents, 20 to 25 million people became seriously injured or became permanently disabled because of these road crashes. These incidents cause almost 518 billion USD loss globally, on average costing 1.5% loss to GDP in every country in the world. Road accidents are ninth leading dead cause in the world, making 2.2% of death rate globally and in 2030 it is predicted that road accidents will become fifth leading death cause [1]. Another matter of concern on roads, especially on highways, is high crime rate. Crimes like kidnapping, breaking road codes, safety violation, theft and other security issues make the journey more unsafe. People around the world not only avoid to gives help in certain situations but even they hesitate to accept help on roads especially on highways in an emergency situation because people traveling on the highways and roads are strangers and anonymous to each other. They have no basic information of other people traveling around them. It is also very common observation that people can't even call for emergency helplines, highways, and roads authorities, public safety organization or any other facility provided by the local government, even after witnessing any unusual activity or accident situation, because of certain law enforcement policies (may vary country to country), and fear for their own security and legal consequences, moreover late or inaccurate accident reporting, inaccurate spatial and geographical information reported or detected and lack of medical information of accident victims available on the accident scene etc. are major reasons for casualties in road accidents.

Social Internet of Vehicles (SIoV) describes both the social interactions among vehicles and among drivers. As described in a vehicular social network is created when a driver enters an area where other people with common interests or relevant content exist [18]. Traffic congestion is another problematic issue especially in urban areas, it happens when the number of automobiles on roads increases from the road capacity which is also called saturation [5]. Rising population, immense export of vehicle and lack of efficient public transportation system are major reasons for traffic saturation. [11]. Only in India annual fuel wastage because of traffic saturation is estimated around Rs.600, 000 million [2] and annual economic loss of Malaysia is RM 20 Billion only because of traffic congestion [11]. A study conducted by Texas A&M University states that average driver in the USA stuck 38 hours in traffic each year, a similar study was conducted in Britain by Center for Economics and Business Research which shows average vehicle idle time is 50 hours per year [14]. Urban Mobility Report (UMR) predicts that traffic congestion cost will dramatically increase from 121 billion USD in 2011 to 199 billion USD in 2020 [15]. Safe and smooth traffic flow by developing smart traffic management systems are main concern and study area of smart cities. Smart and intelligent transportation management system is an advanced approach to integrate Internet of Things and communication technology for designing future smart cities framework [2]. Smart transportation system has multiple applications like enhancing road safety and security, monitoring of traffic flow, saturation detection, reduce travel time, alternate routing, route weather condition, reducing pollution and greenhouse gas emission, efficient fuel consumption, emergency management, noise monitoring etc. [3]. Conventional solutions include monitoring of vehicles speed by CCTV cameras and speed trackers, traditional traffic control lights, continuous pollution check, human monitoring etc. but the theses classical traffic management techniques had failed to ensure effective traffic flow because of increase in vehicular density on roads [12].

Modern automobiles have equipped with many different types of electronic control units for e.g. power steering, rear view cameras, braking systems etc. today automobile industry is no longer mechanical, rather it is mechanical and electronic [14]. Automobiles have the variety of meaning in different classes and group in consumer cultures. Automobile consumption and production are internationally increasing even in growing economies like India, Russia, China and other South American countries.

Internet and its future is now bound up with automobiles, vehicles are in the era of future technological transformation. Drivers use a verity of different electronic devices while driving, for example by sending text messages, watching videos, internet surfing, navigation, listening radio etc. Nowadays smartphone is a single complete package of all these utilities. Portability of mobile phone is a major reason why these communication devices are highly usable in automobiles. Nowadays cars and mobile internet have more positive combination, especially after integrating GPS with mobile phone technology makes a possibility of changing dilemma of navigation technology [4].

Smart transportation management system integrates information technology, artificial intelligence, transportation management etc. to develop effective transformational service system [16]. There are two main approaches for the development of smart transportation management systems which are:

Adaptive Traffic Control Management Systems (ATCMS):

ATCMS uses onboard sensors technique (sensors are installed in vehicles) with standard wireless communication protocols. Adaptive Traffic Control Management Systems receives information from the vehicles like speed, geographical positions etc. [2], and transmit this information via wireless channels.

Road Side Unit Systems (RSUS):

In this technique the sensors are installed on roads completely isolated from the vehicles. These sensors not only sense data generated from the vehicles like speed, position, number of passengers in vehicles, speed limits etc. but also sense road condition like saturation, traffic density weather, pollution etc. [3].

Both techniques have their own benefits and limitations, ATCMS can be useful if the system only needs to sense the only vehicle-generated data like geographical position, vehicle speed, passenger's information in a vehicle etc. ATCMS is more accurate, with wider operational range but only limited to vehicle's generated information. RSUS is more helpful technique when it comes to road sensing and traffic monitoring like traffic flow, congestion etc. RSUS has certain limitations like limited operational area range, needs a large number of the sensor device to operate, the high maintenance cost of sensor device system etc. Hybrid of both techniques can also be used to design smart and intelligent traffic management systems.

2. Literature Review

Nasr et al. proposed an adaptive IoT system which automatically notifies nearby local public safety organization about the geographical location of the accident and basic medical information of passengers after triggering of shock detector sensors to lowering death rates in accidents [1]. Rizwan et al. developed a smart roadside unit traffic management system to predict traffic density and offers alternate routing to avoid traffic congestion and increase traffic flow through IoT and predictive analytic technique (Big data technique) [2]. Al-Dweik et al. proposed Scalable Enhanced Road Side Unit, SERSU, including adaptive traffic control system, pollution detection system and weather information system, SERSU used wireless communication network as well as radio frequency. SERSU modules were placed on the roadsides with different intervals, capturing generated sensor signals by vehicle sensors module [3]. Goggin briefly reviewed modern technologies of cars, internet and their current and future relationship, detail history of usage of electronic devices in automobiles, and social implication of these technologies [4]. Joshi et al. provided Infrared based sensor system, which captures infrared radiations emitted by vehicles on road surface, to monitor traffic flow and provides alternate traffic routing path to drivers for the avoidance of traffic congestion [5]. Handte et al. designed IoT enabled navigational system for effective transport facility, for urban bus riders in Madrid, which was helping in micro-navigation, predicts crowd aware routes and provided complete guidance of routes to bus riding passengers. The system was based upon smartphone devices to interact with onboard sensors to sense the presence of onboard passengers. Their system collected real-world bus user's feedback for better accessibility of travel information [6]. Zanella et al. analyzed key concepts, services, solution currently available for implementation of IoT based smart cities, and further Zanella et al. also suggested web-based service approach for IoT service architecture to resolve integration issues for different end node devices connected to IoT system [7]. Theodoridis et al. discussed key findings, technological challenges and socio-economic opportunities in developing and designing of future smart cities, they also suggested 3-tier IoT nodes and 3-plane architecture model, further they develop a city scale test bed for future internet and Internet of Things experimentation [8]. Skouby et al. described a hierarchy which combines smart homes and smart cities, they also suggested a four-layered model join end nodes IoT devices, communication technologies like 5G, distributed artificial intelligence and cloud of things [9]. Gubbi et al. presented a user-centric cloud-based vision of implementation of IoT using RFID's (radio frequency identification), by the interaction of public and private clouds, major research trends, IoT application domain, current and future enabling technologies etc. that will drive IoT in near future [10]. Chong et al. proposed Base Station infrastructure based architecture sensor system for intelligent traffic light system (TLS). They designed an intelligent software,

implemented on TLS which continuously communicates with the base station and calculates green light time, and provide monitoring of traffic by officers [11]. Dandala et al. proposed Internet of Vehicle (IoV) a unique solution for smart traffic management. They argued that IoV can be an effective solution to overcome traditional traffic issues over conventional IoT based traffic management technique. Further, they described that IoV needs four types of communication to be a reality which is the vehicle to vehicle's owner, the vehicle to vehicle, the vehicle to centralize server and vehicle to the third party like police patrol, ambulance etc. [12]. Thakur et al. proposed density-based signaling to overcome issues raised by fixed time signaling for example in fixed time signaling approach the traffic lights have predefined periodic time system proposed by Thakur et al. provides intelligent signaling by assigning more green signal to dense traffic region to avoid congestion by continuously evaluating traffic density [13]. A similar system is proposed by Ramchandara et al. which control traffic lights dynamically according to the density of traffic using average speed of vehicles. In the proposed system every vehicle is equipped with an onboard device (OBD) which acquire vehicle speed data process and deliver data to centralize server using Zigbee protocol [14]. To reduce traffic congestion and increase reliability to traffic signals Chowdhury et al. proposed intelligent traffic light system for communication between emergency vehicles to infrastructure. The proposed system considers the priority of vehicle depending on the type of incident and to secure signals from hacking [15]. Ou et al. pointed out some shortcomings in the traditional intelligent transportation system and argued to prefer radio frequency identification (RFID), sensor network and communication technologies to overcome traditional intelligent transportation systems issues [16]. Amadeo et al. proposed Information-Centric Networking to design and implement Future Internet architecture. In Information-Centric Networking every end node device has unique, location independent name which is used by IoT applications to access data. ICN not only provides content base security but also enables data caching [17].

3. Proposed System

The proposed technique in this study is sharing of dynamic information to users using smartphones as a communication device. Two great modern day technologies of mobility mobile phones and automobiles are integrated together for a new era of vehicular communication [4]. Modern day smartphones may have limited sensing capabilities but enhanced computational strength, lesser cost, excessive usage, availability of GSM and mobile internet signals, availability of different sensors in smartphones like gyroscope, digital compass, proximity sensor etc., services available like Google map, Google weather etc. is prime motivation to use smartphone as sensor device in the proposed system. Moreover specialized and more accurate sensors like accelerometer, global positioning system, and shock sensor etc. are designed and developed on different

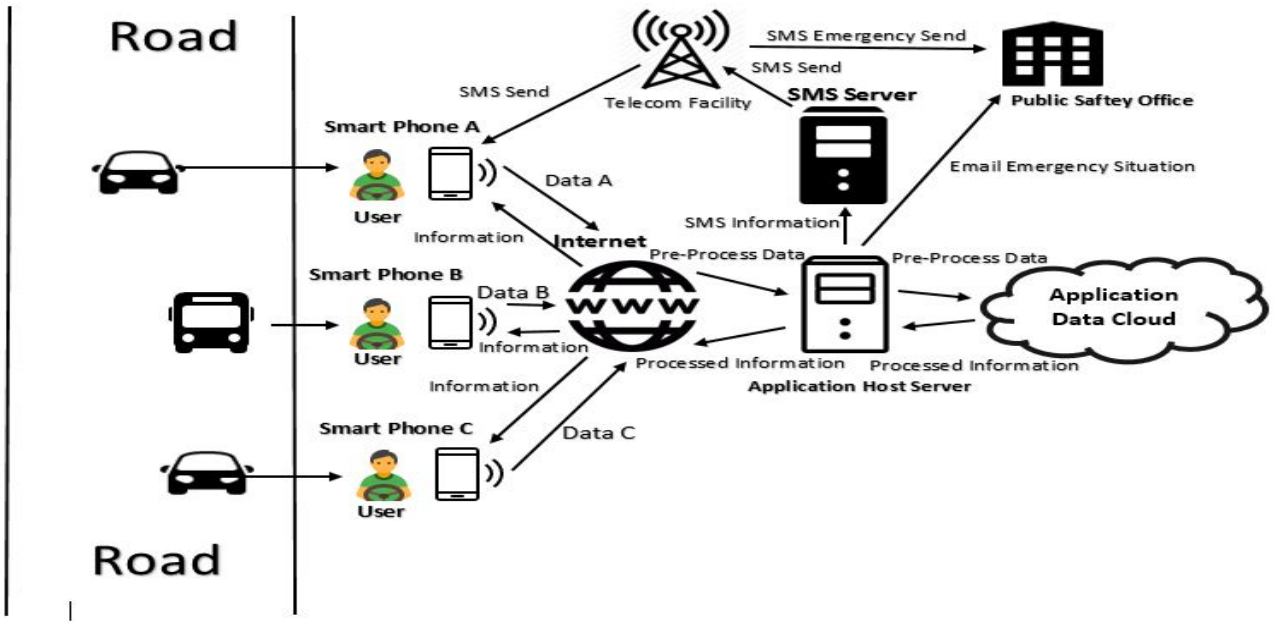

Fig. 1 System Diagram of Smart Drive

platforms and technologies, integrating different sensors technologies in a single system is beyond the scope of this study. The aim of the proposed system are to provide efficient and cost-effective smart traffic management system. In this study, we show how the concepts of the Internet of Things, human-computer interaction, software engineering, cloud computing etc. can be applied to improve the traveling experience and reduce security risks on roads especially on highways. The proposed solution is named as Smart Drive.

Studies suggest that travelers need specific information for experiencing effective journey by making efficient transportation decisions like trip planning, choosing among different routes etc. [6]. Travelers are short of important information like nearby local public safety organization, pinpoint geographical and spatial locations, and basic information of other passengers traveling with them. In case of an emergency situation, even local public safety organizations have no medical records or emergency contact numbers of accident victims. On highways, people hesitate to do or accept help from other travelers in emergency situations, because of no information about one and other. To overcome these issues Smart Drive offers following key technical innovations:

- Users will get real-time and dynamic information about the traveling route form other users in a particular range inform of newsfeeds.
- Smart Drive will alert users about road congestion in form of audio message.
- Provide basic information about other travelers traveling around the user and also provides a platform to communicate with them inform of audio and text messages.
- Track Record of user's journey from start to destination and generates alerts of important places nearby like fuel stations, restaurants etc.
- Smart Drive perform journey analysis which provides complete details of user journey after reaching the destination.
- A user can send and receive one push emergency messages to other travelers (using GSM as well as Internet services) as well as nearby emergency management organizations in the form of an email.
- Users can comfortably offer or accept emergency pickup, share rides form other travelers especially on highways because Smart Drive will keep track of these share ride journeys.
- Reporting of crime, abuse or any other misconduct to authorities nearby (if witnessed) with proper privacy.
- A user receives text messages as well as messages in audio format to prevent mental divergence while driving.

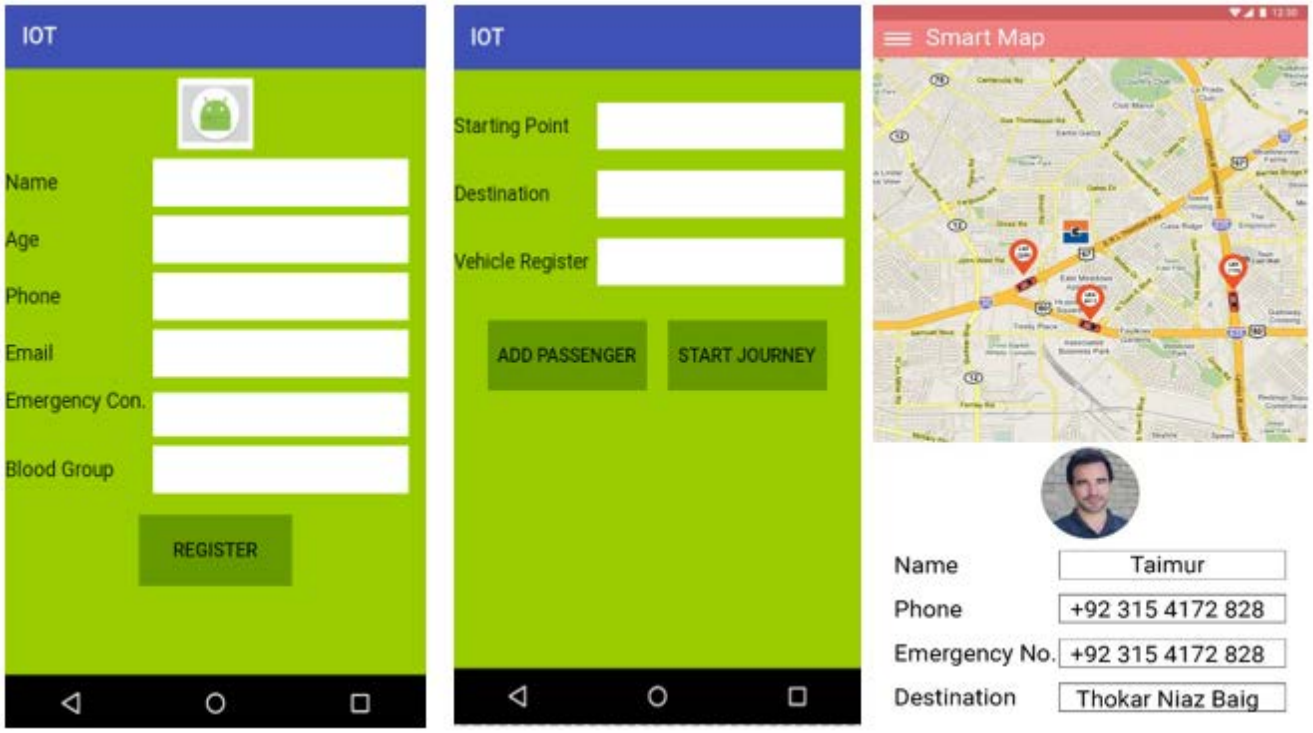

Fig. 2 Screenshots of Smart Drive

Smart Drive is using user's smartphone as a sensing as well as a communication device. In the proposed system smartphones will act as wireless sensor network's node. Internet and Mobile telecommunication GSM signals will act as a medium of communication between all wireless sensor network nodes. The application server will host Smart Drive application and is connected to SMS server which will generate text messages and it is also an interface between end nodes and application data cloud. The application server will also send emails to public safety organizations in case of an emergency. Application data cloud will provide all the necessary computations. Microsoft Azure IoT cloud server will be used because of enhancing security features. The system diagram of Safe Drive is illustrated in figure 1.

3.1. Smart Drive Working

The user will add two types of information in Smart Drive to prepare the application for use i.e. personal information and medical information. Personal information includes name, age, email address, contact number, emergency contact number, etc. Medical Information includes blood group, diabetes level (if any), blood pressure (if any), allergies (if any) etc. Figure 2 illustrates user interface of Smart Drive. After application preparation user will get following services from Smart Drive.

3.1.1 Start Journey:

After preparation of the application user will activate "Start Journey" module by pressing one push button. Smart Drive will detect starting journey location. The user has to input vehicle registration number and add passenger's (if any) information traveling with. Soon after user's data will be sent to the application server. Start Drive will show Smart Drive Map. Smart Drive Map will show registration numbers of other vehicles within defined range. A user can get basic information from all travelers like name, contact number, emergency contact number and destination location by a single touch.

3.1.2 Smart News Feeds:

News feeds is a novel feature of Smart Drive by which user can get news feed about their route they are traveling from other travelers in emergency situation for example in case of traffic saturation, road accident, change in weather

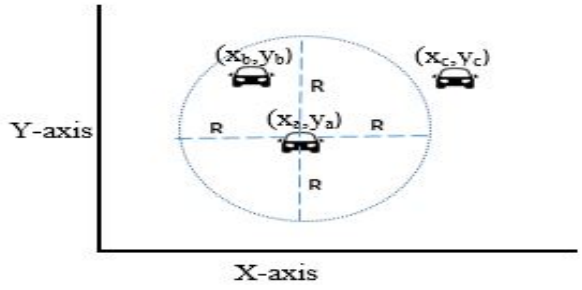

Fig. 3 Range Calculation

etc. Smart Drive have built-in messages like emergencies, weather, accidents, and crime reporting etc. moreover user can send custom messages as well to all users within range, the detailed message will be automatically sent to public service organization via email, which contain all the necessary information like emergency scene geographical coordinates, user's personal and basic medical information, and passengers information traveling in his vehicle. To find other users within message range. Figure 3 illustrates the phenomenon to find vehicles in range. The range is calculated as:

If (xb - xa = = ± R && yb – ya = = ± R)

{

Range ( )

{

Sendmessage ( );

}

}

Where,
xa is the latitude of vehicle sending message
ya is the longitude of vehicle sending message
xb is the latitude of vehicle receiving message
yb is the longitude of vehicle receiving message
R is the range to send messages

3.1.3 Traffic Congestion Alert:

Traffic congestion occurs when the number of vehicles on road exceeds from vehicle capacity of the road to accommodate vehicles the phenomenon is explained in equation 1.

$$Congestion = \frac{number\ of\ vehicles\ on\ road}{capacity\ of\ vehicles\ on\ road} \quad \ldots\ldots\ldots \text{equation 1}$$

The number of vehicles entering on a particular road is countable with the help of different modern and advanced sensors like cameras, infrared sensors etc. but there are no accurate and defined parameters available to determine the capacity of a particular road to accommodate the vehicle. Road capacity depends upon different variables like the number of lanes, road condition, busy hours, speed limits etc. Smart Drive uses more appropriate and realistic approach to find road congestion on the basis of the average speed of the vehicles and speed limit allowed on the particular road, the phenomenon is explained in equation 2.

$$Average\ Vehicle\ Speed\ in\ Range = \frac{sum\ of\ vehicles\ speed\ in\ range}{number\ of\ vehicles\ in\ range}$$

$$Average\ Road\ Speed\ Limit = \frac{Upper\ Speed\ Limit + Lower\ Speed\ Limit}{2}$$

$$Congestion = \frac{Average\ Vehicle\ Speed\ in\ Range}{Average\ Road\ Speed} \quad \ldots\ldots\ldots$$

equation 2

The approach used by Smart Drive to calculate traffic congestion is more appropriate and simple to implement. Smart Drive will calculate traffic congestion automatically and send an audio alert to the user i.e. alerting that user is about to enter in traffic congestion zone, a user could adopt an alternate route.

3.1.4 Smart Emergency Reporting:

In case of any of any emergency, user can send one push built-in message or custom message. Smart Drive will send user's information like name, geographical location, type of emergency, number of passengers traveling with, etc. to all other travelers nearby. The detailed personal and medical information of user's and passenger's traveling will be sent to the local public service organization in form of an email.

3.1.5 Smart Pick Up:

This is a very common observation that sometimes people need emergency rides, but they face a lot of problems to get it. People on the other side did not give or share their rides with other travelers because they are strangers to them, i.e. they have lack of information about other travelers. To increase user's security Smart Drive offers a unique feature that if users want an emergency pickup or share ride Smart Drive will send a confirmation message to both parties and after confirmation Smart Drive will share information of both parties to each other, and also keep the track record of the ride. Users can also search other users by Smart ID to initiate Smart Pick Up.

3.1.6 Smart Crime Reporting:

A user will report any criminal activity, miss conduct or any unusual activity witnessed. The user can also upload images using smartphone cameras, and all other details. The basic details will be sent to users within range and detailed information of the event will be sent to local public safety organization via e-mail. Detail of user reporting crime will be completely confidential and did not share with any other user.

3.1.7 Smart Audio Messages:

Smart Audio Messages (SAM) is another exciting feature of Smart Drive, the emergency messages or news feeds received to other users are send inform of text as well as in audio format, to prevent users distracting while they are driving. The text message will be received using GSM frequency. Audio messages will be received in Smart Drive inbox, but automatically start executing. The user will automatically hear all audio messages receives in Smart Drive inbox.

3.1.8 End Journey:

After the end of the journey, a user will activate end journey module by a single touch. Smart Drive will perform journey analysis, like time taken to reach the destination, number of stops, total traveling distance etc. The details of user's journey will also be emailed to the user and a text message would be sent to the emergency contact number given by the user.

3.2 Limitations of Smart Drive

The approach used in this study has certain shortcomings as well which are discussed below:

3.2.1 Dependency on Internet Signals:

Today internet signals (3G, 4G/LTE) covers almost all urban areas but they have low coverage on rural side especially on highways. Smart Drive is almost dependent on internet signals, GSM signals are only providing text messages but most communication is dependent on internet signals. In the absence or in week signal strength zones Smart Drive will not be able to perform well.

3.2.2 Sharing of Confidential Information:

Users will hesitate sharing their personal information with other people, because of privacy issue. People always hesitate to share their data and information so that it can't be miss used. Smart Drive is also obtaining personal data of users and sharing with other users, but the data obtained by Smart Drive is very basic like name, age, destination city,

number of passengers travelling with, blood group etc. and also this information is not very critical in nature and the only information shared with other users is user's name, destination city, and image. The detail of user's data will only be shared in emergency condition like accident with public safety organizations.

3.2.3 Use of Smartphones as a Sensor Device:

Smart Drive is using smartphone as a sensor device rather than specialized vehicle sensors. The aim of Smart Drive is to reduce road side emergencies by removing information barriers about roads, highways and people travelling around users in an economical manner. The specialized sensors installed in the vehicle will increase the cost of system. Another burning issue of IoT is integration of different sensor devices which are designed and programmed on different architectures onto one single platform. The integration of different sensors on one platform is beyond the scope of this study. Moreover smartphones provides satisfactory computational capabilities in economical way, also with the emergence of mobile internet and cloud computing different advance sensors and services are available to smartphone user nowadays.

3.2.4 Maximum Human Interaction:

Many features in Smart Drive are not automatic, they need more user interaction with the system, like accident reporting is one touch operation but it is not automatic yet, it is still manual and in many conditions especially after accident user is not able to perform even such simple task. Use of shock sensors which automatically send alerts is better approach, but lab results showed that poor road conditions especially in country like India and Pakistan shock sensors mostly generates false alarms.

4. Analysis

In this section social network analysis of vehicles as a sample has been performed as an example in form of graph. A graph is a data structure which consisting of finite number of edges and nodes. There are many ways to represents nodes and edges on graph for example adjacency matrix, graph ML format, CSV files. Adjacency matrix is a two dimensional square matrix whose size is equal to the number of nodes in the graph. However if input graph contain large number of nodes and less number of edges then the adjacency matrix became sparse and space consuming. Figure 4 represents a sample graph and 5 represents an adjacency matrix 6*6 of a graph.

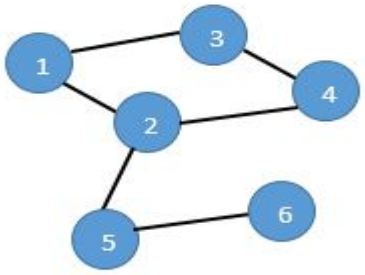

Fig. 4 Graph of Vehicles

	1	2	3	4	5	6
1	0	1	1	0	0	0
2	1	0	0	1	1	0
3	1	0	0	1	0	0
4	0	1	1	0	0	0
5	0	1	0	0	0	1
6	0	0	0	0	1	0

Fig. 5 adjacency matrix 6*6

In the given graph illustrated in 6 nodes represents user or vehicles in different range and edges for instance roads, paths and connectivity or relationship between vehicles in different ranges. Edges define the relationship between different users or vehicles, a directed edge from Vehicle 1 to Vehicle 2 represents that Vehicle 1 can communicate with Vehicle 2 and Vehicle 3. Vehicle 2 can communicate with Vehicle 3, Vehicle 4 and Vehicle 6 and so on for every vehicle in a graph. Adjacency matrix is represented in figure 7 in this figure "0" represents no relationship or out of range and "1" represents positive relationship or within range. If Vehicle 1 wants to communicate with Vehicle 4 it can communicate with the help of Vehicle 3 with the help of shortest path algorithm between two nodes.

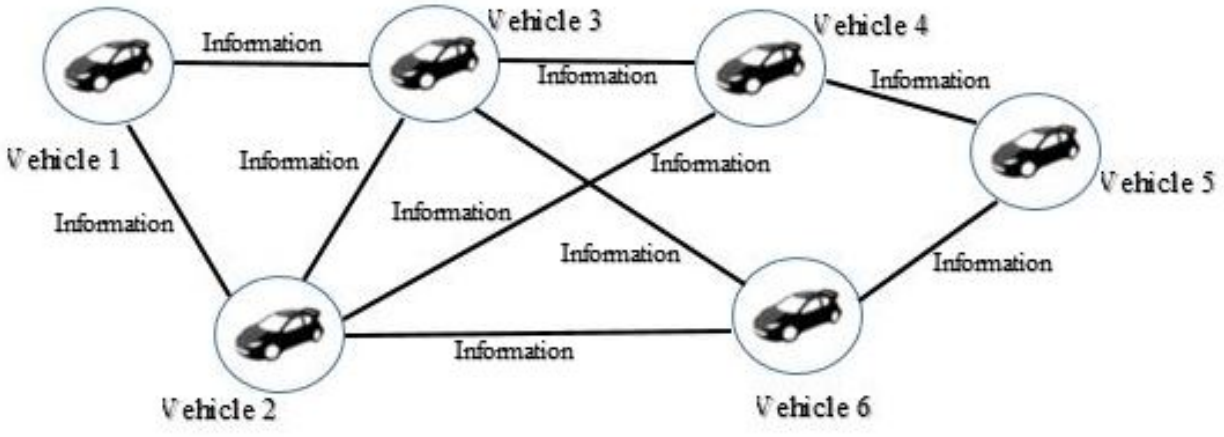

Fig. 6 Directed Graph between Vehicles

	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5	Vehicle 6
Vehicle 1	0	1	1	0	0	0
Vehicle 2	1	0	1	1	0	1
Vehicle 3	1	1	0	1	1	0
Vehicle 4	0	1	1	0	1	0
Vehicle 5	0	0	0	1	0	1
Vehicle 6	0	1	1	0	1	0

Fig. 7 Adjacency matrix of Vehicles

This phenomenon can be used on the higher level as well. In which every node represents a group or cluster of vehicles or users and edges represents any one of the vehicle which can possibly resides or act as intermediate vehicle between two groups or clusters. This intermediate vehicle would be helpful for communication between vehicles on different geographical areas might be different cities or roads. This technique will enhance the range of communication between two vehicles. The model of communication of distant (out of the range) vehicles is shown in figure 8. The adjacency matrix of distant vehicles is shown in figure 9.

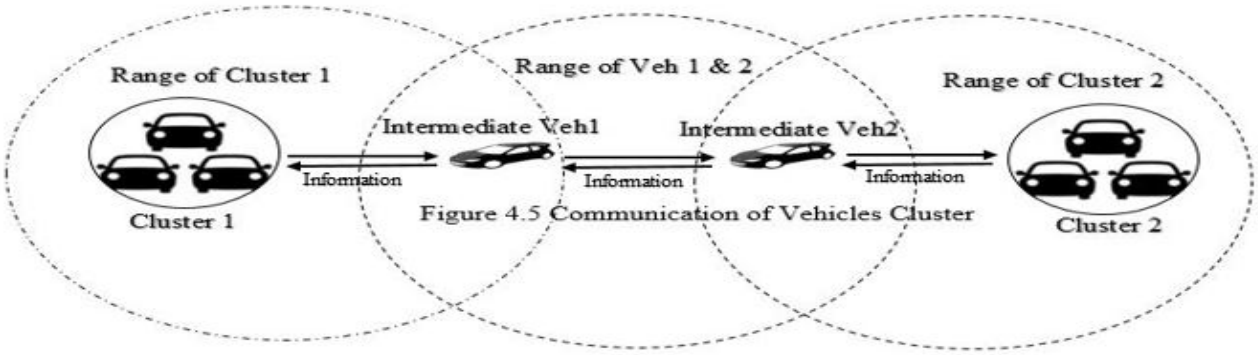

Fig. 8 Communication Model for Distant

Vehicles

	Cluster 1	Intermediate Veh 1	Intermediate Veh 2	Cluster 2
Cluster 1	0	1	0	0
Intermediate Veh 1	1	0	1	0
Intermediate Veh 2	0	1	0	1
Cluster 2	0	0	1	0

Fig. 9 Adjacency matrix of distant vehicles

5. Testing

The Smart Drive System is tested with help of 50 smart phone devices with GPS active. Every device was acting as a node and sending geographical coordinates to Smart Drive Server Application Server. The range was set 15 meters (range was set low to reduce testing range). The information received by Smart Drive System was converted to CSV file and latter simulated on Gephi 0.9.2. The graph generated by Gephi in Fruchterman Reingold layout is shown in figure 10. The size and colors of nodes are ranked according to the degree of node.

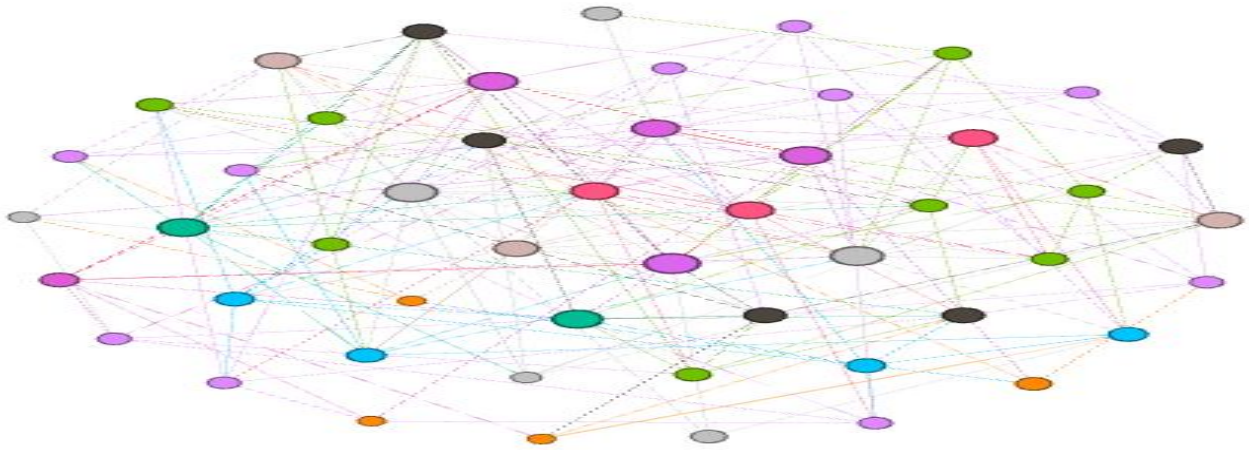

Fig. 10 Network Graph of Vehicles

The figure 11 illustrate the shortest path between two nodes calculated by Gephi 0.9.2.

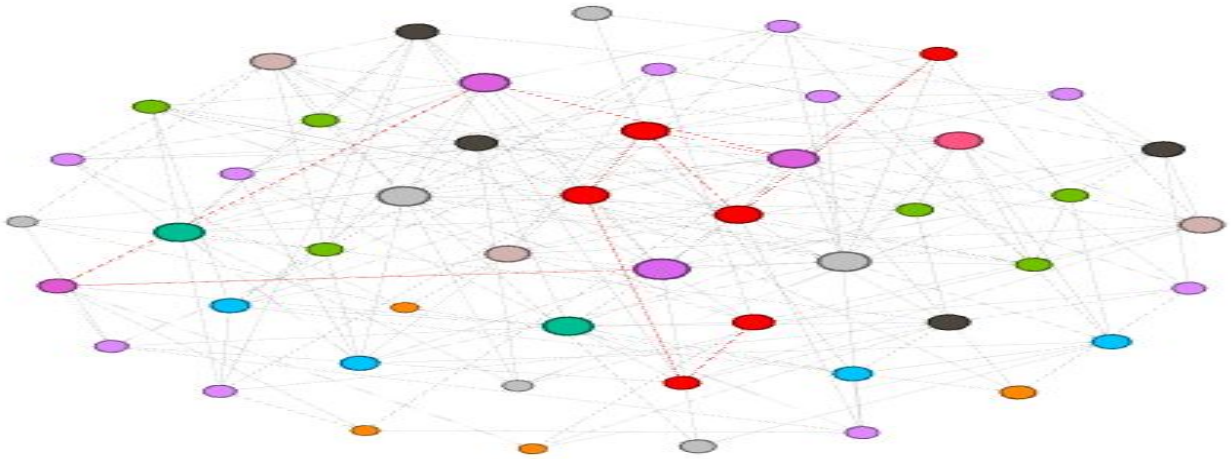

Fig. 11 Shortest path between vehicles

6. Conclusion

This paper presents a novel Socio-IoT based approach for smart and safe traveling for smart city by using on board sensors technique. The system is using user's smartphone as a sensor as well as communication device which is using internet and GSM signals to communicate. Smart Drive is logically connecting all the passengers traveling on a particular road by collecting and sharing real time and dynamic information about travelers and their route like road congestion, weather updates, etc. The aim of proposed system is to provide dynamic information to travelers and remove information barrier which will help users to make smart transportation decision based real time information.

6. Future Work

By acquiring real time and dynamic data, Smart Drive system have too many opportunities to evolve in future. Smart Drive is currently using Smartphone as a sensor device, in future more appropriate and specialized sensor devices could be used. The data generated by users can be useful in vehicle to infrastructure communication like traffic lights control, communication with law enforcement patrolling vehicles, ambulances etc. The proposed system currently needs more user interaction to operate, but it needs to minimize. System should have more self-operated automated features rather manual, which requires minimum human to machine interaction. The algorithm for Range calculation is not very optimized in first version of proposed system, it should be more optimized and accurate. Currently Smart Drive is based upon Vehicle to Infrastructure communication architecture using internet and GSM signals in future Smart Drive can also be upgraded for vehicle to vehicle communication. Short range vehicle to vehicle's owner and vehicle to vehicle communication can be made possible by using Bluetooth and Wi-Fi signals respectively. This short range communication can also be used for vehicle collision detection. Bluetooth and Wi-Fi signals would also be better alternate in absence or low coverage zone of internet signals. The huge amount of data collected by Smart Drive data cloud can also be utilized for Big Data analysis and data mining to generate useful patterns.

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References

[1] Nasr, Elie, Elie Kfoury, and David Khoury. "An IoT approach to vehicle accident detection, reporting, and navigation." In Multidisciplinary Conference on Engineering Technology (IMCET), IEEE International, pp. 231-236. IEEE, 2016.

[2] Rizwan, Patan, K. Suresh, and M. Rajasekhara Babu. "Real-time smart traffic management system for smart cities by using Internet of Things and big data." In Emerging Technological Trends (ICETT), International Conference on, pp. 1-7. IEEE, 2016.

[3] Al-Dweik, Arafat, Radu Muresan, Matthew Mayhew, and Mark Lieberman. "IoT-based multifunctional Scalable real-time Enhanced Road Side Unit for Intelligent Transportation Systems." In Electrical and Computer Engineering (CCECE), 2017 IEEE 30th Canadian Conference on, pp. 1-6. IEEE, 2017.

[4] Goggin, Gerard. "Driving the internet: mobile internets, cars, and the social." Future Internet 4, no. 1 (2012): 306-321.

[5] Joshi, Yashashree, Ashwini Joshi, Neha Tayade, Priyanka Shinde, and S. M. Rokade. "IoT Based Smart Traffic Density Alarming Indicator." (2016).

[6] Handte, Marcus, Stefan Foell, Stephan Wagner, Gerd Kortuem, and Pedro José Marrón. "An Internet-of-Things Enabled Connected Navigation System for Urban Bus Riders." IEEE internet of things journal 3, no. 5 (2016): 735-744.

[7] Zanella, Andrea, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, and Michele Zorzi. "Internet of things for smart cities." IEEE Internet of Things journal 1, no. 1 (2014): 22-32.

[8] Theodoridis, Evangelos, Georgios Mylonas, and Ioannis Chatzigiannakis. "Developing an iot smart city framework." In Information, intelligence, systems and applications (iisa), 2013 fourth international conference on, pp. 1-6. IEEE, 2013.

[9] Skouby, Knud Erik, and Per Lynggaard. "Smart home and smart city solutions enabled by 5G, IoT, AAI and CoT services." In Contemporary Computing and Informatics (IC3I), 2014 International Conference on, pp. 874-878. IEEE, 2014.

[10] Gubbi, Jayavardhana, Rajkumar Buyya, Slaven Marusic, and Marimuthu Palaniswami. "Internet of Things (IoT): A vision, architectural elements, and future directions." Future generation computer systems 29, no. 7 (2013): 1645-1660.

[11] Chong, Hon Fong, and Danny Wee Kiat Ng. "Development of IoT device for traffic management system." In Research and Development (SCOReD), 2016 IEEE Student Conference on, pp. 1-6. IEEE, 2016.

[12] Dandala, Tej Tharang, Vallidevi Krishnamurthy, and Rajan Alwan. "Internet of Vehicles (IoV) for traffic management." In Computer, Communication and Signal Processing (ICCCSP), 2017 International Conference on, pp. 1-4. IEEE, 2017.

[13] Thakur, Tanvi Tushar, Ameya Naik, Sheetal Vatari, and Manjiri Gogate. "Real time traffic management using Internet of Things." In Communication and Signal Processing (ICCSP), 2016 International Conference on, pp. 1950-1953. IEEE, 2016.

[14] Ramachandra, Sujit H., K. Nitesh Reddy, Vivek R. Vellore, Sumanth Karanth, and Tareesh Kamath. "A novel dynamic traffic management system using on board diagnostics and Zigbee protocol." In Communication and Electronics Systems (ICCES), International Conference on, pp. 1-6. IEEE, 2016.

[15] Chowdhury, Abdullahi. "Priority based and secured traffic management system for emergency vehicle using IoT." In Engineering & MIS (ICEMIS), International Conference on, pp. 1-6. IEEE, 2016.
[16] Ou, Haoyuan, Jianming Zhang, and Yi Wang. "Development of Intelligent Traffic Control System based on Internet of Things and FPGA Technology in PROTEUS." traffic 20 (2016): 2.
[17] Amadeo, Marica, Claudia Campolo, Jose Quevedo, Daniel Corujo, Antonella Molinaro, Antonio Iera, Rui L. Aguiar, and Athanasios V. Vasilakos. "Information-centric networking for the internet of things: challenges and opportunities." IEEE Network 30, no. 2 (2016): 92-100.
[18] Luan, T.; Lu, R.; Shen, X.; Bai, F. Social on the road: Enabling secure and efficient social networking on highways. IEEE Wirel. Commun. 2015, 22, 44–51.