A Study on the Necessity and Challenges of Vehicular Network in Context of India

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Abstract— Road related traffic injuries with people are excessive but neglected public health challenge that requires intensive efforts for valuable and sustainable prevention in many developing countries like India. Rapid development of vehicular ad hoc network (VANET) in intelligent transportation system provides useful and promising safety services in transportation life of many developed countries. The emergence of VANET can also provide the key answer to the many transportation related issues in developing countries. In this paper, we will give strong reasons for necessity of VANET in countries like India. Also, we have found that VANET has many challenges to be implemented for countries like India. We identified many challenges posed by the lack of infrastructure, poverty and other issues present in the countries like India. We have tried to address and provide a basic overview about all these hurdles in a way to VANET. We have also talked about a wide range of applications of VANETs that can directly applicable to countries like India to improve their transportation system and less road traffic injuries.

Index Terms— India, Security, Sensor, Vehicular Ad-hoc Network (VANET).

1 Introduction

More than 1.2 million people die in road traffic crashes every year. Because of road traffic crashes, around 50 million people gets injured or disabled every year [1]. Global trends on road safety indicate that fatalities on roads and highways will be the highest killer by following years. Apart from this, road crashes result in all kinds of social costs such as medical costs, production loss, property damage, settlement costs and costs due to congestion. Road traffic crashes cost countries up to 4% of their Gross National Product. Mostly Low and middle income countries are responsible for 90% of all road traffic injury deaths in entire world [1].

Unfortunately, India has the uncertain distinction of having the worst record of road safety in the world. India has over the years emerged as the world's road deaths capital with fatalities skyrocket by remarkable percent in all over the world. As mentioned by NCRB of India, the incidence of accidental deaths has shown increasing trend during the decade 2000-2010 with an increase of 50% in the year 2010 as compared to 2000. The population growth during the corresponding period was 18.3% whereas the increase in the rate of accidental deaths during the same period was 32.4%. TABLE I shows various statistics from the year 2007-2011.

TABLE I
ROAD ACCIDENTS AND DEATHS IN INDIA FROM 2007-2011[2]

Sl. No	Year	Road Accidents (in thousand)	% variation over previous year	Persons injured (in thousand)	% variation over previous Year	Persons killed (in nos.)	% variation over previous Year	No. of vehicles (in thousand)	% variation over previous Year	Rate of Deaths per thousand Vehicles (Col.7/ Col.9)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	2007	418.6	6.1	465.3	2.7	1,14,590	8.4	72,718	–	1.6
2	2008	415.8	– 0.7	469.1	0.8	1,18,239	3.2	89,618	23.2	1.3
3	2009	421.6	1.4	466.6	-0.5	1,26,896	7.3	89,618	–	1.4
4	2010	430.6	2.1	470.6	0.9	1,33,938	5.5	1,14,953	28.3	1.2
5	2011	440.1	2.2	468.8	-0.4	1,36,834	2.2	1,14,953	–	1.2

Source: for Col.9, 'Road Transport Year Book' of Transport Research Wing, Ministry of Road Transport & Highways, Govt. of India.
Note: for Col.9, data for the year 2006 is repeated in 2007 due to non availability of data for this year.
for Col.9, data for the year 2008 is repeated in 2009 due to non availability of data for this year.
for Col.9, data for the year 2010 is repeated in 2011 due to non availability of data for this year.

Along with the ongoing advances in Dedicated Short Range Communication (DSRC) [3] and wireless technologies, inter vehicular communication (IVC) and road–vehicle communication (RVC) [4] have become possible, giving birth to a new network-type called vehicular ad-hoc network (VANET). The key role that VANETs can play in the realization of Intelligent Transport Systems (ITS) [5], [6] has attracted the attention of major car manufacturers (e.g., Audi, BMW, Daimler-Chrysler, Fiat, Renault, Toyota, and Volkswagen are investing for ITS in VANET and have united to form a nonprofit organization Car2Car Communication Consortium(C2CCC) [7]).

VANETs have a number of similarities to that of Mobile Ad hoc Networks (MANETs), such as short radio transmission range, self organization, self management, low bandwidth and dynamic topology. Thus, VANETs are special in-

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stance of MANETs in which nodes are vehicles instead of small mobile and handheld devices [8].

Initially we had planned to begin with an intense research on those simple but effective ways on how VANET could be incorporated in the bulging traffic system of India and be useful in transportation development. Very soon, we came across lot of difficulties in obtaining the required data to employ the technology of VANET. So, we tried to find out the challenges that are making VANET implementation difficult in India. Therefore we have proposed the thought behind the aim of writing this paper as a small but yet no less significant way to improve the current poorer traffic condition and make a way for the development.

2 Necessity of VANET in Indian Scenario

In India, implementing a system where the vehicles can communicate, share information, and take protective allotment based on the information to prevent from incidents could impoverish the number of accidents and mishaps. A vehicular communication network was developed under ITS- a combination of different types of technologies implemented in transportation to provide driving safety and convenience with safety applications (collision avoidance, lane change assistance, etc.) as well as traffic management and commercial applications.

As mentioned in the TABLE II, VANET could be useful in every way of transportation in India. TABLE II describes various applications of VANET along with importance of VANET in various areas. It provides solution for serious safety related problems, traffic related problems, etc. VANET applications can be divided into two major categories [4]. Applications that increase vehicle safety on the roads are called safety applications. Applications that provide value added services, for example, entertainment, are called user applications. TABLE II describes main four categories of VANET application and their related situation/purpose with their related application examples as mentioned in [9].

TABLE II
APPLICATION OF VANET [4]

	Situation/purpose	Application examples
I. Active safety	1. Dangerous road features	1. Curve speed warning, 2. low bridge warning, 3. warning about violated traffic lights or stop signals
	2. Abnormal traffic and road conditions	1. Vehicle-based road condition warning, 2. infrastructure-based road condition warning, 3. visibility enhancer, 4. work zone warning
	3. Danger of collision	1. Blind spot warning, 2. lane change warning, 3. intersection collision warning, 4. forward/rear collision warning, 5. emergency electronic brake lights, 6. rail collision warning, 7. warning about pedestrians crossing
	4. Crash imminent	1. Pre-crash sensing
	5. Incident occurred	1. Post-crash warning, 2. breakdown warning, 3. SOS service
II. Public service	1. Emergency response	1. Approaching emergency vehicle warning, 2. emergency vehicle signal preemption, 3. emergency vehicle at scene warning
	2. Support for authorities	1. Electronic license plate, 2. electronic drivers license, 3. vehicle safety inspection, 4. stolen vehicles tracking
III. Improved driving	1. Enhanced Driving	1. Highway merge assistant, 2. left turn assistant, 3. cooperative adaptive cruise control, 4. cooperative glare reduction, 5. in-vehicle signage, 6. adaptive drivetrain management
	2. Traffic Efficiency	1. Notification of crash or road surface conditions to a traffic operation center, 2. intelligent traffic flow control, 3. enhanced route guidance and navigation, 4. map download/update, 5. parking spot locator service
IV. Business/ entertainment	1. Vehicle Maintenance	1. Wireless diagnostics, 2. software update/flashing, 3. safety recall notice, 4. just-in-time repair notification
	2. Mobile Services	1. Internet service provisioning, 2. instant messaging, 3. point-of-interest notification
	3. Enterprise solutions	1. Fleet management, 2. rental car processing, 3. area access control, 4. hazardous material cargo tracking
	4. E-Payment	1. Toll collection, 2. parking payment, 3. gas payment

A.

A.Active Safety

One of the primary goals behind this paper is to make driving safer using existing technology VANET in lower and middle income countries like India. VANET

technology has rich and adorable assets of applications. With the help of communication, drivers are warned about a dangerous situation or even that vehicle can make an effort to avoid an accident or respond appropriately if an accident cannot be avoided any more.

In TABLE II, danger level is being used to categorize active safety applications. Dangerous road features like curves are stationary and thus foreseeable. Thus, danger is low. Out of the ordinary traffic and road situations are still almost stationary, but have a dynamic impression (i.e., vary from the belief of drivers that frequently pass the event spot). In above cases danger is elevated. When applications try to prevent collisions at that time danger is high (e.g., if a vehicle brakes heavily in urban environment). If this does not help anymore (i.e., in case of forthcoming danger when a collision cannot be avoided anymore), pre-crash sensing will prepare the vehicle in order to reduce the impact of the imminent crash (e.g., by closing windows or raising dampers). At last, when danger has turned into a mishap, it is necessary to warn the approaching vehicles or call for help.

B. Public Service

VANET is also projected to help the job of public services such as police or emergency recovery units. Support of emergency vehicles by virtual sirens or signal preemption capabilities are eye-caching examples of this class of applications. By means of these applications, emergency vehicles may proficient to reach their target place much more rapidly than today. In addition, traffic surveillance could be simplified by applications such as an electronic license plate. On the other hand, such applications must not be misused, which plainly underlines safety measures and necessitate for a discussion of official aspects of vehicular communication.

C. Improved Driving

Applications those are useful to improve or facilitate driving by means of communication lies under this group. The idea comprises of tiny scenarios in the direct surroundings of a vehicle to major optimization of traffic capability. In the former case, supporter applications are anticipated to aid the driver in normal traffic situations such as when entering a motorway and merging into the flowing traffic or the cooperative shrinkage of glare due to upper beam head lights. In the subsequent case, traffic efficiency in a greater area is paying attention which illustrate that an accident warning is scattered in a bigger space to enlighten vehicles about the probable barrier so that drivers can choose a substitute route. Another useful service under this category is the dissemination of parking information or even the advance reservation of a parking space in urban environment.

D. Business and Entertainment

A massive amount of applications can useful under the terms business and entertainment comes under this category of VANET applications. The focal point of such applications are delivering services to customers, to automate vehicle-related tasks or payment applications, such as download of music, fleet management, vehicle maintenance, or payment for fuel, parking and road usage.

3 CHALLENGES IN PERSPECTIVE OF INDIA

TABLE III
LIST OF SENSORS

Sensor name/Type	Purpose
Solar-powered sensor	To control traffic signals at intersections
Radar traffic flow sensors	To measure traffic flow
Portable axle sensors	Weighing and load control of loading truck in road transportation
Proximity sensor	To detect the presence of nearby objects without any physical contact
Inductive loops	To detect vehicle presence
Blind spot monitor	To detect other vehicles located to the driver's side and rear
Accelerometers	To measure the motion and vibration of a structure that is exposed to dynamic loads
Load cells	To measure the loads
Infrared sensors	To develop pre collision system or to detect vehicles
Light dependent registers	For automatic light control and as a position sensor
Doppler radar	To produce velocity data about objects at a distance
Light Detection And Ranging	To measure the distance of target
Closed circuit camera	To monitor vehicles, to recognize number plate
Alarm sensor	To sense an abnormal condition
Automatic number plate recognition	To read vehicle registration plates
Ultrasonic sensors	To park the vehicles
Weather Sensor	To give information regarding weather
Mobile Phone	To provide internet connectivity, GPS feature, etc.

A. Network Infrastructure

Vehicular ad-hoc network (VANET) requires the presence of a trustworthy and sturdy network infrastructure to be based upon so that the functions can be efficiently carried out. All the developed countries have excellent network infrastructures present, henceforth, it is easier for them to apply and put into effect this technology of VANET and with accomplishment. In India, the scenario is completely different.

India is still developing country and it is a nation of villages which are still lacking in primary infrastructures. Apart from some big cities, other areas are far behind in identifying and using the protocols and technologies that are essential for VANET. Thus, the only way that remains to utilize the knowledge of VANET is by employing the available network infrastructures that are in existence at the current moment. Thus, anyone wishing to put VANET into operation over here can proceed with the further work using the mobile networks as now, almost all parts of India are connected extensively through cellular networks.

B. Sensors

A sensor is an apparatus that measures a physical quantity and converts it into a signal, which can be understood and made use of by an onlooker or by an equipment. There are many types of sensors available today but to be used in India, a country plagued with poverty, only the inexpensive varieties of sensors should be chosen. Networks of sensors connected through the web technologies are making it possible to monitor traffic, parking availability, road quality, air pollution, and many other services in real life and that too across large distances. For India, the practice of employing cheap sensors should be the ideal and more practical action. Unfortunately, the number of such sensors that could be used to implement VANET is very limited till date. TABLE III describes a list of comparatively less costly sensors that could be used in India.

C. Traffic Data

The traffic posts on every intersection or avenues lack the mechanism to record traffic related data. Thus, it is very difficult to actually decipher the traffic pattern on a particular road at any time of the day and prediction of when the road is busy, idle, or is thoroughly jam-packed. The developed and few of the developing countries have successfully managed to overcome their problem of traffic jams through the introduction of well equipped traffic posts that have the ability to perform their respective functions with agility and perfection. The problem for India also has reached to the point of being acute because the people who are trusted with the responsibility of managing the traffic posts are not skilled enough and also has severe budget deficiencies.

D. Road Network

VANET mostly works over the principle that there are alternate roads or substitute routes available for people to take it when needed. This is hardly the case in India where seldom alternate routes are available and even when they are, then either these routes are plagued with traffic jams or not in that condition for vehicles to ply on because of either being in a battered state or full of pot-holes where vehicles can get stuck. Thus, for implementing VANET, the road network over here is a major challenge. Issues mentioned in TABLE IV further complicate this problem and we need to incorporate it while designing a vehicular network.

One of the major challenges that changes carried out due to ongoing road construction makes available maps rather coarse or out of date. Here, GPS and navigation system fails. Unavailability of digital maps may also happen in cases where the vehicles travel to a new place whose map does not exist in the drivers' local navigation database. Nevertheless, in these cases of absence of digital maps, collision warning is even more requisite because the traffic sign system in such suburban places may not be fully developed or may be unfamiliar to the driver. In this situation forwards technique mentioned in [10] can be useful.

In India, heavy and heterogeneous traffic are on roads. This traffic or vehicular movement can be energy source for many road side sensors as described in [11]. Inductive loop mentioned in [12] can be useful as vehicle detection system, in heterogeneous and lane-less traffic which is the situations of most of the roads in India.

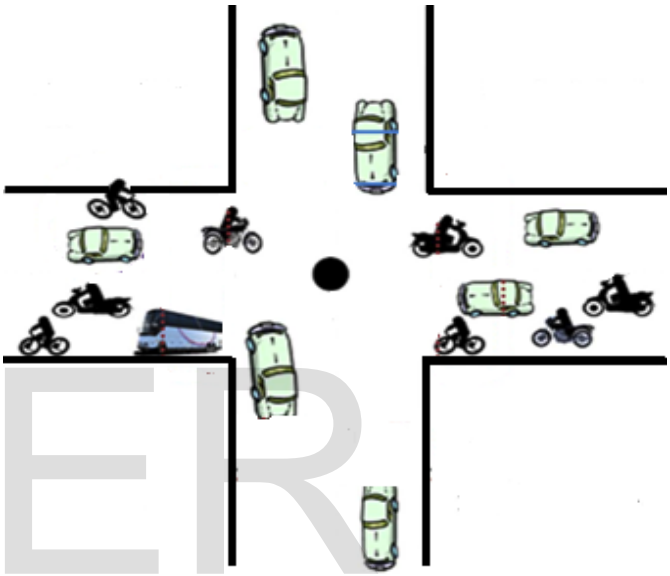

Fig. 1. Heterogeneous and Lane-less Traffic

E. Economy effect

Poverty in India is widespread, with the nation estimated to have a third of the world's poor. In 2011, World Bank stated, 32.7% of the total Indian people fall below the international poverty line of US$ 1.25 per day (PPP) while 68.7% live on less than US$ 2 per day [13]. Poverty also affects existing condition of transportation of nation. Many people in the India are unable to change their vehicles even when it crosses its permissible age limit (mostly 15 years). As a result, we have many outmoded vehicles those are still running on road. Government has many more primary needs to fulfill than development and investment in transportation. Thus, in countries like India we require VANET with minimum investment cost as well as maintenance cost. We have to also take in account regarding limited support from present condition of vehicles so need to develop feasible solutions for existing vehicles.

TABLE IV

LIST OF ROAD RELATED PROBLEMS

Problem	Description
Unstructured roads	Roads that were not constructed with proper planning
Narrow roads	Roads not possible for heavier vehicles to ply and only subjected for use by small vehicles
All roads not allowed for all vehicles	Many roads are restricted to only some types of vehicles like only small and medium vehicles are allowed whereas there are some others that only heavy vehicles can access
Busy roads	Roads that are plagued with heavy gridlock
No defined speed limit at every road	There are many streets and roads in India where the speed limit for the vehicles is not assigned. Also, when assigned, they are not strictly monitored. As a result, all the vehicles are given free rein to drive at any speed according to their wishes, resulting in havoc in the streets and roads, a situation we can not imagine in developed countries
No lane maintained at most of the road	Different lanes with instructions are not maintained in most of the roads. The vehicles are not told which lane they should drive through. For example, London maintains this strict rule where there are different lanes assigned for bicycles, cars and buses. This is non-existent in India where every lane is for every vehicle plying the streets
Frequency of Thievery or accidents	Thievery or accidents taking place more frequently than in developed countries
Absence of automatic traffic or speed control methods	Often the automated traffic light system does not work and motor vehicles do not know when to stop or when to continue on with the driving. Also, as there is no speed control method available, the motor vehicles speed cannot be kept in monitoring
Lack of education	People need to be educated to create awareness amongst them so that they know and follow the road safety procedures and rules
Plenty of intersection	Intersection at every short distance that increase congestion
Changes carried out due to ongoing road construction	Many times available maps are rather coarse or out of date. so here GPS and navigation system fails
Multiple check-posts, toll tax and octoroon duties collection points	This brings down the speed of the traffic, waste time and cause irritation to transporters. Rate of road taxes vary from state to state and inter-state permits are difficult to obtain
Less number of way side amenities	Repair shops, First aid centers are lacking along the Indian roads thus it make high ways congested by occupying them unnecessarily for long time
Poor road sign marking	Using outmoded signs and marking of these are extremely poor and also not present at many city and village area.

4 Conclusion

We presented importance of VANET through its different

applications which are suitable to develop transportation of countries like India and the challenges that exist in developing and undeveloped countries to utilize the knowledge and power of VANET. These challenges are often inherent to the socio economic conditions in this area and unique solutions are required for them. We suggested a few based on our literature survey and observation and now working to cope up with a few other issues. We hope that this research will help the scientific community working in this domain to find better technological solutions for this kind of regions in the world.

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