Vehicle Tracking in Vehicular Ad-Hoc Networks

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Abstract- **The number of vehicles owned by people is rapidly growing with development of economy and society. The safety problem in transportation is increasingly outstanding. It brings a serious threat to human's life and property. Safe driving is always one of the most important topics in vehicle engineering. VANET (vehicular Ad-Hoc Networks) increases comfort and safety of the driving experience. In this work the system helps to track the targets in a VANET and cooperatively give information to all the vehicles in the path of the target with the help of some service providers (SP). The advantage of this work is that, it assists the driver to take correct action whenever some situation occurs and also improve the confidence of driving. Here the system helps to track moving as well as stable objects in VANET.**

Keywords— VANET, SP, MANET, V2V, V2I, MTT

I. INTRODUCTION

A vehicular ad-hoc network or VANET is a form of Mobile Ad- Hoc network to provide communications among nearby vehicles and between vehicles and nearby fixed equipments usually described as roadside equipment. That is, it is a combination of vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) communication. The main goal of VANET is providing safety and comfort for passengers. Each vehicle equipped with VANET device will be a node in the Ad- Hoc network and can receive and relay other messages through the wireless network. Vehicular ad hoc network (VANET) is a subgroup of MANET- mobile ad hoc networks. Here the mobile nodes being vehicles and Road Side Units (RSUs) as static nodes. The communication is very interesting since the communication is between the vehicles and the road side units..

About half of the 43000 accidents each year on U.S highways result from vehicles leaving the road or travelling unsafely through intersections [1]. Traffic delays waste more than a 40- hour work week for peak time travelers and the major reason for traffic delays are collisions and traffic jams in road. The objective of the system is to reduce collisions and traffic jams in a road. Vehicle tracking system tracks the targets in the VANET and cooperatively give information to all the vehicle nodes in the path.

The vehicle in VANET is equipped with GPS localization technique and some sensors. A number of applications are envisioned for these networks. Driving means changing location constantly. This means a constant demand for information on the current location and specifically for data on the surrounding traffic, routes and much more. A very important category is driver assistance and car safety. This includes many different things mostly based on sensor data from other cars. One could think of brake warning sent from preceding car, collision warning, information about road condition and maintenance, detailed regional weather forecast, premonition of traffic jams, and caution to an accident behind the next bend, detailed information about an accident for the rescue team and many other things. One could also think of local updates of the cars navigation systems or an assistant that helps to follow a friend's car.

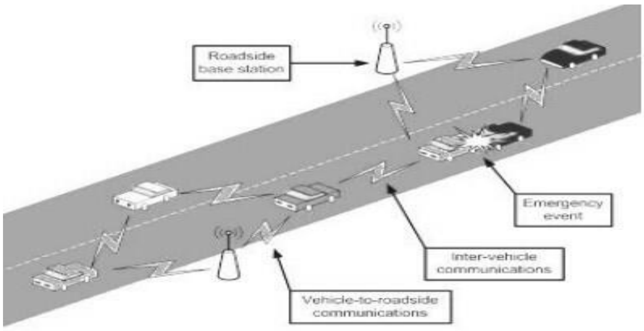

Figure caption : Vanet

These are some of the applications of VANET.

- vehicle collision warning
- security distance warning
- driver assistance
- cooperative driving cooperative cruise control
- Internet access
- map location
- automatic parking
- driverless vehicles

The total work is divided into 3 modules

1. Topology formation.

In this first module here initially implement trackers, Base stations, and targets.

2. Broadcasting signals:

Broadcasting signals from the base station to all vehicles. Target tracking system was fixed in the vehicles. So by the use of this vehicle tracking method, system can receive signals from the base station.

3. Tracking targets.

In this final module tracker will tracking the targets in the vehicles moving path. And after finding obstacles it system will send safety message to the nearby vehicles and also the own vehicle's driver.

This paper is organized into different sections such as section II discuss about previous works. Section III gives assumptions and explanations for the proposed work and section IV shows the simulation results and evaluation. Finally, section V concludes this paper.

II. PREVIOUS WORK

The ability to track targets is essential in many applications. Current technology has enabled the development of sensor networks, distributed ad-hoc networks of hundreds or thousands of nodes, each capable of sensing, processing and communication. Much of the theory of tracking was developed for centralized processing of data from a relatively small number of radars or similar large devices endowed with plenty of power and high-bandwidth communications. Sensor networks demand a somewhat different approach, focused on scalable performance and the management of limited resources. Single target tracking can do with some estimation techniques based on the measurement history. For simplicity of illustration, the common assumption that the target's dynamics are characterized by a stationary Markov model. MTT is not a trivial extension of single target tracking but rather a challenging topic of research. To elaborate, consider the simple case of tracking two targets and can formulate MTT rigorously as a sequential Bayesian filtering problem of a Markov process with noisy measurements, just as in the single target. No discussion on multiple target tracking would be complete without mentioning the following two predominant approaches. MHT which stands for Multiple Hypothesis tracking [8] was proposed by Reid. The idea is to exhaustively enumerate recursively the set of all associations, called hypotheses, of measurements to existing tracks, new tracks, and false alarms while respecting the mutual exclusion association constraint. An advantage of this approach is that the number of tracks need not be known a priori because track initiations and terminations are explicitly hypothesized. Furthermore, data association decisions are effectively delayed until more data is received since multiple hypotheses are kept. Thus, MHT can address low detection probability, high false alarm rates, initiation and termination of tracks, and delayed measurements. However, this approach suffers from large storage space requirements and exponentially increasing processing, so that a key part of making this approach practical is to prune bad hypotheses or combine similar hypotheses as in. JPDAF which stands for the joint probabilistic data association filter was proposed by Fortmann, Bar Shalom, and Scheffe. The approach is to update each individual track state with weighted combinations of all measurements. Thus, the key part of this approach is computing the probability that measurements can be associated with tracks so that the mutual exclusion constraint is respected. A disadvantage of this approach is that the number of targets needs to be known a priori.

While we considering the simulation concept there are several models already generated based on the Vanet concept. When mobility was first taken into account in simulation of wireless networks, several models to generate mobility patterns of nodes were proposed. The Random Waypoint model, the RandomWalk model, the Reference Point Group (or Platoon) model, the Node Following mode, the Gauss-Markov model, just to cite the most known ones, all involved generation of random linear speed constant movements within the topology boundaries. Further works added pause times, reflection on boundaries, acceleration and deceleration of nodes. Simplicity of use conferred success to the Random Waypoint model in particular; however, the intrinsic nature of such mobility models may produce unrealistic movement patterns when compared to some real world behavior. The simple Freeway model and Manhattan (or Grid) model was the initial steps, then more complex projects were started involving the generation of mobility patterns based on real road maps or monitoring of real vehicular movements in cities. However, in most of these models, only the macro-mobility of nodes was considered. The IMPORTANT tool [3] and the BonnMotion tool [4] implement several random mobility models, plus the Manhattan model. While the IMPORTANT tool includes the Car Following Model which is a basic car-to-car inter-distance control schema, the BonnMotion does not consider any micro-mobility. When related to the framework, it can easily see that the structure of both tools is definitely too simple to represent realistic motions, as they only model basic motion constraints and hardly no micro-mobility. The MONARCH project proposed a tool to extract road topologies from real road maps obtained from the TIGER database. The possibility of generating topologies from real maps is considered in the framework; however the complete lack of micro-mobility support makes it difficult to represent a complete mobility generator. The Obstacle Mobility Model [2] takes a different approach in the objective to obtain a realistic urban network in presence of building constellations. Instead of extracting data from TIGER files, the simulator uses random building corners and voronoi tessellations in order to define movement paths between buildings. It also includes a radio propagation model based on the constellation of obstacles. According to this model, movements are restricted to paths defined by the Voronoi graph. The Mobility Model Generator for Vehicular Networks (MOVE) was recently presented as an on-going work . It seems a quite complete tool, featuring real map extrapolation from the TIGER database as well as pseudorandom and manual topology generation. No micro-mobility and complex traffic generation are considered yet, but the in-progress status of the project allows us to think that this might be corrected in the near future

III. PROPOSED WORK

Aim of the proposed system is to reduce collisions and traffic jams in road. For this, here proposing a vehicle tracking system which track the targets in the VANET and cooperatively give information to all the vehicle nodes in the path. This system can use to find all the obstacles in the

VANET and give warnings based on the road conditions. Each vehicle contains some display system which displays the current position of nearby vehicles and give the safety warnings according to the position of the nearby obstacles or vehicles. Here the system considering 3 cases of road conditions: Collisions, Overtaking and Traffic junctions.

A. *Measurements and Motion models*

The most common approach used in target tracking systems is to describe the targets dynamic as the evolution of the targets state along the time. The main reasons for the popularity of model-based systems are that the models are almost always available, and they usually outperform any model-free system. The target motion uncertainty, the lack of an accurate model of the target from the trackers view point, is one of the most challenging problems in target tracking. Therefore, the choice of an expressive and tractable model, which captures the target dynamic, poses an important and challenging role for the success of target tracking systems. Here considering two groups of motion models: 1D models, which assume the target makes straight movements at each time step, and 2D models, in which the coupling between the coordinates is considered [5].

In the cooperative target tracking context, the measurements come from three different sources: Self data (SD), .the measured data from the vehicles. Autonomous data (AD), the data from other objects collected by on-board sensors .Cooperative data (CD), the data those other vehicles transmit using the vehicles communication capability. Most of the sensors used for target tracking applications provide the measures in a sensor coordinate system, which in many cases is spherical in 3D and polar in 2D, with the following components: range r, bearing (or azimuth) b, elevation e, and possibly range rate (or Doppler) r.

Other sources of data are available in CTT systems due to their communication ability. In this scenario, the vehicles can broadcast their self-measurements to their neighbourhood. Hence, the SD data can be made available for all neighbour vehicles, and depending on the application, it can be made available for any reachable vehicle in the network by multi hop data dissemination [9]. For instance, vehicles can broadcast their GPS, compass, speedometer, and gyroscope data to their neighbours. Thus, a mixture of data collected on Cartesian and sensor coordinates is available. The CTT system must be able to cope with this new data. In VANET environments measurements are challenging once the target behaviour is very dynamic; usually the number of targets is unknown and the targets typically perform quick maneuvers. Thus, a good combination of motion and measurement models is important to achieve good tracking results.

B. *Localization Techniques*

A number of localization techniques have been proposed for computing the position of mobile nodes. An interesting aspect of VANETs is that most localization techniques can be applied easily to these networks. There are a number of localization techniques that can be used by vehicles to estimate their positions, namely Map Matching, Dead Reckoning, Cellular Localization, Image/Video Processing, Localization Services, and Relative Distributed Ad Hoc Localization. All of these techniques have their pros and cons.

C. *Communication*

The communication model plays a crucial role on target tracking systems once all cooperative data are exchanged through a wireless channel either using V2V or I2V communication. There are issues regarding the communication channel that can influence the CTT performance such as delay and packet loss. Different access methods of communication, such as WiFi, cellular, and WiMax, can be used for VANETs. However, the DSRC protocol [10] is the most promising solution since it was devised specifically for vehicular communications. Dedicated short-range communications is a standard also referred to as IEEE 802.11p. It is a recently approved amendment to the IEEE 802.11 standard that adds Wireless Access in Vehicular Environments (WAVE). This standard defines the use of the licensed 5.9 GHz band dedicated to V2V and I2V ITS communication. The frequency range 5.850 - 5.925 GHz is divided into seven channels of 10 MHz each, reaching high communication rates of order of 6 to 27 Mbps [9]. The channels are half-duplex and the typical communication range is 300m (up to 1000m). The standard is designed to have an expected low latency on the order of 50 ms, and features eight priority levels. The channel allocation is designed in a way that most central channels are the control channel, which is restricted to safety communication only. The two channels at the edges of the spectrum are reserved for future advanced accident avoidance applications.

D. *Filtering*

The filtering component of tracking systems is responsible for defining how the pdf of the targets state at time step k is recursively calculated by a Bayesian approach. The Kalman filter is a particular case of Bayesian filtering under the assumption that the target dynamic , described by the motion model and the measurement model , are both linear; moreover, the uncertainties in both models are assumed to be Gaussian and uncorrelated. If all those assumptions hold, the posterior probability is also Gaussian, and the Kalman filter recursively updates its mean and covariance based on the measurements updates. The Kalman filter presents some interesting properties such as being the optimal estimator when the noise is Gaussian, and is the linear optimal estimator even when the noises are not Gaussian . This is optimal in the sense that it provides an unbiased minimum variance state estimation. The Kalman filter is the best option when all assumptions hold. However, system linearity and precise knowledge of the system properties (motion model, measurement model, and noise covariance) are not always granted for real systems. Some techniques can be used to relax some assumptions.

E. *Vehicle tracking*

The objective of this paper is to reduce the problems in the traffic like collisions, traffic congestions etc. For this purpose we can consider some cases, first one is two vehicles travelling longitudinally with constant velocity. To avoid the collision between them the drivers should keep a minimum distance between them. Consider vehicle p0 and vehicle p1 are running on the same lane and vehicle p0 is ahead of vehicle p1.

Minimum space = max ((V1 − V0) t, 0) , t ∈ [0, t m] .

V0 and V1 are the longitudinal velocity of vehicle p0 and Vehicle p1.As both vehicles make uniform and linear motion, the relative velocity is always a constant, V = V0 − V1 = const, which deduces Minimum spacing as the following rules:

Minimum spacing = {(V1 − V0) t m   V1 − V0 ≥ 0
0   V1 − V0 < 0 }

(1) When relative velocity V > 0, inter-vehicle safe spacing will linearly increase by time. As time increases, the distance between two vehicles is getting shorter. To compensate the distance that vehicle p1 travels More than vehicle p0 before they collide, the MS must be increased, so Minimum spacing = V ∗ t m.

(2) When relative velocity V < 0, inter-vehicle distance is increasing by time, so Minimum spacing = 0.

(3) When relative velocity V = 0, the Minimum spacing can be set to any value approximating to 0.

F. Queuing to avoid collision

The capacity of roads is proportional to the velocity of vehicles. It will help to avoid the collisions and congestions also. Normally the highway traffic velocity is limiting between 40km/h to 100 km/ h. By this information we can classify the vehicles into 3 categories

Vehicle queue 1: the velocity is lower than 60 kilometers per hour (km/h);

Vehicle queue 2: the velocity is between 60 km/h and 90 km/h;

Vehicle queue 3: the velocity is higher than 90 km/h.

Vehicles in specific queues run at different lanes and vehicles in the same lane are put in descending order by velocities. Then for regroup the vehicle is needs when the vehicle changes its velocity and its position also must detected.

IV. SIMULATION AND EVALUATION

The proposed method is applied on a number of vehicles, and evaluated with the help of a simulator tool NS2. The input number of nodes is given by the user statically. Each vehicle is equipped with sensors. The road structure also developed with the help of ns2 tool. For the proposed method here considering some service providers (SP) and communication is between the vehicle to vehicle and between vehicle and SP. For starting the simulation of the proposed system first here doing the node deployment. After the node deployment vehicle movement is established. The communication range is fixed based on the Euclidian distance equation. Each vehicle consist of a display board near to driver's view , which shows the nearby vehicles and also give the correct indication for the driver based on some colors. Consider the figure below, the vehicle 36 is trying to overtake other vehicles at the same time 3 , 24, and 25 can't overtake any vehicles. It is indicated by red. By this method tracking and observation of multiple vehicles is possible at a time. It improves the confidence of driving as well as reduces the accidents and traffic jams in road.

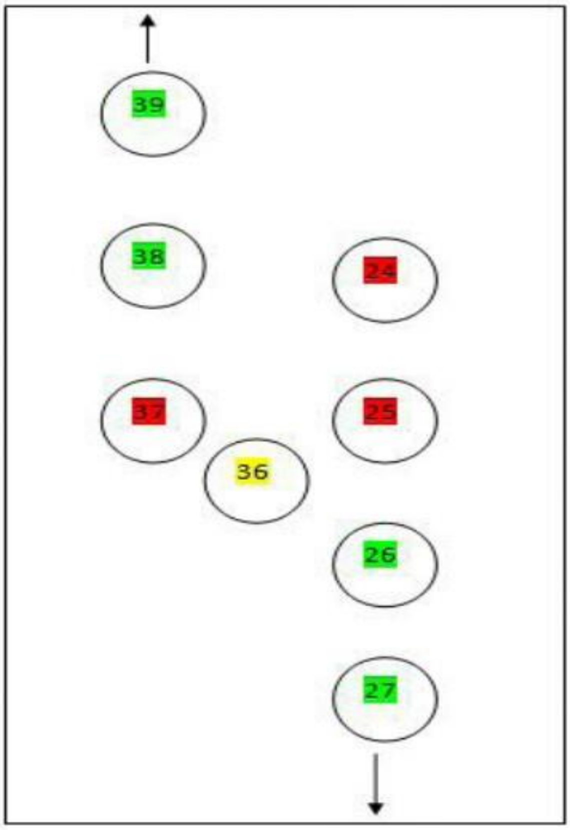

Figure caption : Display Structure

V. CONCLUSION

The proposed system deals with target tracking in VANET. It cooperatively gives indication to all the vehicles in the path of target. Different techniques can be used to find the location of the vehicles like GPS. But with the existing systems we can give indications only to the tracker vehicle. But it will cause collision in urban areas. To avoid that we can use cooperative target tracking. By this method we can give information to all the vehicles under the range of service provider. The ability to track targets is essential in many applications. Well established military applications include missile defense and battlefield situational awareness. Civilian applications are ever-growing, ranging from traditional applications such as air traffic control and building surveillance to emerging applications like supply chain management and wildlife tracking.

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