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Vanet Based Intelligent Road Traffic Monitoring And Management System

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Abstract: Vehicular ad hoc networks (VANETs) involves vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communication and has a greater attention in the recent years. Though safety is the main objective for the development of vehicular ad-hoc network, they also provide applications like managing traffic flow and journey time. Vehicular Ad-hoc Networks (VANETs) are self-organized networks built up from moving vehicles, and are part of the class of Mobile Ad-hoc Networks (MANETs). Vanet provides a framework to design and develop an advance raod traffic monitoring syetem to reduce traffic congestion. In this paper I present a unique Intelligent Road Traffic Monitoring And Management System that could significantly improve traffic flow and safety of road users. Here I introduce a Intelligent Road Traffic Monitoring And Management System (IRTMMS) based on the VANET. The paper includes some initial simulation results which are obtained by using NS2 (Network Simulator) based simulation model. Simulation results show the proposed architecture can efficiently serve road traffic using the 802.11p based Vehicular ad hoc networks.

Keywords – Vanet, Ad hoc Network, IEEE 802.11p, Network Simulator

1. INTRODUCTION

Over 6 million crashes have been taking place every year in US causing around $231 billion economic loss [9]. The increase in traffic has increased the pollution and the accumulation of traffic near junction has caused huge amount of fuel wastage. Recent advances of wireless technologies in VANETs have helped in deployment of various safety, comfort and entertainment applications. Collision warning, road side alarms and traffic updates gives the driver essential information to decide the best path along the way to avoid the traffic blockage and accidents. Most of the safety and traffic related applications rely on dissemination of data in the network which has to be addressed in an effective way.In VANET, there is three communication modes, i.e., vehicle to vehicle (V2V) communication, vehicle to infrastructure (V2I) communication and hybrid vehicle (HV) communication are expected to be supported to provide users with safety related applications such as accident warning, road congestion control, intersection reminder, etc. V2V communication refers to vehicles communicate with each other through Ad Hoc manner, while vehicles may access infrastructures such as BS or AP directly for information interaction in V2I communication mode. In the case that no available infrastructure around, vehicles (referred to as source vehicles hereafter) may connect BS/AP through multi-hop routing with road side units (RSUs) or other vehicles serving as fixed or mobile gateways, and the corresponding communication mode is referred to as HV communication.Here we present a VANET based Vehicle to Infrastructure (V2I) based road traffic control system which can collect traffic information from individual cars and share the road traffic information over a wide area network to dynamically control the traffic signaling cycle. In the current road traffic signaling systems road side sensors are used in some busy locations of cities to estimate traffic arrivals which provide a very limited snap shot of the total traffic scenario. Due to high cost and infrastructure installation problems such systems can't be extended over all areas of large cities. Our proposed method receives total traffic information over a very wide area network by using the VANET infrastructure and disseminates the traffic information to neighboring signaling nodes over a wide area so that traffic signaling sequencing can be planned in advance to reduce traffic congestions, reduce journey time.

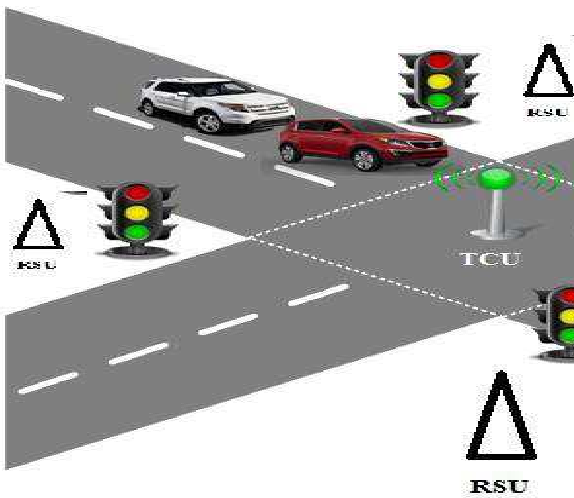

Figure 1 The basic architecture of the V2I communication

2. REVIEW OF INTELLIGENT ROAD TRAFFIC MONITORING AND MANAGEMENT SYSTEM

Most of the previous works on the detection method of real time traffic in intelligent transportation system are based on wireless sensor networks (WSNs), Radio frequency identifiers (RFIDs), Video and image processing or loop detectors. Reference [5] proposed an adaptive scheme for changing the signaling phases where vehicle movements and traffic flow is detected using a wireless sensor network. Road information such as vehicle density, speed, length of the cars were accumulated and sent to the intersection control agent (ICA) to optimize the signaling sequence for the adaptive traffic signal settings. The performance of the system was analyzed in an open loop manner. Traffic flow statistics measured by the wireless sensor network were fed into the traffic simulator for performance analysis.

In Reference [6] it was suggested to mount the RFID tags on the vehicles to determine the vehicle density on different roads for implementing intelligent road traffic signaling system. A central computer system will handle the dynamic database where vehicle information will be sorted out by the vehicular identification number (VIN) and the volume of the traffic. The computer model can handle number of variables such as type of car, priority of vehicles, time of the day or night etc. The document didn't present any performance analysis of the RFID based adaptive traffic signaling system. An RFID based system is very similar to currently used e-tag system, however such systems require significant roadside infrastructure to collect vehicle information.

An adaptive traffic light control system has been proposed in Reference [4] based on a learning algorithm. To acquire the optimum signal phase for each traffic light a road-user based function has been used where the decision is made by the cumulative vote of drivers waiting at the intersection. The proposed algorithm allows drivers to choose the route which has the lowest expected waiting time. This may lead to a crowed state as all the drivers may choose same route.

Reference [3] proposed a Direction Based Clustering algorithm (DBCV) based on the VANET which is used to measure the density of the vehicle approaching at an intersection. The model uses the V2V communication architecture and optimizes the adaptive signaling phase is estimated by modifying the Webster's equation. The transmission range is not sufficient to accommodate high volume of approaching vehicles.

3. VANET BASED INTELLIGENT ROAD TRAFFIC MONITORING AND MANAGEMENT SYSTEM

The VANET is uses cars as mobile nodes in MANET to create a mobile network. A VANET turns easy participating car into wireless router or nodes allowing cars approximately 100 to 300 meters of each other to connect and, in turn, create a network with wide range. As cars falls out of the signal range and drop out of network, other cars can join in, connecting vehicles to one another so that a mobile internet is created. A VANET is used for the short range communication among the roaming vehicles as well as between the vehicles and the road side information infrastructure. Usually, the moving vehicles are equipped with On Broad Units (OBU) (IEEE802.11p based units) and the road side communication infrastructures are referred to Road Side Units (RSUs). For the wireless access in the vehicular environment (WAVE) the new WLAN standard IEEE802.11p was developed which is also referred to as Dedicated Short Range Communication (DSRC) that offers strong baseline for the V2V and V2I communication. The licensed spectrum of 75MHz has been allocated at 5.9GHz for the DSRC. The physical layer of the IEEE 802.11p is similar to the IEEE 802.11a standard. Although in both cases OFDM (Orthogonal Frequency Division Multiplexing) technique has been adopted but the channel width has been reduced to 10MHz from 20MHz for the DSRC applications.

The basic packet transmission mechanism used in the IEEE 802.11 protocol is the distributed coordination function (DCF). It adopts the carrier sense multiple access collision avoidance (CSMA/CA) method to support the random access scheme for the basic service set (BSS) devices. The DCF can support the ad hoc network without any infrastructure element such as the access point. For applications such as intelligent road traffic Monitoring and Managments system (IRTMMS) the VANET needs to accommodate mobility of the vehicles. Usually the speed of the vehicles in an urban road network can vary from 40km/h to 80 km/h. The latency requirements of the IRTMMS are moderate, particularly for the city traffic. For the highest speed in a city for a packet transmission delay of 1 sec the maximum distance a vehicle will travel is only 22.22 meters. Hence, it is feasible for a VANET based system to accurately obtain traffic information using the on board unit (OBU) within a vehicle. In the next section detail performance evaluation of the VANET is presented. One of the main design issues of the IRTMMS is to control the total channel traffic so that QoS (Quality of Service) can be maintained. The idea used in the system design is very simple. A road infrastructure unit known as the RSU is responsible for periodically broadcasting signaling and other road traffic information on the downlink of a communication network. The car on board unit sends vehicle information such as car ID, type, destination/route, etc. via the uplink to the RSU. The OBU supplies information packet via the IEEE802.11p link on the uplink. The RSU supplies the information to the traffic analysis server that controls the traffic signal parameters. For a wide area networked based traffic control system the RSUs are connected by a backbone network where RSUs can exchange traffic information.

Communication network

The communication infrastructure of the proposed IRTMMS is shown in figure 2. The system utilizes the basic architecture of the V2I communication application of the DSRC consisting of RSUs and OBUs, where RSUs are connected through an TCU. Each RSU covers 500 meters sized cell that allow the all cars approaching a junction can communicate with the RSU. Each RSU covers 500 meters sized cell that allow the all cars approaching a junction can communicate with the RSU. The RSU via the broadcast packets send the signaling information based on received traffic information. At any particular road intersections such as crossroad or T-junctions the RSUs can be used to disseminate the traffic signaling information to the OBUs. The driver has to react with information received by the OBUs embedded in the vehicle navigation system.

Signaling system

The proposed model for the IRTMMS has been developed by taking into consideration of the network operating characteristics and the vehicular mobility modeling issues. The RSU broadcasts the signaling information based on the measured statistics of the traffic flow coming at an intersection. The RSU process a unique optimization scheme has been implemented to adjust the timings of the adaptive signaling system. Whenever an OBU comes into the coverage area of a RSU and gets the first broadcast message from the RSU, the OBU keeps on sending unicast massages with an interval of 5sec to the corresponding RSU to update its speed, position (latitude and longitude), and time to reach the intersection. The RSU updates the list of the active OBUs in the range after every 5 sec and broadcasts the current traffic signal state every second to all OBUs. By comparing the remaining time to reach the intersection and the current signal phase duration an OBU can determine whether it will be Green, Amber or RED signal phase when it will reach the intersection. Thus the OBUs can take necessary actions such as whether to decelerate or to continue its current speed based of the information. Figure 4 shows the working principal of our proposed IRTMMS.

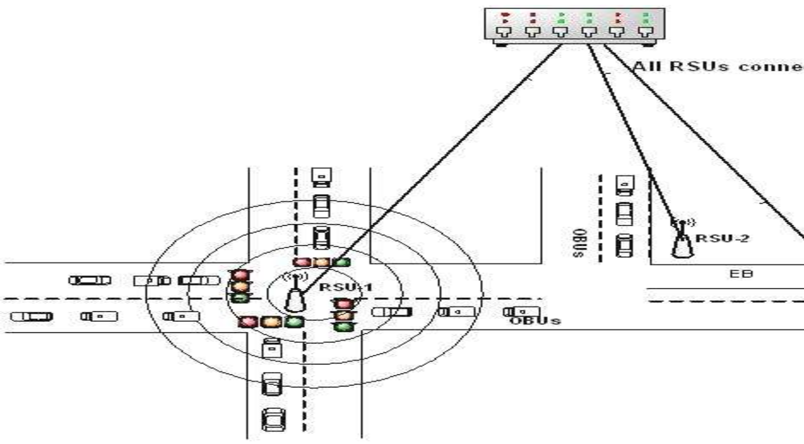

Figure 2: Illustration of the Road Network and the Communication network architecture for IRTMMS

4. CONCLUSION

In this paper a novel VANET based intelligent road traffic monitoring and management system has been presented. The intelligent traffic signal adopts an unscheduled signaling scheme that optimizes the signal durations based on a real-time traffic estimation technique. The IRTMMS has been developed based on a simplistic VANET architecture. The model will be further developed to implement a wide area traffic control system. In the wide area traffic control system all OBUs will be connected to TCU via a RSU that will allow traffic information over a large area to be distributed to all OBUs resulting better traffic control mechanism. The wide area system will also allow vehicles to inform the OBUs about their final destination. OBUs could use the destination information to calculate load on different roads and possibly load balance traffic on different roads to reduce the congestions. As a part of the future work the research is working on the development of such a wide area traffic control system.

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