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Real–Time Intelligent Transportation System based on VANET

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Abstract - ***There is a rapid growth in the field of Vehicular Ad-hoc Networks (VANET) as they are being used for many applications. One of the important application of VANET is in Intelligent Transportation systems (ITS). It consists of vehicle-to-vehicle and vehicle-to-infrastructure communications based on wireless local area networks. Traffic accidents and congestion problems are becoming more worse these days. Because of vast number of vehicles on road, transportation sector is significantly stressed, this leads to more accidents and fatalities, and adverse environmental and economic impact. One of the solution to all these problems is to have an intelligent transportation systems, which will help to avoid traffic related problems and can make our life easier. Many techniques have been developed in the field of vehicular ad hoc networks, but they are not that efficient and face a lot of problems at the time of implementation. This paper gives an overview of the past few techniques in this field and presents a real–time intelligent transportation system based on VANET, which addresses the issues of earlier techniques. This technique is based on the RFID and ARM controller to minimize the traffic congestion with proper signal control, at the same time, path planning will take place to provide the vehicles with suitable path having minimum traffic with the help of android mobile application.***

Key Words: *VANET, ITS, signal control, path planning, android mobile application.*

1. INTRODUCTION

Traffic congestion, as an important societal problem, has received considerable attention. The survey of 2007 Urban Mobility stated that the traffic congestion causes 4.2 billion hours of extra travel every year in U.S.; it almost accounts for 2.9 billion extra gallons of the gasoline [1]. Although many existing advanced navigation devices have functionalities of providing an optimal end-to-end path [2], [3], traffic congestion problems have not been fully resolved. Conventional techniques still face a number of technical challenges, for example, Google Maps involve the existing networks for individual path planning to avoid the traffic congestion. However, these provided services are very costly, and they are unable to make quick response to an emergency situation caused by any accident/incident. The main reason for this imperfection is the lack of real-time traffic information. Thus, to enhance the performance of path planning, it is essential to study how to efficiently collect and further utilize the real-time traffic information for path planning and traffic congestion avoidance.

Intelligent Transport Systems (ITS) describe technology applied to vehicles and infrastructure (RSU) to transfer information between them to improve the safety, productivity and avoiding traffic congestion. This includes applications such as traffic management systems, information and warning systems, as well as cooperative ITS applications involving vehicle-to-vehicle as well as vehicle to infrastructure communications [2].

Intelligent transportation systems are advanced applications that are aim to provide innovative services related to transport and traffic management and allow various users to be better informed and make safer, more coordinated, and much smarter use of transport networks [1].

Vehicular Ad Hoc Networks (VANETs) are formed by applying the principles of mobile ad hoc networks (MANETs) which are the spontaneous creation of a wireless network for data exchange. They are a key component of intelligent transportation systems. VANETs support a wide range of applications from one hop information dissemination to multihop dissemination. Most of the concerns of interest in mobile ad hoc networks (MANETs) are of interest in Vehicular ad hoc networks, but their details may differ. Rather than moving at random, vehicles tend to move in some organized fashion [1].

First, to collect the real-time traffic related information, VANETs can provide the enhanced communication

capabilities for cost effective and real-time traffic information delivery [4]. Both vehicle-to-vehicle and vehicle-to-roadside communications are supported in VANETs to efficiently collect/report traffic updates from/to vehicles as well as roadside units. As a result, the collected real-time traffic information can be utilized for freeway-traffic-flow management, individualized vehicle path planning, and vehicle localization [5]. However, most of the related works assume that the incorporated techniques have sufficiently small delivery delay for real-time collection of the information. As vehicular ad hoc networks rely on short-range communications, the transmission delay cannot be neglected in some scenarios. Therefore, it becomes necessary to study how the transmission performance affects the performance of path planning and how to design the different transmission mechanisms to reduce the delay when it cannot be neglected [6], [7].

Second, to utilize the obtained real-time traffic data, many algorithms are designed to discover optimal paths for individual vehicles. However, individual path planning may lead to new congestion if it is not performed coordinately. To smooth the network flow, many works plan optimal paths from a global perspective for a group of vehicles [8]. However, most of the existing path-planning algorithms focus more on the network-side performance improvement than the drivers' preferences (for e.g., travel length). Since the re-planning decisions are made to avoid traffic congestion and balance the traffic rather than discover optimal paths for some of the individuals, some vehicles may pay additional cost (for e.g., a longer travel length). Therefore, algorithms should be designed to jointly consider the balance of the network traffic and the reduction of average travel cost of the vehicle [9], [10].

We propose a real-time algorithm that utilizes the VANET communication capabilities to avoid vehicles from traffic related congestion in an urban environment. Both the network spatial utilization and vehicle travel cost are considered equally important to balance both the overall network smoothness and drivers' preferences.

2. RELATED WORK

Traffic congestion can result in late arrivals and additional cost for drivers and becomes a major problem in transportation, caused because of unbalanced traffic flow or an emergency because of sudden accident or any incident. However, this cost can be reduced by route navigation or path planning which will help to avoid congestion. For example, the vehicles can be rerouted with the shortest path based on GPS navigation [11], advance route reservation [12] and the accident duration prediction [13]. However, these approaches are not effective to make quick response to an emergency due to a sudden accident since a real-time update of the traffic information is lacking. Thus, the real-time traffic information delivery is important.

To collect real time traffic information, most existing techniques in conventional ITS usually rely on cellular systems and/or loop detectors. Cellphones with cellular access have been investigated to collect real-time traffic condition information. For continuous traffic measurement and monitoring, a traffic management system with loop detectors is introduced. However, because of inevitable drawbacks, the application of cellular systems and loop detectors are lacking somewhere. As cellular systems are not dedicated for traffic data collection, these collection services can be costly, and the traffic congestion becomes even more worse for high volume of traffic data. The deployment expense can also be very high, for the loop detectors. Also, the inaccuracy of position measurement can cause a serious problem for short-distance transmissions in dense networks, which may degrade the performance of path planning algorithm [14].

Vehicle to vehicle and vehicle to infrastructure communications in VANET can make real-time information delivery much quicker and cheaper, to become more efficient than the existing systems. Moreover, RSUs in VANET are capable of enhancing the timeliness of data collection and dissemination, and hence it is possible to perform coordinated path planning more effectively for a group of vehicles [15].

Many techniques have studied real-time vehicle path planning with VANETs. A distributed path planning method is studied to avoid congestion using real-time traffic information collected from VANETs, with increased amount of traffic flow. A navigation system is studied to save gasoline for individual vehicle, and also to avoid congestion. However, the individual path planning may introduce additional amount of traffic congestion due to human uncoordinated selfish behaviors. Thus, to balance the network traffic, the paths of different vehicles should be jointly planned. In multivehicle path planning, the drivers' preference or the average travel cost is not considered. Moreover, how the communications in VANETs can affect the path planning algorithm is still not clear [15].

Many techniques have been developed in the field of VANET communications. A brief summary of some of the earlier VANET techniques supported by consortia in USA and Japan are given below.

Some of the earlier techniques includes:

Fleetnet mainly concentrated on various research areas and it is supported by some manufacturers and academic centers in Europe. It is based on vehicle to vehicle as well

as vehicle to infrastructure communications with the main objective of driver assistance and security. It includes character description of VANET, suggesting the new routing and MAC protocols, with exploration of other technologies in wireless and Ad-Hoc [16].

The main objective of the VII (Vehicle Infrastructure Integration) project is to deploy the communications infrastructure that will support the vehicle to infrastructure communications as well as the vehicle to vehicle communications, for a variety of vehicle safety and security applications. Principal applications are under development such as noticing drivers for unsafe situations and collisions which they can avoid [16].

VSC (Vehicle Safety Communications) consortium has run many experiments in coordination with the National Highway Traffic and Safety Administration (NHTSA). Its objective is to improve safety scenarios with the use of Dedicated Short Range Communication (DSRC) along with positioning systems, with the requirements and parameters for safety applications, traveller information, on board entertainment and fuel efficiency [16].

The IVI (Intelligent Vehicle Initiative) goal is to decrease the severity of crashes through avoiding driver mistakes. It is based on vehicle to vehicle communication only [16].

The C2C (Car-to-Car Communications) project was started in 2001 and its main objectives is the development and release of an open European standard, driver assistance and safety applications. It is based on vehicle to vehicle communication only [16].

Goal of NOW (Network-on-Wheels) project is to perform optimum protocols for transferring messages in addition to methods for secure data transfer that used in Car to car communication consortium. It is based on vehicle to vehicle communication only [16].

The CVIS (Cooperative Vehicle Infrastructure System) project was developed in 2006 to design, develop and test the techniques to allow cars to communicate with each other (V2V) and with the nearby roadside infrastructure (V2I) with goal of road safety and productivity. It is based on vehicle to vehicle as well as vehicle to infrastructure communications [16].

The main objective of EVITA (E-safety vehicle intrusion protected application) project is to design and verify an architecture for automotives with security components and sensitive data protecting. In addition, it also focuses on protecting the intra-vehicle communication. It is based on vehicle to vehicle as well as vehicle to infrastructure communications [16].

Some of the recent techniques includes:

Realization of the bus transportation system is studied, which uses the radio frequency identification (RFID) and wireless sensor technology [17], [18], to enhance the public transportation systems.

Intelligent transportation system with wireless sensor networks based on ZigBee technology is studied, to monitor the online travel buses in real-time, to achieve the purpose of intelligent management as well as traffic measurement [19].

A predictive road traffic management system (PRTMS) is studied, which is based on the Vehicular Ad-hoc Network (VANET) architecture [20]. PRTMS uses a novel communications method to estimate the future traffic flow at different intersections based on a linear prediction algorithm. With this prediction, a central controller starts reducing the congestion level by re-planning the vehicle path.

Vehicles equipped with the onboard units to enable V2V communication used in delivering the vehicle information is studied, (for e.g., vehicle location, vehicle density, and its velocity) [1]. When vehicles sense any accident related congestion, the warning message will be generated and shared among vehicles as well as with the nearest roadside unit via V2R communications.

3. PROPOSED SYSTEM

Overview of the main system is shown below in fig.1

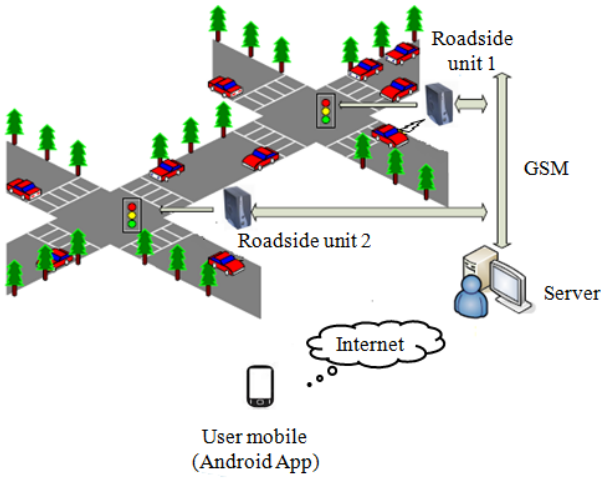

Fig -1: Overview of the system

The system contains following main components:

3.1 Signal monitoring and control:

Signal monitoring and controlling is becoming more complicated in today's life, where nobody is ready to wait

on signal until it turns into green. This leads to large number of accidents and traffic congestion. One of the solution to this problem is to control the traffic signal on real time using Vehicular Ad-Hoc Network (VANET) protocol. So that nobody has to wait unnecessarily on the signal, and it can be helpful to minimize the accidents at the signal.

3.2 Path planning:

Because of rapid growth of the car ownership, traffic congestion problems have become a very crucial problem, causing great inconvenience in people's daily life and to their work and also bring environmental pollution, waste of energy, and traffic jams. This greatly affects the improvement of people's living standard as well as the social and economic development. Path planning for the urban traffic can solve the problems of road congestion, travel inconvenience to a certain extent.

3.3 Cloud computing:

All the traffic logs and data can be maintained on cloud which can be helpful to analyze city traffic and beneficial to take various traffic control decisions.

3.4 System view:

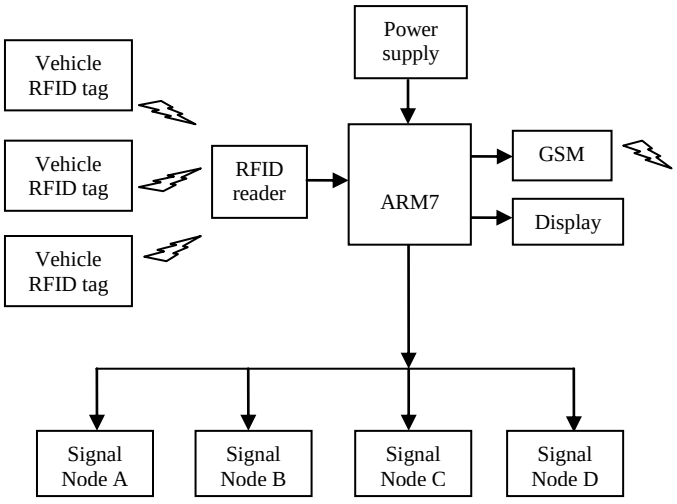

Fig -2: Block diagram of the roadside unit

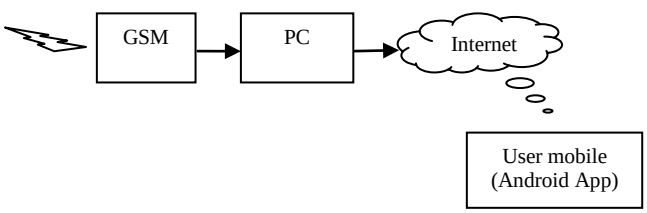

Fig -3: Block diagram of the server unit

Fig.2 shows the block diagram of the roadside unit, every vehicle equipped with RFID tag will be read by the corresponding roadside unit having RFID reader. By sensing all the vehicles present at particular signal node by their RFID tag, the roadside unit will collect the information about strength of traffic on that road, and the information is processed by the controller.

The traffic cycle is controlled by sensing the amount of traffic at each signal node (i.e. at every junction) and according to this, appropriate time will be allocated to each signal node, namely, signal node A, signal node B, signal node C and signal node D. This time slot may vary at every instance depending upon the quantity of vehicles at that node. Because of this, nobody has to wait unnecessarily on the signal, and it can be helpful to minimize the accidents.

Information collected by each roadside unit will be provided to the central server via GSM which will be stored in database. Fig.3 shows the block diagram of the server unit, user can have access to this server via an android mobile application. By providing the source and destination in this application, user will be recommended with a path having minimum traffic. This can solve the problems of road congestion, traffic jams, travel inconvenience to a certain extent.

Proposed system is a privacy preserving system, as it senses the vehicles by their RFID tag and processes this information. It does not need any other details of those vehicles, hence privacy is maintained.

4. CONCLUSION

In this paper, different techniques in the field of vehicular ad-hoc networks are studied. To address their issues, one suitable approach is recommended, which will minimize the traffic congestion with the help of a system based on RFID and ARM controller. Also, the android mobile application will help the user to find a path with minimum traffic to their destination. This can solve the problems of road congestion, traffic jams, travel inconvenience to a certain extent.

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