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Controlling Traffic Light Signals to Implement Traffic Scheduling Using Density Calculation

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Abstract— Road traffic is continuously increasing around the globe resulting in to congestion which has become a major concern for the transport management specialists and decision makers. The existing fixed time methods for traffic signal management, surveillance and control are not adequately efficient. The propose system is the Traffic Management System using Density Calculation and Emergency Vehicle Alert which mainly focuses on traffic signal management by density calculations and assigning priority for the emergency service vehicles like Fire Services, Police Vehicles, Ambulances etc. to provide better and smart traffic signal management. Considering the main scenario at time when there is no vehicle on one lane and suppose if the traffic gets on increasing on other lane then, the problem with previous algorithm was that, the vehicles on first side would have to wait for the signal to go green even if there is no vehicle on the first lane . We are proposing such a system that deal with such kind of problem by automatically switching the signal by calculating the density at intersection and switching the signal if the density of vehicle is high then the maximum time is allocated. We also introduce emergency vehicle alert and allow emergency vehicles to pass without waiting.

Keywords— Road Side Unit (RSU), Traffic Control Unit (TCU), VANET, Vehicle To Infrastructure (V-2-I), Intelligent Traffic system (ITS).

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I. INTRODUCTION

The proposed system will examine the possibility of deploying an intelligent real-time traffic signal controller, which will receives information transmitted from vehicles, such as the position and speed of vehicle, and then utilizes this information to optimize the traffic signal scheduling at the intersection. To monitor the density of the traffic, we will keep the Road Side Unit (RSU) besides the road and depends upon the images from the Road Side Unit (RSU), the delay of the traffic signals will be increase or decrease. The Improved Priority Based Signal Management in Traffic System is to solve traffic congestion problem which is a big problem in many modern cities all over the world. We have designed a framework for a dynamic and automatic traffic light control system and developed a simulation based model with codes in to help build the system for solving the problem. Generally, each traffic light on an intersection is assigned fixed signal time. It is possible to propose dynamic time-based coordination schemes where the green signal time of the traffic lights is assigned based on the present conditions of traffic.

The Improved Priority Based Signal Management in Traffic System is used in heavy traffic roads and the junction which is based on the time as well as the density and the time delay will be controlled and density will control by programme coded. If the traffic density is high on particular side more priority is given for that side. The Road Side Unit (RSU) continuously keeps watching density on all sides and the green signal is given to the side on priority basis, though there is no traffic on the other side it can be avoided. Maximum density of traffic will allow traffic with maximum timing assigned. Minimum density of traffic will allow traffic with minimum timing assigned.

II. LITERATURE SURVEY

In the recent past, researchers have tested a wide array of technologies in an attempt to find improved methods of monitoring traffic conditions. This research in traffic surveillance has ranged from studies of traditional loop detection methods to the use of anti-submarine warfare technology. h. A brief survey of technologies explored during the past decade and a half is given below to provide an understanding of the level of research interest in traffic surveillance technologies.

Bohnke and Pfanner still acknowledged a need for more reliable traffic data acquisition than localized data collection generated by traditional loop detectors (1986). The pair introduced a pattern recognition algorithm which could utilize unique vehicle presence signatures generated by successive series of inductance loop detectors. By identifying and re-identifying platoons of vehicles travelling across links bounded by loop detection equipment, vehicle travel times could be obtained.

Ju and Maze performed simulations on incident detection strategies using the FREQ8PE simulation model (1989). Their research evaluated a comparison of incident detection strategies using police patrol versus the use of motorist call boxes at 1 km spacing. The motorist call boxes formed the backbone of the modelled freeway surveillance and control system (FSCS). This FSCS yielded a benefit-to-cost ratio of 2.69 as it generated benefits from travel-time reduction and reduced fuel consumption. These benefits were brought about by reduced incident detection time afforded by the motorist call boxes.

AT&T experimented with the use of applied acoustic and digital signal processing technology to produce a vehicular traffic surveillance system (Nordwall, 1994). Labelled the Smart Sonic Traffic Surveillance System (Smart Sonic TSS-1), the project was intended by AT&T to replace buried magnetic loop9 detection systems. This technology was originally

developed from research used by the U.S. Navy for submarine detection purposes. Mounted above passing vehicles, the Smart Sonic TSS-1 listens to the acoustic signals of vehicles and is capable of distinguishing between larger trucks or buses and smaller vehicles. Applications were to include traffic monitoring and vehicle counting, with the potential for incident detection being an area for further research.

In their discussion of video-based surveillance, Berka and Lall continue the discussion of improving upon the use of loop detection to gather traffic data (1998). The authors claim that loop detection reliability is low, and that maintenance and repair of such a pavement-based system creates safety risks for repair crews. Berka and Lall maintain that non-intrusive technologies such as video surveillance provide reduced traffic disruption during installation or repair. In addition, video surveillance is capable of detecting incidents on the sides of roadways, outside of the detection range of loop detectors.

III. RELATED WORK

Many techniques have been used including, above ground sensors like video image processing method, microwave radar method, laser radar, passive infrared, ultrasonic, and passive acoustic array. However, these systems have a high equipment cost and their accuracy depends on environment conditions. Another widely-used technique in conventional traffic surveillance systems is based on intrusive and non-intrusive sensors with inductive loop detectors, pneumatic road and micro-loop probes in addition to video cameras for the efficient management of public roads[3][4]. However, intrusive sensors may cause disruption of traffic upon installation and repair, and may result in a high installation and maintenance cost. On the other hand, non-intrusive sensors tend to be large size, power-hungry, and affected by the road and weather conditions; thus resulting in degraded efficiency in controlling the traffic flow.
The sensor nodes that are to be deployed along the road are small in size and have low energy consumption [11]. These sensors run on both battery power as well as solar energy. They have the capability and potentiality to draw solar energy so that they can use sunlight for functioning in bright and sunny condition and the battery power for functioning at night or in cloudy, foggy and rainy condition. Sensors used in the Wireless Sensor Network for traffic signal systems are mainly of two types: i) Intrusive type and ii) Non-Intrusive type [12]
(i)Intrusive types of sensor are kept under the road and sense the traffic waiting at the signal. This type of sensor has the similar working principle as that of a metal detector. (ii) Non-Intrusive types of sensor is fitted on the road. The establishment of this type of sensor is easy as no cutting of road is needed to be done. Non-intrusive sensor includes audio sensors or video image processors to detect the presence of vehicles waiting at the traffic intersection. Although Intrusive sensors are very effective or efficient still Non-intrusive sensors are preferred over Intrusive sensors as they are cost-effective, easy to install, immune to natural corrosion and degradation.

In energy efficient protocols which are used to improve traffic safety using WSN were proposed and widely used to implement an intelligent & smart traffic management system. In vehicle to vehicle communication (V2V) scheme between neighbouring vehicles and in the absence of a central base station was proposed earlier. Traffic Management System using Density Calculation and Emergency Vehicle Alert has the potential to revolutionize traffic surveillance and control technology because of its low cost, easy to use and potential for large scale real time deployment.

Traffic Light optimization is not simple problem, even for single intersection there might be no optimal solution. With multiple intersections, the problem becomes even more complex, as the status of one light influences the flow of traffic towards many other lights. Another major issue is flow of traffic density constantly changes, depending on the day of the week, time of day. Road construction work or road accidents also influence complexity and performance. In this paper, we propose two different approaches the first approach is communication between the road side unit and then road vehicles for density calculation. The second approach to process the input data by Computer and finally display it on the traffic light signal to control the System.
Several other vehicle detectors such as microwave detectors, loop, infrared, ultrasonic, and radar exist in the literature. These sensors are more expensive with limited or less capacity and involve implementation, maintenance, and installation difficulties. For example, loop sensor might need maintenance due to road ground deformation or metal barrier near the road might prevent effective detection using radar sensors [1]. In recent years, video for vehicle detection processing techniques have attracted researchers.

IV. PROPOSED SYSTEM

The proposed system describes to overcome the problem of traffic jam on intersection at the Traffic Signal system [13] [14] is introduced. Here the first objective idea is to calculate the density of vehicle on the road for flow traffic smoothly without congestion. Second objective is developing Priority Based Signalling which helps to give the priority to the emergency vehicles.

This approach is used to control the traffic smoothly. It is also helpful to overcome the traffic jam problem to reducing the delay problem and avoiding congestion. It also helps in providing the emergency services like Ambulance, Police or Fire Brigade Vehicle, on pursuit at right time. Traffic Signal Management when properly maintained designed and operated yields significant benefits like saving fuel consumption, less congestion. Vehicle emissions are also reduced and it also improves the air quality.

Fig. 1 Traffic Scenario showing vehicles on one lane with the other three lanes as empty.

The above given Fig.1 explains the phase1 i.e. the traffic scenario in which only one lane consists of vehicles and other lanes being empty or no vehicle is there, but still the vehicles need to wait for the signal to get green. The delay for the vehicles waiting for the signal to get green is very large, so the solution to this problem is to re-time the green signal if the density on the other lanes is very low. If this solution is not provided to the signals then the tendencies of road disasters may occur such as accidents because if by chance a vehicle arrives from one lane and the vehicles on the other lane don't hesitate to wait for a long time and moves forward, then there is a chance of a disaster or accident. Maximum density [15] [16] of traffic will allow traffic with maximum default timing assigned. Minimum density of traffic will allow traffic with minimum defined timing assigned [17]. It explains that if the traffic density of the lane increases, then the green timing increases accordingly. The given graph in Fig.2 explains about this.

Fig. 2 Traffic Density vs. Green Timing

Fig. 3 Showing Emergency Vehicle Alert

The above given figure. 3. shows emergency vehicle alert [18] [19] that will transmit the vehicle geo-location which will then be received by the road side unit at signal and it will start the green light and this light will be in ON state till the vehicle is within the GPS range. This will be useful for the emergency vehicles such as Ambulance, Police cars, Fire Brigade.

The Traffic Management System using Density Calculation and Emergency Vehicle Alert, track traffic density at intersection using Road Side Unit (RSU) and Traffic Control Unit (TCU) will decide the timing of the traffic signal. The delay given for Red or Green Signal at a square will dynamically determine the traffic density by communicating with the vehicles Road Side Unit (RSU) and transfer the information to Traffic Control Unit (TCU). The uniqueness of our work is that the control is not just based on traffic density calculation but priority also. Priority will be given to the specific class of vehicles like Ambulances, Police Department Vehicles and Fire Department Vehicles etc. The Traffic Management System using Density Calculation and Emergency Vehicle Alert. System is capable enough to track multiple priority based vehicles.

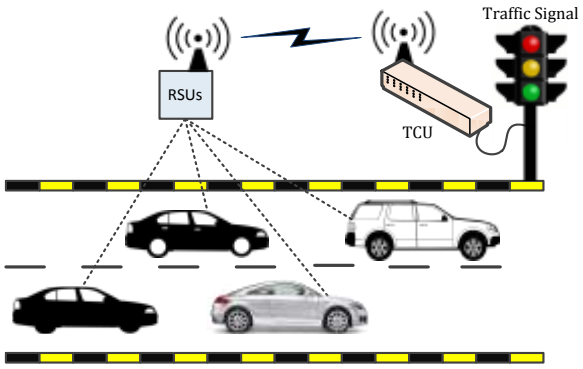

Fig. 4 Roadside Units Communication with Vehicles

Fig. 4 shows the one side lane where each vehicle communicates with the RSU and according to the data received from RSU; the TCU will decide the signal timing of the particular lane. If the RSU shows high density then the TCU will make the signal active of that particular lane. Vehicular Ad Hoc Network (VANET) is a network in which each node represents a vehicle equipped with wireless communication technology and can communicate with other nodes like other vehicles or Road Side Units (RSUs).The main goal of VANET is to provide safety and comfort for passengers on road. A Road Side Units (RSUs) is an access points, used together with the vehicles, to allow information dissemination in the roads. The concern data can be used to create Intelligent Traffic Management Systems, which can automatically update traffic light delay, assigning priority to the emergency vehicles or study the daily population of vehicles in the road etc.

V. METHODOLOGY

Each vehicle fitted with a RF transmitter woks at a predefined frequency at factory or can fit as a custom accessory in the vehicle. At every intersection there is a RF receiver fitted known as Roadside Unit (RSU) for the particular lane of the road. As soon as the vehicles come nearby to RSU, the transmitted data collect by the RSU and will calculate the number of vehicles as per the communicating nodes.

Density Calculation: Wireless technologies, through vehicular networks, enable peer-to-peer wireless communications vehicles and infrastructures (V2I). A Road Side Unit (RSU) establishes the connection between vehicle and Traffic Control Unit (TCU) i.e. Adhoc just to inform the Arrival of Vehicle. The capacity of vehicles to communicate with an infrastructure depends on the number and radio coverage of existing RSUs in the nearby area.RUS inform to switch the Green time as per the number of connection that is density.

Traffic Signal Switching: Traffic Control Unit will switch the traffic signal on the regular pre-defined interval of time. The signal will switch on the basic of information provided from the Roadside Unit. If the density of the road traffic is high then maximum density of traffic will allow maximum default timing for traffic lights and minimum density of traffic will allow traffic with minimum timing for traffic lights.

Emergency Vehicle Alert: The Roadside Unit will continuously communicate with the on road vehicles. As soon as the Emergency Vehicle comes near to intersection, it will broadcast emergency packet which will receive by the RSU. It will send Acknowledge to the TCU (Traffic Control Unit) to clear particular lane till the time ok packet generated by the emergency vehicles.

Fig.5 Simulated Result of the System

Fig. 5 shows the snapshot of the traffic signal where the signal with high density get active with the help of RSU that calculate the number of vehicle on the lane. The right hand side block shows the data calculation done according to the receiving of signal with the help of OMNET++ simulator. The green rectangle shows the lane where is green signal is currently active. The other three red rectangles show the red signal of the lane. The four channels across the road are the RSU receiving device. The Traffic Management System using Density Calculation and Emergency Vehicle Alert aims at saving a large amount of man-hour cause by traffic problem. In the future this system may be implemented for the practical implementation which will work for various dynamic traffic flows.

VI. CONCLUSION AND FUTURE SCOPE

An intelligent traffic light controlling system with a enhance method of vehicle density calculation and dynamic traffic signal time manipulation along with emergency vehicle alert is used for the entire project. The Traffic Management System using Density Calculation and Emergency Vehicle Alert demonstrate how the Traffic Light Signal control, including with the implement of Traffic Scheduling Algorithm which is used to gain information from the vehicle position and the speed. The acquired data from Road Side Units reschedule the traffic light timing according to the traffic condition for low or high density road traffic. If the density of the road traffic is high then Maximum density of traffic will allow maximum default timing for traffic lights. Minimum density of traffic will allow traffic with minimum timing for traffic lights. If the traffic rate on both side is Equal or gap within traffic then according to arrival time traffic light signal set to minimized. The simulated result under high as well as low density road traffic load.

The proposed approach will consider not only the priority of the vehicles but also the density of the vehicles on the road and also will control the traffic light sequence efficiently and more accurately and the accuracy of the GPS is more than that of a Camera. This system aims at saving a large or huge amount of man-hours caused by traffic problems and accidents, where prevention can save lives and property. It is able to manage priority emergency tag vehicles.

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