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Intersection Movement Assistance for Vehicles

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***Abstract:** Connected vehicle, wireless communication technology is expeditiously evolving in recent years, and host vehicle (HV) can transmit or receive the basic safety message (BSM) from the remote vehicles (RVs). A collision warning predicted that provides connected automated vehicle and alert driver when time to collision (TTC) is within specified bound. Then, distance is calculated by using Haversine formula, and the error statistics of the estimation of latitude and longitude are analysed and alert the driver. Vehicle collision can be detected in real time and the vehicle can prevent the potential conflict accordingly by using this information provided by BSM.*

The goal of Intersection Movement Assistance (IMA) is to develop a vehicular communication system to alert the driver from a potential collision at the intersection based on the Basic Safety Message (BSM) from the neighboring vehicles in the V2V environment.

***Keywords:** Basic Safety Message, Host Vehicle, Remote Vehicle, Intersection Movement Assistance, Haversine Formula.*

INTRODUCTION

Road intersections are one of the most complex and accident prone of the modern traffic. The collision at the intersection of roads occurs most frequently and involves the largest number of fatalities. Wireless technologies are rapidly evolving, and this evolution provides opportunities to utilize these technologies in support of vehicle safety applications. In particular, the Dedicated Short Range Communications (DSRC) offers the potential to effectively support wireless data communications between vehicles (V2V), and between vehicles and infrastructure (V2I).

DSRC communications can be utilized to detect all vehicles, their position, speed, increasing speed, and yaw rate while moving towards the intersection. The road side unit (RSU) or the onboard unit (OBU) determines when a collision is imminent and issues alert the drivers in the vicinity. The devices installed in light vehicles as part of the Connected Vehicle Safety able to transmit and receive messages from one another, with a security management system providing trusted and secure communications among the vehicles.

Intersection mobility Assistance (IMA) application alerts the drivers when a collision at an intersection is probable. Intersection Mobility Assistance aims to integrate state-of-the-art cooperative technologies with the purpose of increasing the safety and efficiency of the transportation system.

PROBLEM DEFINITION

The advancement in the technology to alert the driver from a potential collision at the intersection by using Advance Driver Assistance Systems (ADAS) and Dedicated Short Range Communication (DSRC).Where in ADAS, it doesn't support line of sight propagation.

The sensors like ultrasonic sensors are used to assist the driver during dangerous situations such as collision avoidance, parking assistance, traffic sign assistance or pedestrian detection. RADAR is used to detect the long range obstacle detection and distance measurements. However, Sensors have limitations not accurate for changes in the atmospheric conditions.

To overcome this wireless communication DSRC technology is used to take the driver to the next level.

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LITERATURE SURVEY

There are many collision detection methods developed for IMA. The following is the brief introduction for some of those methods which describe the algorithms for a collision at an intersection.

The principal of bounding volume hierarchical is to wrap the complex geometrical objects with big volume and simple shape boxes and create the regions at the point of intersection of roads. For collision detection, the overlapping tests (regions) among bounding boxes at first. Then, geometrical objects should be detected accurately to check for overlapping of regions. Bounding volume method is not much effective to judge whether two geometrical objects are overlapping.

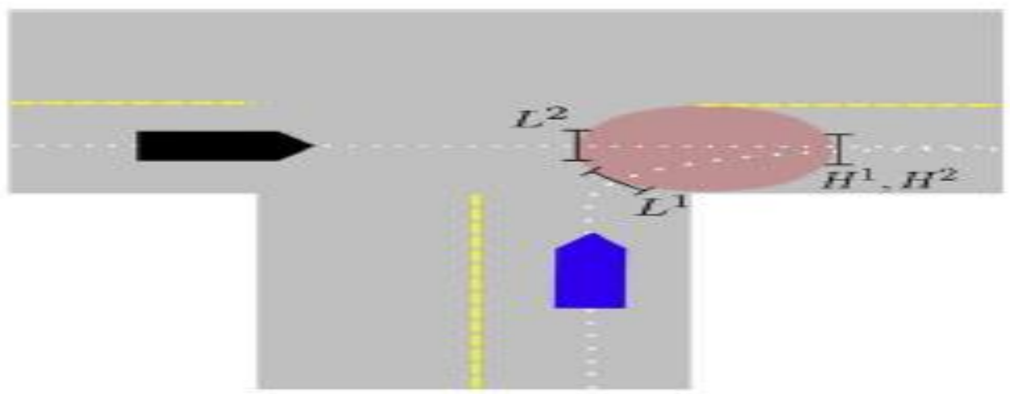

Fig. 1 Bounding volume hierarchical algorithm

Prediction of the trajectory path of an automobile into the future is a hard worker, and even more so during non-straight paths, as experimental in some of the research studied. Many times the predicted future position of where the vehicle will be some seconds later in time falls outside of a physical road, making this prediction highly improbable.

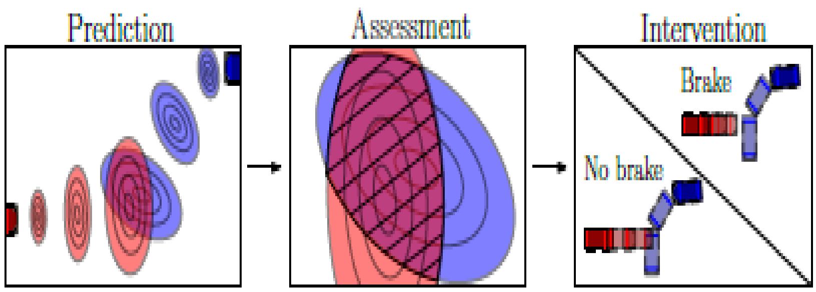

Fig. 1 Prediction based collision warning system

Probability density of each vehicle at the current position is calculated. The overlapping region of the probability density function has less amplitude as shown in the figure. In this method confidence level of probability of collision needs to set which is not effective as compared to proposed system.

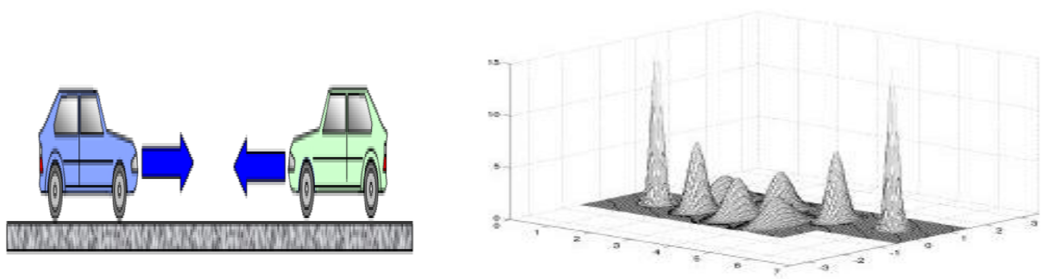

Fig. 3 E PDF's for the two vehicles in figure 1 at 4-time instances. The narrow peaks correspond to time 1 and the widest peaks correspond to time 4.

DEDICATED SHORT RANGE COMMUNICATION

Dedicated short-range communication is one-way or two-way short-range to medium which is particularly used for automobiles by a set of protocols and standards. DSRC is a wireless technology for active vehicle safety systems, which may help prevent or

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mitigate traffic accidents by providing drivers with greater situational awareness of nearby vehicles and roadway conditions. DSRC provides low latency, accuracy, and reliability needed for active safety.

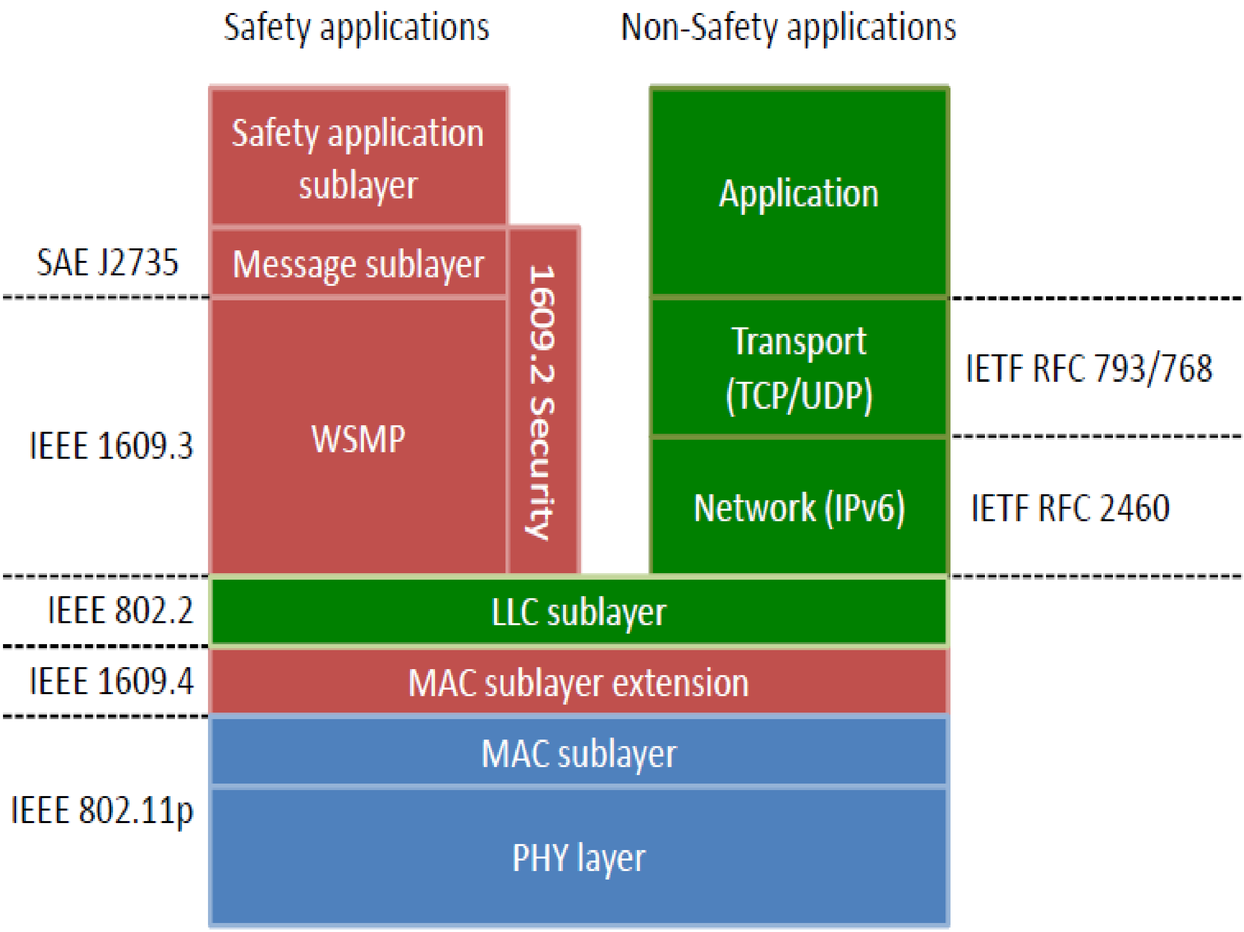

Fig. 4 Layered Architecture of DSRC communication

A. DSRC spectrum

The DSRC range ranges from 5.850 GHz to 5.925 GHz, for DSRC operation in the United States. IEEE 802.11p standard uses 7 channels inside the 75 MHz data transmission in the 5.9 GHz band. 802.11p is a part of 802.11-2012 standards.

This spectrum is isolated into seven 10 MHz channels with a 5-MHz guard band at the low end, as shown in Fig. Pairs of 10 MHz channels can likewise be consolidated into a 20 MHz channel. Testing of DSRC in the U.S. has concentrated on 10 MHz channels, to support many types of vehicle safety applications.

WAVE device requires two channels to monitor, Control Channel (CCH), Service Channel (SCH).

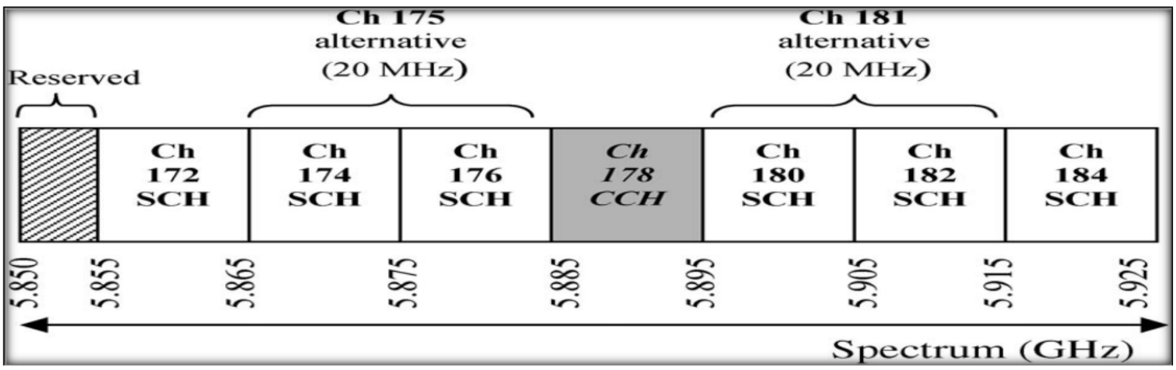

Fig. 5 DSRC channel arrangement

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METHODOLOGY

A. Haversine Formula

The haversine formula is an important equation in navigation, giving great-circle distances between two points on a sphere from their longitudes and latitudes. It is a special case of a more general formula in spherical trigonometry, the law of haversines, relating the sides and angles of spherical triangles.

$$a=\sin^2(\Delta latDifference/2)+\cos(lat1).\cos(lat2).\sin^2(\Delta lonDifference/2)$$

$$c=2.\mathrm{atan2}(\sqrt{a},\sqrt{(1-a)})$$

$$d = R.c$$

Where ΔlatDifference = lat1 – lat2 (difference in latitude)

ΔlonDifference = lon1 – lon2 (difference in longitude)

R is radius of Earth

d is the distance between two position

B. Modification of Haversine formula

The Haversine formula calculates the distance for given two GPS coordinates. So the Haversine formula is modified to consider heading and speed of the vehicle.

lat1=lat1+speed (1)*cos (heading (1))/111
lon1=lon1+speed (1)* sin (heading (1))/111

lat2=lat2+speed (2)* cos (heading(2))/111
lon2=lon2+speed (2) * sin(heading(2))/111

Where speed(1)= Speed of the HV
speed(2)= Speed of the RV
heading(1)=Heading of the HV
heading(2)=Heading of the RV

IMPLEMENTATION

To produce and send a Basic Safety Message, a device must know its own position, (for example, by means of a GPS). When its position is known, the device needs a PC handling unit that would take be able to its area and would combine be able to it with other on board sensors (e.g., speed, heading, yaw rate, breaking) to produce the required BSM information string. Once the BSM is created, a device needs to transmit this message remotely to another vehicle. As the on board processor is creating the BSM, a security module is handling and setting up the security data and declarations for transmission to give the receiving vehicle confirmation that the message is legitimate. This security data should be transmitted remotely too. To get and decipher a BSM, a device must be fit for receiving the BSM that is transmitted from a close-by device and it must match the technique for BSM transmission, the accepting device must have an RF beneficiary). It likewise should have a get together that can decipher the BSM appropriately.

A GPS reception apparatus and collector is expected to confirm the relative separation between the sending device and the accepting device. The BSMs take after SAE J2735 standard casing structure. SAE J2735 is expected to address the reason so that all V2V safety applications are worked around a typical system. SAE J2735 characterizes the outline particulars for the security messages, including determinations for the message sets, information casings, and information components. In conclusion, the device that is accepting the BSM should likewise have a security module that is fit for getting and preparing the security certification.

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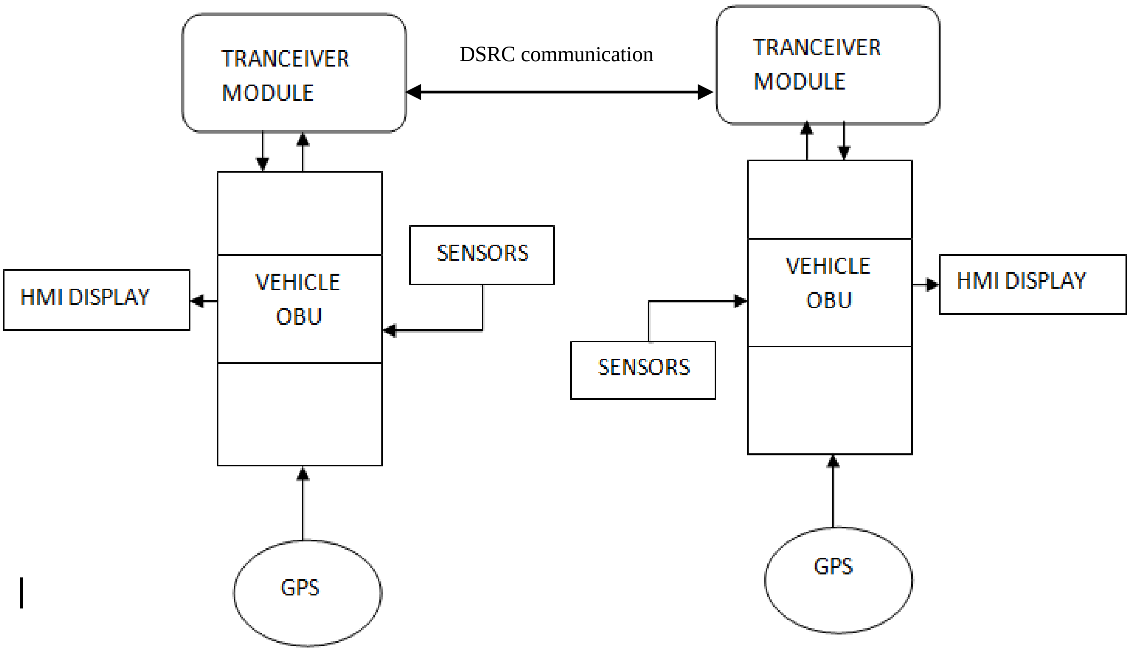
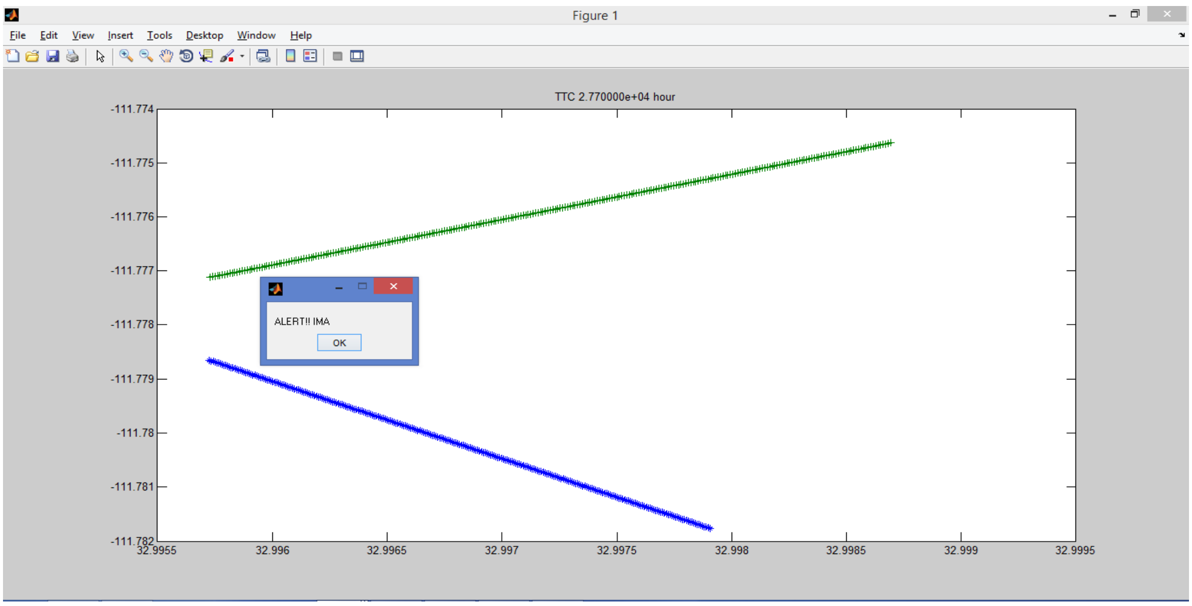


Fig. 6 Block diagram implementation of V2V communication

SIMULATION RESULTS

The Matlab simulation plot results where 'green mark' represents the Host vehicle and 'blue mark' represents the remote vehicle.



The scenario at which the host vehicle and remote come close to each other and high probability of collision, an IMA alert message is displayed to alert the driver.

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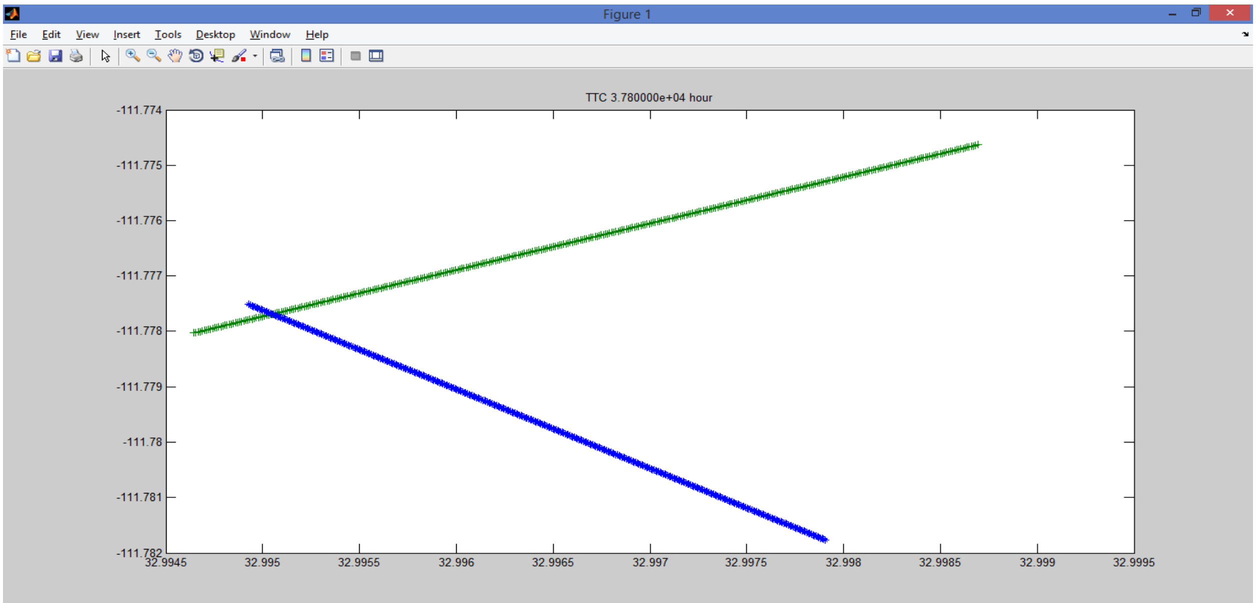
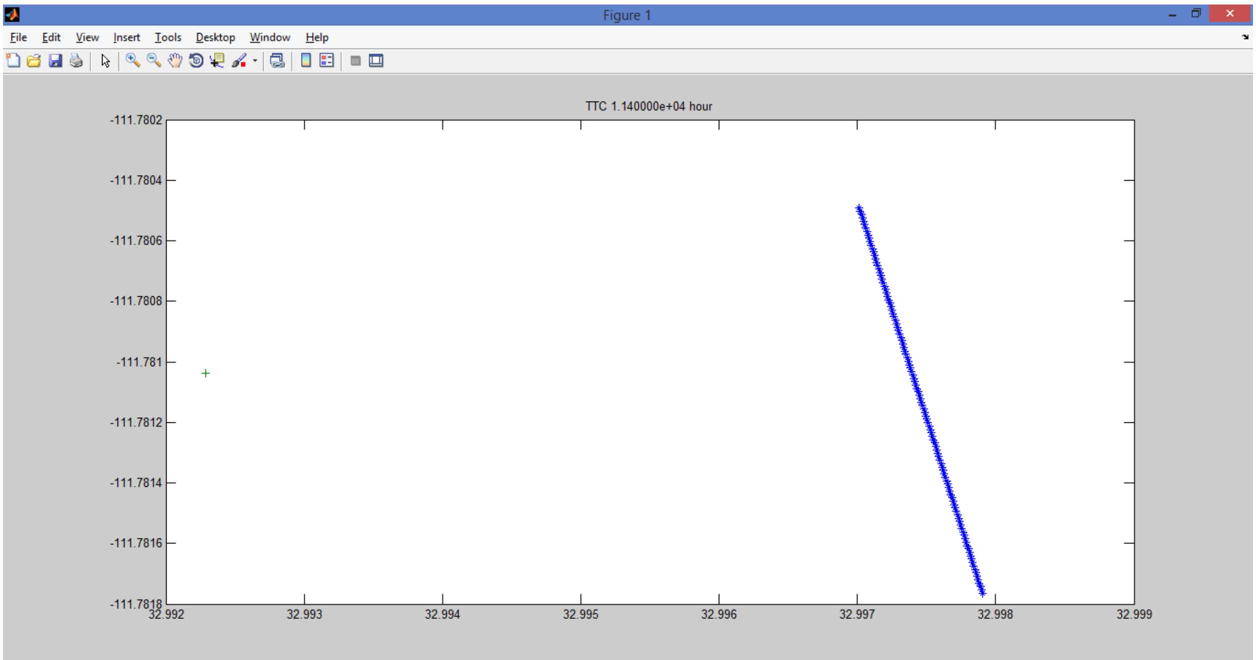


The scenario at which HV is faster when compared to RV. Hence HV crosses the intersection moves ahead. So the alert message is not displayed.



The scenario at which the RV is at rest and the HV is in motion alert message is not displayed.

CONCLUSION AND FUTURE SCOPE

In this paper, collision warning system at the intersection has been proposed, wherein the safety distance between vehicles is calculated based on the relative velocity between two vehicles. As most vehicles, today, are equipped with GPS receivers, the proposed system provides a simple and feasible solution for collision avoidance at the intersection**.** Since the relative distance between the vehicles is used for calculation; the safety distance can be accurately estimated to alert the driver.

As future work, to carry out more precise testing with multiple nodes simulating traffic at different times of day to depict real-time vehicular traffic movement and traffic congestion. Also plan to consider the time taken for computation and its impact on the computation of minimum distance to provide for the computational delay, elevation, yaw rate and vehicle length. The algorithm could be modified to include prediction of future states of the vehicles to predict the time to collision. Further research and development will be required to cover aspects related to improvising the alert during curved intersection.

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The artificial neural network models have the potential to reduce the uncertainty in the estimation of vehicle future states. Artificial neural network models for statistical observations may be collected at that stage to produce more realistic estimates for the vehicle path prediction algorithms may be revised to have optimal estimations.

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