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Intelligent Traffic System for VANET: A Survey

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Abstract

During the last decades, the total number of vehicles around the world growing enormously. Therefore the focus of manufactures, researchers and government is shifting towards improving the on road safety rather than improving the quality of the roads. The vast development in the wireless technologies emerged a new type of networks, such as Vehicular Ad Hoc Networks (VANETs), which provides communication between vehicles themselves and between vehicles and infrastructure. Various new concepts such as smart cities and living labs [1] are introduced in the recent years where Vehicular Ad Hoc Networks (VANETs) plays an important role. A review of various Intelligent Traffic Systems (ITS) available and various routing protocols with respect to our proposed scheme is done in this paper. This paper also introduces a new scheme consist of a smart city framework that transmit information about traffic conditions that will help the driver to take proper decisions. Our proposed scheme consist of a warning message module composed of Intelligent Traffic Lights (ITLs) which provides information to the driver about current traffic conditions.

Keywords

VANET, Smart City Framework, Intelligent traffic Lights (ITLs), Intelligent Traffic System (ITS), Routing Protocol.

1. Introduction

Road safety has become a main issue for governments and car manufacturers in the last twenty years. The total number of vehicles in the world has experienced a remarkable growth, increasing traffic density and causing more and more accidents. In India traffic is growing four times faster than the population.

The development of new vehicular technologies has shifted companies, researchers and institutions to focus their efforts on improving road safety. During the last decades, the evolution in wireless technologies has allowed researchers to design communication systems where vehicles take part in the communication networks. Thus networks such as Vehicular Ad Hoc Networks (VANETs) are created to facilitate communication between vehicles themselves and between vehicles and infrastructure. Vehicular ad hoc network (VANET) is a technology that 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.

Car accident prevention, safer roads, pollution and congestion reduction are some of the goals of VANETs. The development of an efficient system in VANETs has many important benefits, from road operators as well as drivers point of view. Efficient traffic alerts and updated information about traffic incidents will reduce traffic jams, increase road safety and improve the safe driving in the city. Furthermore, it also helps in sustainable and economic ways; real-time traffic alerting will reduce trip time and fuel consumption and therefore decrease the amount of CO2 emissions [3].

Vehicular ad hoc networks (VANETs) are getting attention due to the various important applications related to road safety and traffic control. Smart cities would like to minimize their transportation problems due to the increasing population that results in congested roads. VANETs aim at solving this issue by improving vehicles' mobility and increasing road safety and also aim at having more endurable cities. At the beginning of the development of vehicular technologies, the more focus was to have more efficient and safer roads. Nowadays, due to the huge development of wireless technologies and their application in vehicles, it is possible to use Intelligent Transportation System (ITS) that will change our way to drive and help emergency services. VANETs allow vehicles to easily communicate among them and also with fixed infrastructure. This will not only improve the overall road safety, but also raise new commercial opportunities.

2. Literature Review

During 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 goals of ITS is to provide road safety, comfortable driving and distribution of updated information about the roads. Many papers related to ITS have been presented in recent years. In this section some work about ITS in smart cities is discussed.

The work in [4] is a survey about multifunctional data driven intelligent transportation system (D2ITS), 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).
There are some problems regarding object reorganization in some complex situations as shown in figure 1.

In such a situation it becomes difficult to recognize each vehicle (object) and perhaps to find out the centroid of each object. Hence it creates problems centroid of each object. Hence it creates problems while calculating traffic density. Another problem is while doing object subtraction, if the color of vehicle and the color of background matches then it becomes difficult to uniquely identify the object.

Figure 1: Complex scenario of traffic

In [5] an adaptive traffic signal control system based on car-to-car communication is presented. This system reduces the waiting time of the vehicles at the intersection along with the reduction in queue length. To realize this system, the concept of clustering is used for the vehicles approaching the intersection. The density of vehicles within the cluster is computed using a clustering algorithm and sent to the traffic signal controls to set the timing cycle. It uses DBCV algorithm. This algorithm is a combination of cluster and opportunistic dissemination technique and is used to gather the required density information. The clusters are created based on the direction of the vehicles in a given geographic region approaching the intersection. This direction parameter is computed within the vehicles by employing GPS and digital maps.
Another system [6] that takes the control decisions based on the information coming from the other vehicles. Each vehicle is equipped with a short range communication device and controller nodes are placed in the intersection with traffic lights as shown in following figure. This controller node at intersection acts as adaptive control signal system.

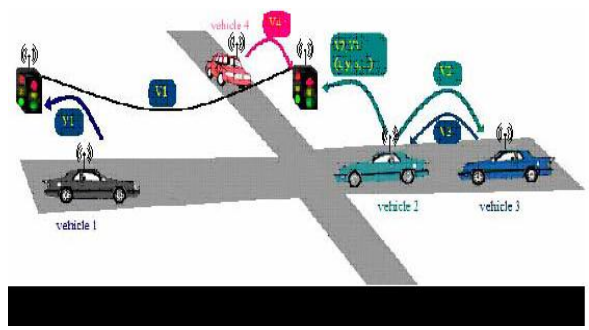

Figure 2: Traffic lights communicate with cars to adapt timings

In [5] and [6] two adaptive traffic light systems based on wireless between vehicles and fixed controller nodes deployed at intersections are designed and developed. These systems improve traffic fluency, reduce the waiting time of vehicles at intersections and help to avoid collisions.

The e-NOTIFY [7] system was designed for automated accident detection, which sends the data to the Emergencies Center and assistance of road accidents using the capabilities offered by vehicular communication technologies. e-NOTIFY focus 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.

3. Proposed System Overview

The proposed solution consists of a smart city framework that has intelligent traffic lights (ITLs) set in the crossroads of a city. 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 congestion free path. Also, ITLs will send warning messages to vehicles in case accident occurs to avoid further collisions. As [4], our proposal manages traffic information seeking to avoid accidents, although the information here is gathered from the vehicles themselves so no further infrastructure is needed. Also our proposal could easily be used by the traffic information centre to design an adaptive traffic light system similar to [5] and [6].

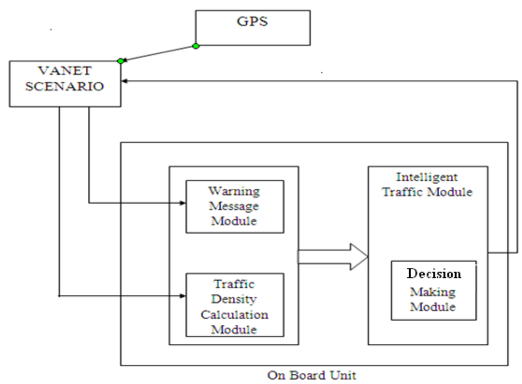

Figure 3: System Architecture

It is assumed that vehicles have a global positioning system (GPS) device, a driver assistant device i.e. on board unit, full map information of the city including the position of the ITLs, so that vehicles can easily select which is the nearest ITL. Each vehicle will transmit the hello message after every 2 second from which we get the exact location of each vehicle present on the road.

Traffic density calculation module will get the data from warning message module. Then calculations are made in this module and traffic density of each road is calculated.

The decision making module will take the data from first two module and the appropriate decision is made here and the 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 was configured with Ad hoc On-Demand Distance Vector (AODV) [8] routing protocol. AODV was selected because of its simplicity. Though it is well known that AODV is not suitable as routing protocol for general use in VANETs, there are some applications which work well with AODV with respect to situation. The main advantage of AODV is its simplicity and widespread use. The major drawback of AODV is that it needs end to end paths for data forwarding, which is difficult to handle because in VANETs end-to-end paths does not exists long due to high speeds of vehicles. Other routing protocols that use other strategies like greedy forwarding and geographical routing.

For instance, GPSR (Greedy Perimeter Stateless Routing) [8] and GOSR (Geographical Opportunistic Source Routing) [9] shows good performance in VANETs, but has greater complexity and increased delay. Other protocols like Destination Sequence Distance Vector (DSDV) and Dynamic Source Routing (DSR) are also there. AODV shows higher throughput than the DSR and DSDV.

The AODV can handle more routing packets as compared to DSR because the AODV avoids loop and freshness of routes while DSR uses stale routes. The AODV has higher throughput than other two routing protocols at high mobility [10].

The applications that require a short delay, AODV can perform well. Our proposed work consists of smart city services where vehicles send warning messages (traffic density) to the closest ITL, so it is not necessary to establish long paths that last long. Instead, vehicles need to establish very short paths (1-2 hops) to the nearest ITL.

Besides, the communication must be quick since vehicles move fast and remain in coverage range of one ITL for very short time. Thus, AODV is best suited for our purposed scheme.

4. Conclusion

In this paper, 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) that transmit warning messages and traffic statistics. The goal is that driver assistance device can take a proper trip decisions and hence avoid congested roads, which results in reduction in trip time and pollution as well and definitely enrich the drivers' quality of life.

Various routing protocols has been discussed and compared. AODV is best suited as per our proposed scheme.

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