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Road Accident Prevention and Collision Avoidance at Intersection In VANET

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Abstract-Now a days on road accidents is a major problem of concern. Road accidents happen due to various different reasons such as street development, surge hours, human conduct, drunken driving, red light jumping etc. Increase in urban population have led to increase in road traffic and road accidents. VANET provides various methods to provide road safety. Maximum number of accidents have occurred at intersections with good visibility in urban areas. This paper presents a focused view on the safety of the vehicles at intersecting roads. A scheme is implementing to provide road safety at intersecting roads. In the proposed scheme vehicle to roadside communication is used with Intelligent Traffic Lights (ITLs) and IEEE 802.11p protocol. The advancement in Vehicular Ad hoc Network have led to various organizations, Institutes to focus on the methods of street security and it is now widely used now a days.

Keywords—*VANET, Ad Hoc Network, Accident Prevention, Collision Avoidance, IEEE protocol, ITLs.*

I. INTRODUCTION

Vehicular Ad hoc Network is a prominent way to provide street security and prevent vehicles from collision by using various methods like message dissemination, traffic management etc. As population is increasing, the highway road accidents are also increasing. Intersections are the most insecure areas because of large number of road accidents and vehicle collisions. According to World Health Organization report [1] 48.7 percent of the accidents in India were reported in 2017. India faces high rate of accidents in the world because of lack of safety techniques. Safety measures are the fundamental elements used for improvement in safety and preventing road accidents. Thus, prime focus is on the improvement in road safety techniques to prevent road accidents and vehicle collisions.

Many places in India are having lack of safety methods and improper facilities to prevent accidents. Due to this, death rates of accidents are increasing. States likes Assam, Bihar, Orissa, Uttar Pradesh seen 2-8 percent increase in road accidents fatalities in 2017. More than 150,000 people are killed in road traffic accidents each year. The World Health Organization estimates that road traffic crashes cost most countries about 3 percent of their gross domestic product. In India 1.24 million people die because of road accidents which happen every minute. Approximately 16 people die in road accidents every hour [2]. Nearly 1214 road crashes occur every day in India. Two wheelers account for 25% of total road crashes [3]. The injury rates are increasing every year throughout the world. VANET now a days is getting a major amount of focus as it provides large number of services. VANET provides three types of communication. These are Vehicle to Vehicle (V2V) communication, Vehicle to Roadside (V2R) and Vehicle to Infrastructure (V2I). In V2I Communication, Wi-Fi hotspot or long-range communication services are used to communicate with Road Infrastructure Unit (RSU). VANET technology also uses Inter Vehicular Communication (IVC). Intelligent Transportation System (ITS) are widely used in VANET to make better communication between vehicles with the help of technology called Telematics technology [4]. This technology provides a solution of communication issue in VANET by the exchange of real time traffic information. IVC methods gained importance to avoid vehicle crashing, crash mitigation and warning systems for Intersection collisions [5]. IVC can be controlled by protocol called Dedicated Short-Range Communication Protocol and IEEE 802.11p. To overcome the issue of road accidents, A scheme is proposed to prevent vehicle collision in urban areas. When vehicles approach intersecting roads then they need to be guided by some signal or some source of unit to have a safety riding and prevent them from collisions. We introduced Intelligent Traffic Lights (ITLs) at an intersection. In the

proposed scheme, the VANET communication takes place between vehicles and ITLs. Warning messages are sent to the vehicles approaching intersection to alert them for any chances of collision. This scheme not only works at an intersection, but at any road having traffic lights by replacing the normal traffic lights with Intelligent traffic lights.

First section gives the brief introduction about this paper. In section II, we briefly describe the related work. Different methods of accident prevention proposed by various authors is discussed in this section. Our proposed methodology is described in section III. Simulation and results are discussed in the section IV. Section V concludes the paper with future work.

II. RELATED WORK

Various systems have been proposed by different authors in order to provide road safety and to prevent vehicle collision using VANET to VANET communication.

In [6], the author proposed a work to provide a solution for car-pedestrian collision. They used a parameterized and reliable method to avoid car-pedestrian collision using VANET. Long Term Evolution (LTE) communication network is used to retrieve information about the pedestrian movement across the area surrounding the car. For positioning, they use Global Positioning System (GPS) in cars and mobile phones of the pedestrians. A server is also designed to get information about the location of both cars and mobile phones. The server has all the information about the position of cars and pedestrians. If the server detects that the pedestrian is going to enter car's area, then it will inform the cars and mobile phones of the pedestrians to establish point to point (P2P) communication using 802.11b so that they can select the appropriate path. A car cluster algorithm is designed which is based on the overlapped breaking distances to reduce the load on the infrastructure. To reduce the load in the LTE network an adaptable pedestrian position reporting design is proposed which is based on the distance from the VANET's road side unit. RSU's are used to retrieve the location and speed of the car. The RSU's then send alert messages to the cars about the collision.

In [7], a warning service mechanism is designed to prevent accidents by warning drivers about accidents and dangerous road conditions. The proposed system is divided into three steps:

Step1: Sensed environment data is collected from vehicles on the road.

Step2: Data is processed by RSU's and this data is shared by all the other RSU's in the same road.

Step3: The processed information is then distributed to the vehicles.

In [8], a solution is given for road traffic by transmitting information about traffic condition so that the driver can take appropriate actions. The solution consists of framework of a smart city having Intelligent Traffic Lights (ITLs) at the intersecting roads of a city. The information about traffic density is gathered by ITLs and update the statistics about congestion in the city. These statistics are send to the vehicles so that vehicles can select the best possible path which is free from congestion. If in case accident occurs, then these ITLs send the warning message to the vehicles informing about the accident so that no further collision can occur.

In [9], a method is proposed that manages the traffic information to avoid accidents. The information is gathered from the vehicles itself, so no infrastructure is needed in the author's proposed work. The vehicles are having a GPS, on board unit and full map of the city including the positions of ITLs. Every vehicle sends hello messages from which the exact location of each vehicle is determined and using this information, traffic density of the city can be calculated. The author studied various different protocols like Greedy Perimeter Stateless Routing (GPSR) [10] and Geographical Opportunistic Source Routing (GOSR) [11] but uses AD hoc On Demand Distance Vector (AODV) [12] routing protocol because of the simplicity of the protocol and its widespread use.

In [13], the Red Signal Delay method is proposed to prevent vehicle from collisions at the intersections. Their proposed method consists of traffic light, camera and a controller. The controller is used to control the camera and traffic lights. Camera is used to capture the image of the vehicles which are arriving at the left turn. Controller is responsible for red signal delay to avoid vehicle collisions turning left at intersection. The author used various methods to determine the speed of the vehicle and entry at the intersection [14] [15].

In [16], a scheme is mentioned to avoid collisions at intersection by using congestion control concept. The author also uses IEEE 802.11p protocols to avoid congestion of vehicles. In their scheme, they used two types of safety messages. These are beacon messages and event-driven messages. Vehicles and RSUs are assumed to equipped with short range wireless communication devices which is based on IEEE 802.11p so that the vehicles can communicate with each other. These messages are need to be disseminated within an area within certain delay limit. The scheme works by sending the beacon messages which are also known as Hello messages. This message contains information about the

vehicle position, speed, location etc. Event-driven messages are generated when any abnormal situation is detected. Beacon messages are sent by vehicles to RSUs periodically to inform about vehicle position, direction, speed with the neighboring vehicles and to make them aware of their environment. These event-driven messages must be delivered to vehicles with high reliability and as fast as possible. To avoid congestion in this scheme author uses 802.11p protocol. The congestion in the traffic is mitigated by reducing the transmission duration of beacon messages. If large number of vehicles transmit beacon messages at high frequency rate then the bandwidth will get exhausted completely. Due to this, packet collision occurs which in turn cost the lives of the people. So, to overcome this problem, author uses congestion detection method by providing dynamic time slot reservation to the vehicles that generates warning messages. If the vehicle does not find any time slot then the author provides unoccupied time slots from the adjacent segments

In [17], a system is proposed for vehicular cloud environment so that the road accident and air pollution get reduced. This system architecture consists of three layers: V2V, V2I, RSU to static cloud and vehicle to dynamic cloud. The author assumed that every vehicle is equipped with on board unit with built-in navigation system. The on board unit transfers data through 3G or $g communication devices like Wi-Fi, WAVE, Wi-max etc. If the vehicle is detected with abnormal behaviour like sudden lane change, exceeding speed limit, accelerating with reverse direction etc then an emergency warning message will get generated and is send to the cloud storage and vehicles. The second layer is vehicle to Infrastructure layer. This layer is responsible for transmitting the movement, location of the vehicles and traffic related information. The third layer is RSU to static cloud which is used to store all the information related to the RSU data on static cloud and is also responsible for creating free space for future use.

In [18], a system is proposed to overcome the road accident issue by using real time simulation. Various tools and techniques are used in the proposed work. They use decision server to collect information about the traffic from RSUs. These devices are used as Wi-Fi and also used for connecting link nodes. Author take vehicles as devices to send and retrieve data from other devices. This system mainly proposed to utilize the decision server which are used to retrieve information from the RSUs. The author in his work assess the performance of various routing protocols. A rule based technique is designed to detect the congestion and also to prevent it. The author implemented their proposed work in three different scenarios. First, they choose the better communication method for V2V communication using Weighted Cluster Algorithm (WCA) to improve the performance of network in different scenarios. Four different parameters are taken such as connectivity to check vehicles are in same range, speed to check the moving speed of the vehicle, distance to check the distance between vehicles and mobility.

The work is proposed for the improvement in the road safety by means of Vehicle to Infrastructure Communication (V2I) so as to prevent accidents and avoid vehicle collisions.

III. METHODOLOGY

As intersections are the most insecure area, there is a need to take proper safety measures to prevent accidents and avoid collisions. Various methods have been studied for road safety at intersection and proposed a new scheme. A road traffic scenario is taken and proposed a system having ITLs that warn the vehicles about collisions in case of any emergency at the intersection. In India, red light jumping, human conduct, drunken driving is the main cause of accident. The proposed work also prevents people from breaking traffic rules at intersections. The design of the system builds on the GPS system, IEEE 802.11p and AODV routing Protocol. We use AODV routing protocol because of its widespread use in Mobile Ad hoc Networks (MANETs), Vehicular Ad hoc Network (VANETs) and other wireless ad hoc networks that may contain thousands of nodes. The architecture of the system contains intersecting roads, ITLs and vehicles. GPS is used to collect the information about the vehicle's position, location and direction of moving. Four different types of vehicles are used in this scheme. These vehicles are assumed to have inbuilt GPS system. Intelligent Traffic Lights are set at intersecting section of the road. V2I and I2V communication is used in the proposed work for sending messages. The structure of the design is shown in Figure 1.

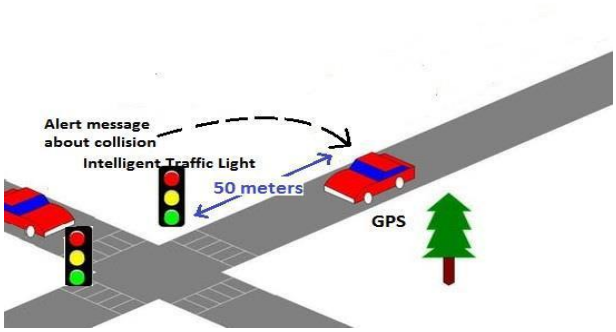

Figure 1. System Architecture

In the proposed methodology, two types of messages are used: Beacon messages and warning messages. Beacon messages are hello messages which are send by vehicles to the nearest ITL. These beacon messages contain vehicle id, speed, position, direction. Vehicle position and direction can

be retrieved through GPS. These messages are sent after every 200 seconds to get the exact location of the vehicles. The other type of messages are warning messages which are broadcasted from ITLs to vehicles. These warning messages are generated whenever there is any emergency situation occurs. The system is divided into three steps:

Step1: Sending beacon messages

The beacon messages are send by vehicles to the nearest ITLs informing about the location, direction, speed and id of the vehicle in every 200 seconds so as to get the exact location of the vehicles.

Step2: Decision module at ITLs

A decision module at ITLs is used to check the emergency situation by calculating distance between vehicles and ITLs and checking the speed of the vehicle by comparing two or more beacon messages from the same vehicle.

Step3: Sending warning messages

These warning messages are broadcasted from ITLs to vehicles whenever there is an emergency situation occur. Accordingly, the vehicle can take appropriate decision.

The vehicle approaching intersection send the beacon message contain vehicle id, location, speed, distance to the nearest ITL. The calculation module at ITL checks the distance between the vehicle and ITL and also check the speed of the vehicle from the beacon message. After 200 seconds the calculation module checks the next beacon message send by the same vehicle. The speed and distance are compared from both the messages. Now if a situation occurs in which traffic light shows red signal and the information retrieved from comparing the beacon messages show constant or increasing speed and reducing distance, then, the ITL send the warning message to the vehicle for the emergency stop. Block diagram is shown in Figure 2.

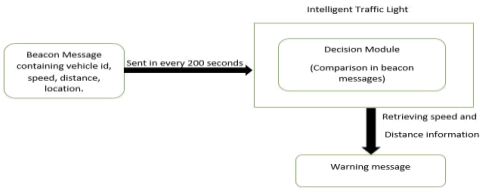

Figure 2. Block diagram of ITL

The warning messages must be sent as fast as possible to prevent any collision as any delay in warning message can cost the lives of the people.

Dedicated Short Range Communication protocol are specially used for VANET communications like V2V, V2I and V2R. We used MAC layered protocol IEEE802.11p in the scheme which is mainly developed for Vehicular Ad hoc Network.

The aim of proposed work is to design a system to avoid collisions at intersecting roads by sending warning messages to vehicles. For this, two types of messages are used. One is beacon messages which are to be send from vehicles to ITLs periodically. These messages contain vehicle information and are send after every 200 seconds. Second is warning messages which is to be send from ITLs to vehicles in case of any emergency situation at the intersection.

IV. RESULTS AND DISCUSSION

In this section, the performance of the proposed scheme is simulated using SUMO simulator [19]. The simulation parameters are summarized in the following table.

Figure 3 shows the Vehicular Ad hoc Network Simulation in SUMO Simulator. In this, we use total 654 vehicle for traffic simulation. The vehicles speed varies from 0-20 m/s. There are four types of vehicles in simulation. These are: Bike, Car, Bus and Heavy Goods Vehicle (HGV). It is assumed that the vehicles are equipped with Global Positioning System (GPS). The MAC protocol used in the simulation is IEEE 802.11p. The total simulation time comprises of 3000ms. Below is the figure of the proposed simulation.

TABLE I. SIMULATION PARAMETERS

Parameter Name	***Parameter Value***
Simulator	SUMO simulator
Simulation Area	1500 X 540
Number of Vehicles	654
Vehicle Speed	0-20 m/s
Number of Lanes	16
Vehicle Type	Bike, Bus, Car, Heavy Goods Vehicle (HGV)
MAC	IEEE 802.11p
Routing Protocol	AODV
Queue Type	Queue, Droptail
Simulation Time Steps	3000

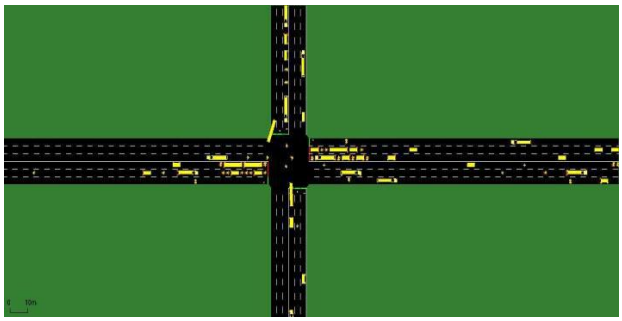

Figure 3. ITL scenario with collision avoidance

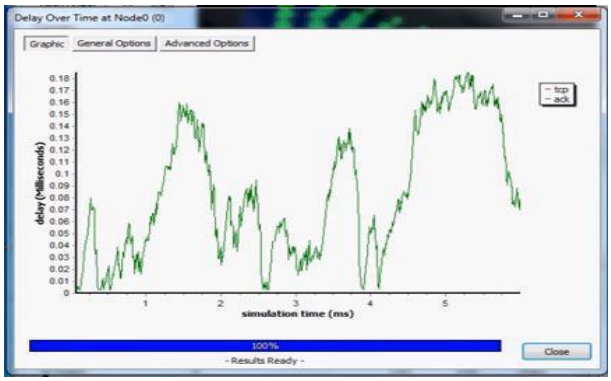

Figure 4

The performance of the AODV Protocol in the proposed scheme is analysed and shown in Figure 4. The Figure contains the graph showing the simulation time and delay in the network.

V. CONCLUSION

In this paper, a scheme for collision avoidance at intersection is proposed. The key idea behind this methodology is to prevent accidents by introducing Intelligent Traffic Lights at intersection. These ITLs send warning messages whenever there is any emergency situation. A decision module is used to compare beacon messages and take the appropriate decisions for sending warning messages to vehicles.

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