Intelligent Transport System (ITS) for Safety Applications

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Abstract: ***The safety application for Intelligent Transport System (ITS) aim to solve some of the biggest challenges in the transportation in the areas of safety, mobility and environment. In this project we focus on V2V communication, once cars are connected which is able to share data with other cars on the road and which help to reduce Highway accidents. VANETS are considered as one of the most important Simulator for safety of intelligent transportation systems. The use of the DSRC technologies support low latency vehicle-to-vehicle (V2V) communication. The safety application for passengers is one of the main objective in this project.***

Keywords: DSRC, V2V, ITS, VA NET.

1. Introduction

Our Prime Minister's vision of building 100 smart cities is expected to change the urban landscape significantly. Even though there is no set definition for it, a smart city broadly includes a smart vehicle system which uses high end to end information & communication technologies to deliver better traffic handling conditions on the road and to reduce number of accidents which is a major problem of the India in present days.

Regarding to this smart vehicle system, automobile industries all over the world worked hard to introduce smart vehicle communication models.

A new vehicle features that make possible the exchange of information with the internet via specific interface will definitely reduce the accidents. So for this purpose Vehicular Ad-Hoc Network also known as VANET which is nothing but advanced application of Mobile Ad-Hoc Network (MANET) can be used to improve traffic conditions [1][2]. VANET have specific features that distinguish them from the other Mobile Ad-Hoc Network, for instance these networks are characterized by highly dynamic topologies due to the fast mobility of the vehicles & their restricted motions to geographical pattern of high ways. As a result, VANET experiences communication discontinuity more frequently compared with traditional Ad-Hoc Networks [3].

DSRC that is dedicated short range communication is one of the important factor regarding to the Intelligent Transport System (ITS). This DSRC is the wi-fi radio whose bandwidth completely dedicated for automobile use. The DSRC gives us wireless links between Road-Side Equipment (RSE) & Onboard Equipment (OBE) in the range of up to 200 m .Automobile safety can be classified as active safety & passive safety. Active safety is used to support in the prevention of the crash while passive safety protects us during the accidents [4]. In this project we will focus on Vehicle to Vehicle communication (V2V) to share data among vehicles, which will help to reduce highway accidents.

2. Literature Review

Set National Highway Traffic Safety Administration (NHTSA) was established by the Highway Safety Act of 1970, as the successor to the National Highway Safety Bureau, to carry out safety programs under the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.28. Vehicle manufacturers respond to NHTSA's standards by building safer vehicles, and safety technology which has developed rapidly since the 1970s, vehicles not only facilitates air bags and standard equipment, but also protect occupants during crash due to advanced structural techniques propagated by more stringent crashworthiness standards. Nevertheless, crashes continue to occur, with attendant property damage, injuries, and fatalities. Although continued improvements in vehicle crashworthiness will still help reduce fatalities and injuries, NHTSA believes the greatest gains in highway safety in coming years will result from broad-scale application of crash avoidance technologies. Automobile safety is the study and practice of design, creation, equipment and regulation to minimize the incidence and consequences of automobile accidents.

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[4].Vehicle-to-Infrastructure (V2I) communication is an approach that has been used to address the intersection problem in prior work in this domain. As the word infrastructure implies, the system mainly consists of an intelligent and powerful computational and communicational unit which would be installed at each intersection to communicate with all approaching vehicles and manage traffic by reserving a safe time-space passage through the intersection for each vehicle. This approach is not very practical because of the high cost and inertia of installing the intersection manager at each intersection. Another drawback of such a centralized system is that if the intersection manager fails, crossing the intersection could be chaotic and dangerous, similar to signal breakdown at a busy intersection.

3. Methodology

3.1 Vehicle to Vehicle Communication

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

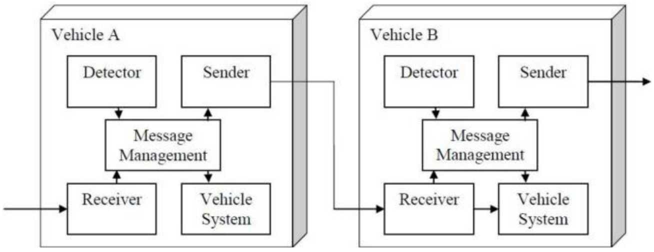

Figure 1: Two Vehicle Communication Architecture

3.2 Collision Detection

The First identify the conditions required for two or more vehicles to collision. Suppose t, is Arrival Time and t, 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 scenario in which vehicle A is coming from the east and turning right while the other vehicle B is coming from the west and also turning to its right. In this case, both vehicles can cross the intersection point at the same time without 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 [5].

3.3 Collision Detection Algorithm

Step-I: Start
Step-2: Recognize the path to be taken to reach target.
Step-3: Plan traffic free routes using the VANET traffic information sharing system.
Step-4: Record speedometer and GPS readings.
Step-5: Transfer GPS, speedometer reading and angle of turn are reported through VANET.
Step-6: Generate Cone movement.
Step-7: Estimate Collision area.
Step- 8 : Control braking and steering systems consequently.
Step-9: Stop. lace table titles above the tables.

3.4 Vehicle to Vehicle Communication Models

In this section we analyzed three models: the Stop-Sign Model (SSM), the Throughput-Enhancement Model (TEM) and Throughput-Enhancement Model with Agreement (TEMA) [6].But in this project we are going to use Stop-Sign Model(SSM) which is described below.

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. The following rules are applicable.

- Sending STOP: As a vehicle approaches a cross point, it transmits a STOP safety message to all other vehicles. Any vehicles within range will receive that message.
- On Receiving STOP: On receiving a STOP message, when more than one car arrives at the same intersection and will be inside the intersection area for an overlapping interval of time, priorities will get assigned to them and the vehicle with the highest priority will cross the intersection after t seconds pass. Other vehicles remains stopped and waits to receive a CLEAR message.
- Sending CLEAR: When a vehicle crosses the intersection secondary and travels a distance defined by a threshold parameter D, it broadcasts CLEAR messages indicating that the intersection is now safe to pass.
- On Receiving CLEAR: On receipt of this message, the vehicle checks assuming that it has halted for at least t seconds and, if it is true, it then checks if the sender of the CLEAR message is the same as the sender of the STOP message. The first come first serve (FCFS), priority and tiebreaking rules are again applied. Assuming that t seconds have not passed so far, the vehicle remains halted while received messages are processed to settle on a choice when the t seconds finishes. In the event that some vehicles are stopped at the intersection, by re-applying the necessity approach, every vehicle chooses in the event that it might as well remain stopped or it can cross the crossing point next as it has the most astounding priority around all stopped vehicles at the intersection. abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract.

3.5 Dedicated Short Range Communication

If 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[7][8].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 Road Side Equipment (RSE) and On board Equipment (OBE) in the range of up to 200m. Vehicle-to-Vehicle(V2V) communications 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.

4. Simulation and Result

We present a detailed evaluation of the proposed protocols using the models. The evaluation is carried out under different types of traffic scenarios and using different kinds of intersections. We compare the different mobility models: the Traffic-Light model and V2V-interaction model [9]. We calculate the trip time for each simulated car under each model and compare that against the trip time taken by the car assuming that it stays at a constant street speed and does not stop at the intersection. The difference between these two trip times is considered to be the trip delay due to the intersection. We take the average trip delays across all cars in a simulation sequence as our metric of comparison. Since there is a large variation in intersection types, we restrict our attention to one of the intersections [10], [11].

We have used "Four-way Perfect-Cross Intersection" for simulation purpose. We run all our simulations on 4-lane roads, with 2 lanes in each direction. The vehicle parameters used are width, height and lane parameters. We have named the axes lanes as West lane(WL), East lane(EL), North lane(NL) and South lane(SL). The vehicles on each lane are shown by different color as red, green, green and blue respectively.

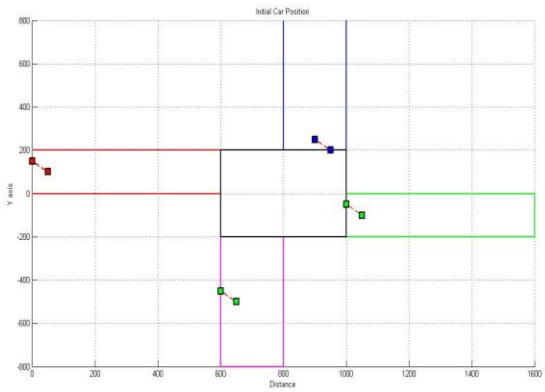

Figure 2: Initial car position

Next we have created road map named as E(from W to E), N(from S to N), W(from E to W) and S(from N to S).The stop-sign-model (SSM) is implemented along the road map. We have used the real time traffic lamp colors as "yellow" and "red-yellow-green" flash which is shown in figure 3.

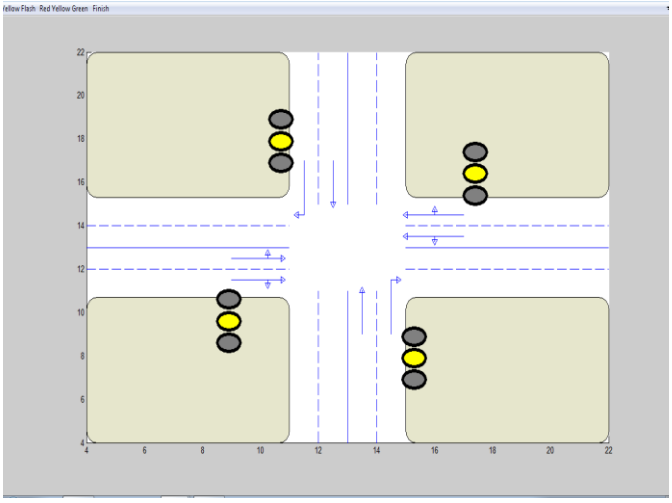

Figure 3 "(a)": Traffic lamp-yellow flash

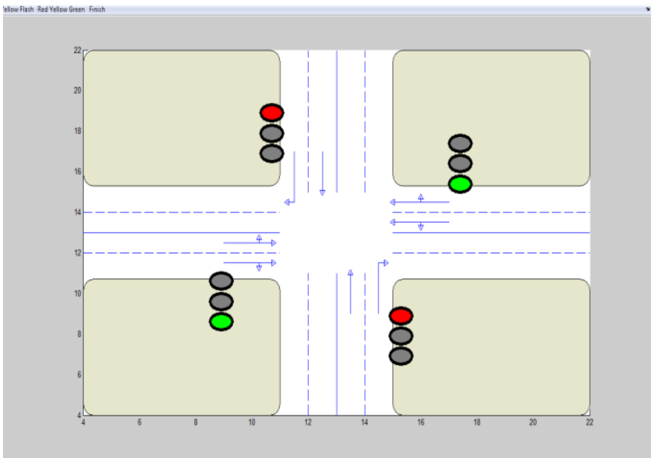

Figure 3 "(b)": Traffic lamp-:red-yellow-green flash

Every vehicle is eliminated from the simulation when it arrives at destination. This file of information is then given into VANET to simulate the crossing point conventions. Traffic volume is specified for per intersection leg with distinctive traffic levels. Every simulation utilizes more number of vehicles and each one run is done when the last vehicle arrives at its destination. In experiments, we use the V2V Intersection protocol which represents both TEM and TEM-A under the assumption of a reliable communication network. According to classical queuing theory, the average delay will asymptotically become very high when the arrival rate (i.e. traffic intensity) exceeds the service rate (throughput) at the intersection. This delay, however, occurs under steady-state conditions only after a considerable amount of time. The experiment for a four cross point and the corresponding outcomes are demonstrated in below figure 4"(a)". For traffic light model,(signal in figure) as traffic volume density increases, the trip delay also reaches to its highest point. The V2V Intersection model performs the best, doing very well at low traffic volumes up to 0.2 vehicles per second resulting in very negligible delay[12].

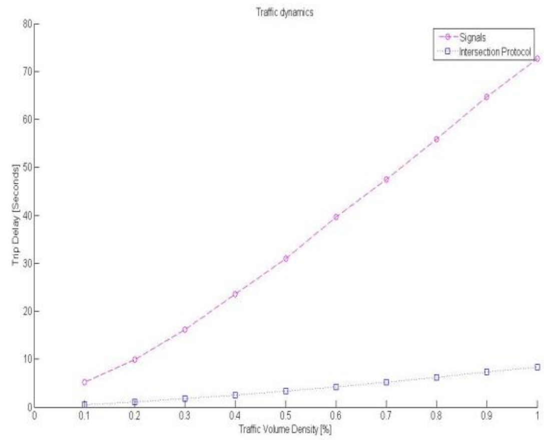

Figure 4 "(a)": Delays for Perfect-Cross Intersection

Next we have compared two models as traffic volume density versus average flow of cars on the map. Nevertheless, our results clearly indicate that before overload conditions are reached, the service rate (i.e. throughput) with the V2V-Intersection protocol is noticeably better than the Traffic-Light models [13], [14].

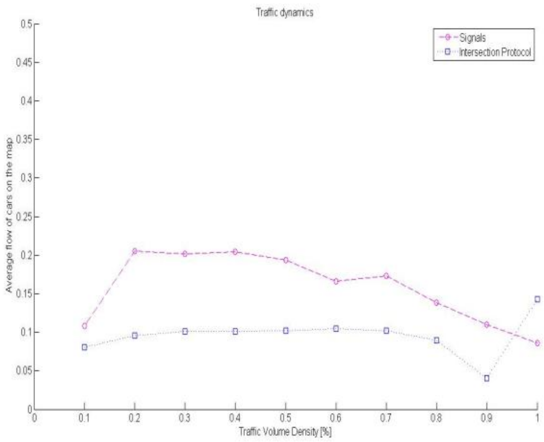

Figure 4 "(b)": Traffic dynamics for Perfect-Cross Intersection

5. Conclusion

A substantial fraction of automotive collisions occur at intersections. Furthermore, intersections are often traffic bottlenecks contributing to significant trip delays. In this paper, we designed intersection management protocols using only vehicle-to-vehicle communications to address these two core issues of safety and throughput. We believe that intersection collisions can be reduced and throughput improved significantly using only V2V protocols. Since installing wireless infrastructure at every intersection to support vehicle to intersection protocols can be prohibitively costly, a V2V-based approach seems more practical for deployment. We have described and evaluated V2V-based protocols namely Stop-Sign model and V2V interaction protocol. We have also compared these protocols to conventional stop-signs and traffic lights, and have evaluated the average delays encountered at an intersection.

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