A Smart City Framework for Intelligent Traffic System Using VANET

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***Abstract*—The total number of vehicles in the world has experienced a remarkable growth, increasing traffic density which results in more and more accidents. Therefore the manufactures, researchers and government is shifting focus towards improving the on road safety rather than improving the quality of the roads. The good development in the wireless technologies emerged various new type of networks, such as Vehicular Ad Hoc Network (VANET), which provides communication between vehicles themselves and between vehicles and road side units. Various new concepts such as smart cities and living labs [1] are introduced in the recent years where VANETs plays an important role. A survey of various Intelligent Traffic Systems (ITS) and various routing protocols with respect to our proposed scheme is described in this paper. It also introduces a new scheme consist of a smart city framework that transmit information about traffic conditions that will help the driver to take appropriate decisions. It consists of a warning message module composed of Intelligent Traffic Lights (ITLs) which provides information to the driver about current traffic conditions.**

Keywords*—*VANE; Smart City Framework; Intelligent traffic Lights (ITLs); Intelligent Traffic System (ITS); Routing Protocol

I. INTRODUCTION

During the last decades, the total number of vehicles around the world growing enormously. Especially in India traffic is growing four times faster than the population. Road safety has become a main issue for governments and car manufacturers in the last twenty years.

The development of new vehicular technologies has shifted companies, researchers and institutions to focus their efforts on improving road safety. The evolution in wireless technologies has allowed researchers to design communication systems where vehicles directly take part in the network. Thus networks such as VANETs are created to facilitate communication between vehicles themselves and between vehicles and road side unit. Vehicular ad hoc network (VANET) is a technology which uses moving cars as nodes in a network to create a mobile network [2]. New concepts like smart cities and living labs has emerged in the last years where vehicular networks play an important role.

VANETs are getting attention due to the various important applications related to traffic controlling and road safety. Smart cities full of traffic would like to minimize their transportation problems due to the increasing population that results in congested roads. VANET helps to solve this issue by improving vehicles' mobility and also helps at having more safe and sophisticated cities. At the beginning of the development of vehicular technologies, the more focus was on building efficient and more safe roads. But nowadays huge development of wireless technologies and their application in vehicles, it becomes possible to use Intelligent Transportation System (ITS) that will change our way to drive and help emergency critical services. VANETs provide easier communication facility among vehicles and also with fixed infrastructure. This will not only improve the road safety, but also gives benefits commercially.

Pollution and congestion reduction, accidents prevention, safer roads are some of the benefits of VANETs. The development of an efficient system in VANETs has many important benefits, to the traffic police as well as to the drivers. Proper traffic alerts and updated information about traffic incidents will make safe driving, increase road safety and reduce the traffic jams in the city. It also helps to indentify where the traffic rules violations takes place. Furthermore, it also helps in economic ways; real-time traffic alerting will reduce trip time and fuel consumption and therefore decrease pollution as well [3]. So it is definitely beneficial in many ways.

Remainder of this paper is organized as follows: In section II, we briefly describe the related work.

Various Intelligent Transportation Systems (ITS) is discussed in this section. System overview is described in Section III. Further our proposed scheme and various routing protocols are compared with respect to our proposed scheme in this Section and at last paper is concluded in Section IV.

II. Literature Review

In the last decades, Intelligent Transportation Systems (ITS) have emerged as an efficient way to improve the performance of the flow of vehicles on the roads. The goal of ITS is to provide comfortable driving, road safety and distribution of updated information about the roads. Various research work related to ITS have been presented in recent years. Some work about ITS in smart cities is presented in this section.

Inter-vehicular communication is presented based on an adaptive traffic signal control system [4]. This system reduces the waiting time of the vehicles at the square also results in reduction in waiting time at the signal. To realize this system, the concept of clustering is used to collect the data of the vehicles coming towards the intersection. Clustering algorithm is used to compute density of vehicles within the cluster and sent to the traffic signal controls to set the timing cycle. It uses Direction based clustering algorithm. This algorithm is a combination of opportunistic dissemination technique and cluster and it is used to gather the required traffic information. The clusters are created using the direction of the vehicles in a given predefined geographic region approaching the intersection. By employing GPS and digital maps the direction parameter is computed within the vehicles.

System that takes the control decisions based on the information coming from the vehicles is very well described by the authors [5]. Every vehicle is equipped with a short range communication device and controller nodes are placed in the intersection with traffic lights. This controller node at intersection acts as adaptive control signal system.

In [4] and [5] two adaptive traffic light systems based on wireless communication between vehicles and fixed controller nodes deployed at squares are designed. Both systems improve traffic fluency, reduce the waiting time of vehicles at squares and help to avoid collisions.

The work in [6] is a survey about multifunctional data driven intelligent transportation system, which collects a large amount of data from various resources: Vision-Driven ITS (input data collected from video sensors and used recognition including vehicle and pedestrian detection); Multisource-Driven ITS (e.g. inductive-loop detectors, laser radar and GPS); Learning-Driven ITS (effective prediction of the occurrence of accidents to enhance the safety of pedestrians by reducing the impact of vehicle collision);and Visualization-Driven ITS (to help decision makers quickly identify abnormal traffic patterns and accordingly take necessary measures). But, it requires large amount of memory to stores the videos. Also in some complex situations as shown in figure 1, there are some problems regarding object reorganization.

Fig. 1. Complex scenario of traffic

In such a situation it becomes difficult to identify each vehicle and perhaps to find out the centroid of every vehicle. Hence it creates problems in traffic density calculation. Another problem is while doing object extraction, if the color of vehicle and the color of background become same then it becomes difficult to uniquely identify the object. Again we have to keep video data which is very large in size.

The e-NOTIFY [7] system was designed for automatic accident detection, which sends the message to the Emergencies Center and assistance of road accidents using the capabilities offered by vehicular communication technologies. e-NOTIFY focuses on improving post collision care with the fast and efficient management of the available emergency resources, which increases the chances of recovery and survival for those injured in traffic accidents. The e-NOTIFY system combines both V2V and V2I communications to efficiently notify an accident situation to the Control Center. Different vehicles should incorporate an On- Board unit (OBU) responsible for (i) detecting when there has been a potentially dangerous impact for the occupants, (ii) collecting available information from sensors in the car, and (iii) communicating the situation to a Control Unit (CU) that will address the treatment of the warning notification and its subsequent sending.

III. System Design

The possible solution consists of a smart city framework that has intelligent traffic lights (ITLs) set in the crossroads of a city as shown in figure 2.

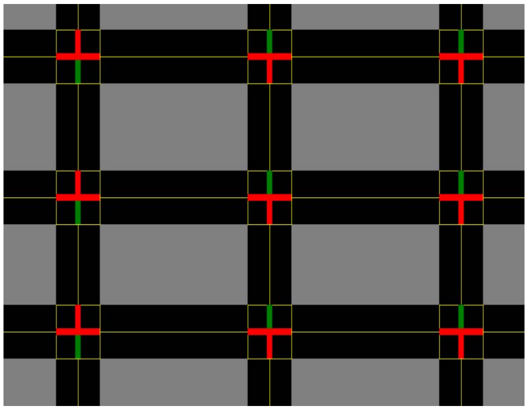

Fig. 2. Smart City Framework

These ITLs gathering traffic information (e.g. traffic density) from the passing vehicles, updating traffic statistics (congestion) of the city and reporting those statistics to the vehicles so that vehicle can select the best path which is congestion free. Also, ITLs will send warning messages to vehicles in case accident occurs to avoid further collisions. As [6], our proposal manages traffic information in order to avoid accidents, though the information here is gathered from the vehicles themselves so no further infrastructure is needed. Also our proposed system could easily be used by the traffic information centre to design an adaptive traffic light system similar to [4] and [5]. The proposed system architecture [8] is as shown in figure 3.

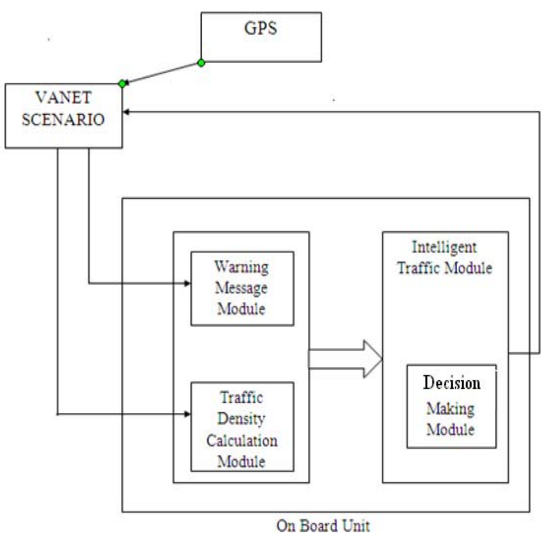

Fig. 3. System Architecture

It is assumed that vehicles have a global positioning system (GPS), on board unit, full map information of the city including the exact position of the each ITL, so that vehicles can easily select the nearest ITL. Each vehicle will transmit the normal hello message after every 2 from which we get the exact location of every vehicle present on the road and this data is used to find the traffic density. Warning message is of three types: yellow circle indicates that vehicle is independent and not communicating with any other vehicle, green circle indicates communication is established and messages transition is going on and red signal indicates two vehicles come closer and there might be the chances of collision as shown in figure 4. Continuous broadcasting is done whether any vehicle is in range or not; communication is established or not.

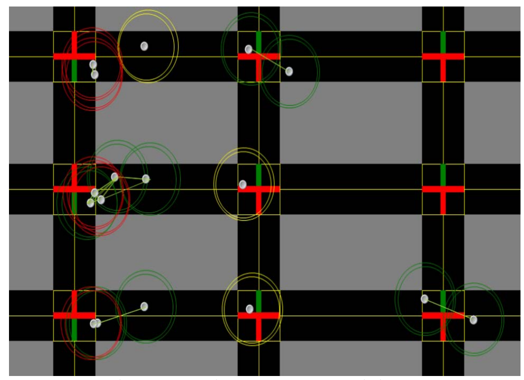

Fig. 4. Warning Message Module

Warning message module then sends the data to the traffic density calculation module. Then calculations are made in this module and traffic density of each road is calculated. The first two module then sends the data to the decision making module and the appropriate decision is made here and hence best congestion free path in provided to the particular vehicle whenever it come in the given ITL coverage range.

Every ad-hoc node set on the scenario is configured with Ad hoc On-Demand Distance Vector (AODV) [9] routing protocol. AODV is selected because of its simplicity and widespread use. Though it is well known that AODV is not suitable for general use as routing protocol in VANETs, there are some applications which work brilliantly with AODV. Other routing protocols that use other strategies like greedy forwarding and geographical routing.

For instance, GPSR (Greedy Perimeter Stateless Routing) [10] and GOSR (Geographical Opportunistic Source Routing) [11] shows good performance in VANETs, but has increased delay and greater complexity as compared to AODV. Other protocols like Destination Sequence Distance Vector (DSDV) and Dynamic Source Routing (DSR) are also there. The AODV can handle more routing packets as compared to DSR and DSDV because the AODV avoids loop and freshness of routes while DSR uses stale routes. AODV also shows higher throughput than the DSR and DSDV [12].

TABLE I. NO OF NODES VS THROUGHPUT

VANET Protocol	Throughput for no. of nodes			
	5	*10*	*15*	*20*
DSDV	10.8	90.8	241.8	509.68
DSR	10.72	72.37	206.99	368.44
AODV	40.91	431.39	1639.73	3759.79

The major drawback of AODV is that it needs end to end paths for forwarding the data, which is difficult to maintain because in VANETs end-to-end paths does not exists long due to high speeds of vehicles. But in our proposed work it is not necessary to establish the long paths because it consists of smart city framework where vehicles send warning messages (traffic density) to the closest ITL. Instead, vehicles need to establish very short paths (1-2 hops) to the nearest ITL. So this drawback of AODV is also overcome.

We require a protocol which provides good throughput and minimum delay because in our proposed work each vehicle transmits a hello message after every 2 seconds. The AODV has both the qualities; good throughput as well as short delay. That's why AODV is best suited with respect to our proposed scheme.

IV. CONCLUSION

Different works about Intelligent Traffic System (ITS) are compared and a new scheme is proposed. The key idea behind the proposed scheme is to create a smart city framework for VANET that consists of Intelligent Traffic Lights (ITLs) which transmit warning messages and traffic statistics. The goal is that on board unit can take a appropriate trip decisions and hence avoid congested roads, which results in reduction in pollution and trip time as well and definitely enrich the drivers' quality of life. Also various routing protocols has been discussed and compared. AODV is best suited with respect to our proposed scheme as it provides good throughput and minimum delay.

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