Solution for Traffic Congestion Using Smart Vehicles and Adaptive Traffic Control System

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ABSTRACT

In a large city or any area where there are lots of commuters on the road, then one faces the effects of traffic congestion. What one may not realize is the extent of the effects heavy traffic congestion can have. This gridlock can have a tremendous impact on one's personal life, career, future and even safety. Finding a solution to traffic congestion could mean a vast improvement in the quality of life in an area. This project aims at tackling this problem by using smart vehicles with V2V technology and adaptive traffic control system based on radio propagation model. With V2V communication, cars are connected to each other, which enables them to share data with other cars on the road, which will help reduce traffic and prevent accidents. Ultimately, vehicles are connected via multiple complementary technologies of vehicle to-vehicle (V2V) and vehicle-to-infrastructure (V2I) connectivity based on Wi-Fi, GPS, Dedicated Short Range Communication (DSRC). Also, an approach to make the traffic signal adaptive to the dynamic traffic flow using Vehicular adhoc network is implemented. The proposed approach is simulated using Vb.net and compared with the already existing fixed time traffic control system. From the results obtained it is observed that the proposed approach possesses better working than the existing approaches.

Keyword : - *V2V, DSRC, V2I, Smart Vehicle, Adaptive Traffic Control System.*

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1. INTRODUCTION

Traffic management in the urban city plays a major role in this era. Rise in traffic congestion is an inescapable condition in large and growing metropolitan area across the world. Peak-hour traffic congestion is an inherent result of the way modern society is operated. It stems from the wide spread desires of the people to pursue certain goals that inevitably overload existing roads and transit system every day. Traffic congestion is not primarily a problem but a solution to our basic mobility problem which is that too many people want to move at the same time each day.

Although it seems impossible, technology can help. For example, cities can use aggregated data from connected vehicles to automatically identify potholes and other poor road conditions. This data can be integrated with government management so that public or maintenance workers can automate dispatching and work orders. One solution to traffic congestion would be to develop a smart city which is integrated with IoT, which will make public transit convenient.

In this project we propose the utilization of Vehicle-to-Vehicle(V2V) communication and implementation of adaptive light control system using approaches such as Genetic Algorithm, Fuzzy Logic Control, Neural Network, etc. V2V technology is when one vehicle is able to communicate with another vehicle nearby – in front, behind, etc. It is the core of autonomous driving technology, where sensors can detect what is going on around the vehicle and additional technology can share that data with other vehicles on the road. This will result in fewer accidents and driver caused traffic thereby reducing congestion. Adaptive traffic light signals get a better idea of traffic flow and how long a vehicle idles at stop lights. This data can be used to modify the traffic signal timing with the changes in traffic throughout the day.

2. LITERATURE REVIEW

Automobile safety is the study and practice of design, creation, equipment and regulation to minimize the incidence and consequences of automobile accidents. There are two type of safety such as active and passive safety. Active safety is used to support in the prevention of a crash while passive safety to components of the vehicle that help to protect occupants during an accident. Airbags, seat belts, Anti-lock braking system, Electronics stability control, Traction control system, Daytime light system are the general example of passive safety of Vehicle in the existing system [1]. Current manual human driver-based cross-roads which are tackled by stop signs and movement lights are not by any means safe, taking into account Federal Highway Administration (FHWA) facts. Our objective is to outline new routines to oversee crossing points, which has fewer crashes and less travel delay for vehicles crossing at cross points. Different driverless vehicles have been created and tried at cross points, for example, in the DARPA Urban Challenge and General Motor's EN-V, which has been as of late showed in China. Our objective is to utilize vehicle-to-vehicle (V2V) correspondence as a piece of co-agent driving in the connection of self-ruling vehicles to oversee crossing point activity productively and securely. Past work in this space includes the utilization of Vehicle to Infrastructure (V2I) correspondence by having a brought together framework in which all vehicles approaching an intersection communicate with the crossing point administrator. The crossing point administrator is the computational framework introduced at crossing points and to make reservations for each one approaching vehicle and deals with all vehicles crossing the convergence. Introducing unified foundation at each convergence is not exceptionally viable because of restrictively high aggregate framework costs.

3. METHODOLOGY

3.1. Vehicle to Vehicle Communication

The architecture of vehicle to vehicle communication as given in figure below

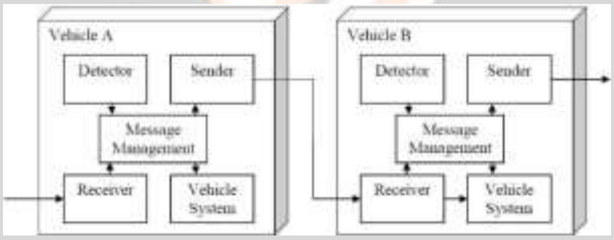

Fig. 1: Two Vehicle Communication Architecture.

3.1.1. Collision Detection

First identify the conditions required for two or more vehicles to collision. Suppose t_1, is Arrival Time and t_2, is Exit Time is the time at which the vehicle exits at any intersection place x. If a vehicle A communicate with another vehicle B is in the intersection place, their intervals must overlap. Two vehicles being inside the same intersection at the same time is a necessary, but not sufficient condition for a collision. A collision occurs if Same Intersection, Time Conflict, and Space Conflict of vehicle condition are true. If any of the above three conditions is false, then there will be no collision and vehicles can safely continue along their route [2].

3.1.2. Collision Detection Algorithm

Step-1: Recognize the path to be taken to reach target.
Step-2: Plan traffic free routes using the VANET traffic information sharing system.
Step-3: Record speedometer and GPS readings.
Step-4: Transfer GPS, speedometer reading and angle of turn are reported through VANET.
Step-5: Generate Cone movement.
Step-6: Estimate Collision area.
Step-7: Control braking and steering systems consequently.

3.2. Vehicle to Vehicle Communication Models

In this section we describe three models: the Stop-Sign Model (SSM), the Throughput-Enhancement Model (TEM) and Throughput-Enhancement Model with Agreement (TEMA) [3].

3.2.1. Stop-Sign Model (SSM)

In this model, Vehicles use STOP and CLEAR safety messages to inform other vehicles in range about their current situation and movement parameters.s

3.2.2. Throughput Enhancement Model (TEM)

This model is intended to V2V communication without utilizing any infrastructure devices. The objective is to improve the throughput at crossing points without bringing on accident. Vehicles again utilize STOP and CLEAR security messages for communication. We characterize the throughput of a crossing point dependent upon the delay of all vehicles attempting to cross the intersection.

3.2.3. Throughput Enhancement Model with Agreement (TEMA)

This model is based on TEM and is totally intended to handle lost V2V messages. Additional CONFIRM and DENY messages are utilized to perform clear handshaking between vehicles approaching the same intersection. Every vehicle affirms its choice to cross the crossing point by sending a CONFIRM or DENY message.

MESSAGE	PARAMETER
STOP	Vehicle, current road segment, current lane, next road segment, next vertex, arrival time, exit time, message sequence number, message type.
CLEAR	Vehicle, message sequence number, message type.
CONFIRM	Vehicle, message sequence number, message type.
DENY	Vehicle, message sequence number, message type.

Table - 1: Vehicle Communication Safety Message Types

3.3. Dedicated short range communication(DSRC)

DSRC is multi-channel wireless protocol used in VANET application which is based on IEEE 802.11a Physical Layer and the IEEE 802.11 MAC Layer [4][5]. This is designed to help drivers travel more safely and reduce the number of losses due to road accidents. In this experiment we used IEEE 802.11 p medium access control (MAC), which uses carrier sense multiple accesses with collision avoidance. It operates over a 75 MHz licensed spectrum in the 5.9 GHz band allocated by the Federal Communications Commission and supports low latency vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. It provides wireless link between RoadSide Equipment (RSE) and On Board Equipment (OBE) in the range of up to 200m. Vehicle-to Vehicle (V2V) communication is good solution to extend the capability of the extant DSRC system. The motivation behind the development of DSRC is mainly the need for a more tightly controlled spectrum for maximized reliability.V2V communications can improve the qualities for both the road security service and the transportation management service.

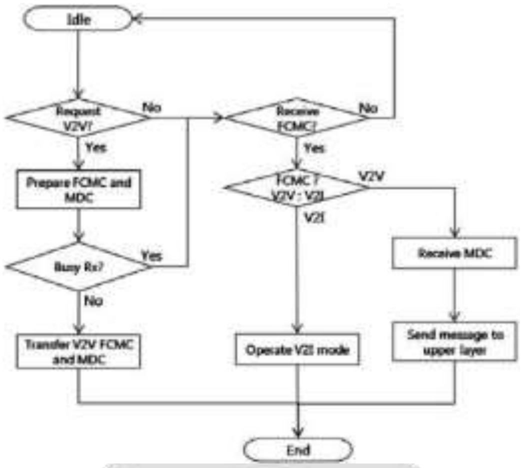

Fig - 2: DSRC Flowchart

3.4. Adaptive traffic control system

3.4.1. Adaptive traffic signal working

For implementing our proposed system, we are using VANET (Vehicular ADHOC network) environment. In this network is created using mobile vehicles. All the communication will take place through these vehicles. An OBU is placed within the vehicle used for communication. Each vehicle has its own transmission range.

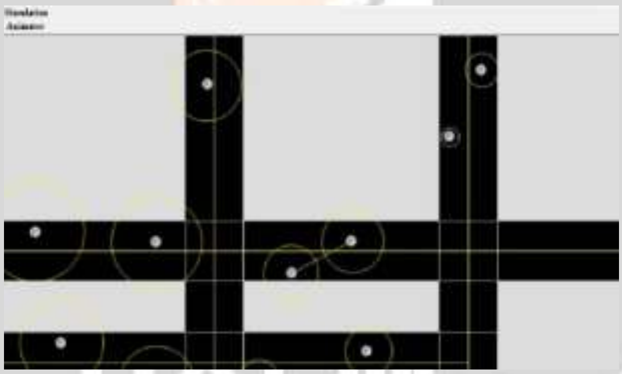

Fig - 3: Traffic scenario based on VANET

3.4.2 Working of VANET environment

Vehicular Ad-Hoc Network (VANET) is a subpart of Mobile Ad-Hoc Network. This environment is widely used for designing intelligent traffic control system. Basically, it consists of the mobile nodes, a router unit called as RSU (Road side units), output unit connected and placed within a vehicle called as OBU's (onboard unit), wireless transmission links.

Output unit/On-Board Units (OBU's): It is an output device which display output and provides instruction to the user present in the vehicle. It is also used to transmit or receive data in adhoc network.

RSU (Road side units): It is a device which works like a router and placed anywhere within the network. It is used to extend the network range. It provides connection to OBU's and forwards data.

Transmission link: This is a link used to transmit data packet/information with is network. Since it is a wireless link its range can be varied as per the network requirement. Its range can be varied as per the network requirement.

As depicted in the Fig. 4, VANET environment is a group of mobile nodes can make a network known as vehicular adhoc network. In this RSU are placed in specific distance to extend the network and creating a network so that each mobile vehicle can communicate with other mobile node. Here a centralized system is used called as traffic controller which will monitor and control the traffic at the intersection using information transmitted by every vehicle. RSU will transmit the data packet from one vehicle to another vehicle. OBU placed with in a vehicle will provide the output to the user who is using that vehicle and will takes its decision for his/her action.

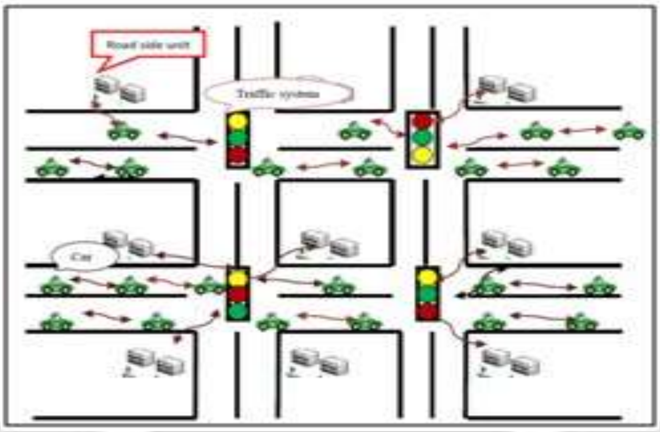

Fig - 4: Working of Vanet Environment

They will continuously detect other vehicles for communication. As shown in yellow colored circles shows the transmission range of mobile vehicles. Whenever another node comes under the transmission range a transmission link will be established between the vehicle and they can communicate with each other, in this way various mobile vehicles will create a network and finally the data will be passed to source node to the destination (Traffic light controller). As the traffic density increases the complexity is also increase. Traffic light control system is having two types of traffic light phase i.e. green light phase and red-light phase. When the traffic system light phase is enabled i.e. when its colour is green, vehicle (mobile nodes) can cross the intersection and when the red-light phase is enable vehicle should stop at the intersection at the particular distance.

Here each vehicle is participating in creating a communication network. Each node is labelled as node0, node1, node2 and so on. Whenever the nodes come under the range of network a transmission link is created between them as a faint green line depicts the link between the nodes and when they will move from outside the network range, link between them will be terminated. As discussed earlier whenever a vehicle comes under the transmission range a communication link will be established and a network will be established between the different communication devices. For modifying the traffic lights, a Webster's equation is used:

Traffic Cycle Time: $1.5Tl+5/1-\sum (Nd/CLn)$

Where, Tl is the sum of lost times at the intersection(sec), Nd/CLn is the ratio of node density Nd in the cluster to the length Ln of the cluster

3.4.3 System flow chart

For varying the traffic light interval, the node density information should be transferred to the TLC (Traffic Light Controller). Cluster head (CH) will transfer the cluster information to the TLC. At every intersection various clusters have been created based on vehicles movement. Each cluster has its own cluster head responsible for transmitting cluster density information to the TLC. Every time a CH will transmit the density of it clusters to TLC & then will wait for 10 sec.

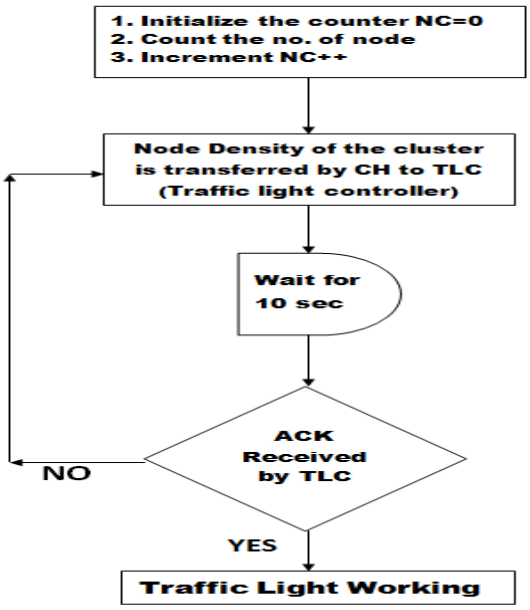

Fig - 6: communication between TLC and CH

4 CONCLUSION

In this paper we proposed a solution for traffic congestion, which is to implement Vehicle-to-Vehicle Communication and Adaptive Traffic Light Control System. We believe that this addresses the core issues of safety and reduces accidents. The simulation results show that the proposed models will work more efficiently and provide better service in dense traffic environment. Hence, we would like to conclude that the Traffic Light Control System based direction oriented clustering algorithm in VANET network holds a good prospective for improving the dense traffic conditions in urban areas. In the future cross layer intersection will also be implemented using this system.

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