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Multi Agent Assisted Safety Information Dissemination Scheme for V2V Communication in VANETs: Intelligent Agent Approach

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Abstract: The safety information dissemination plays a vital role in the VANET communication. It is a technique of transmitting the information at scheduled intervals or during road hazards by detecting the events using onboard system and interfaces. Information is shared between vehicles and road side units which are further used to predict vehicle collisions, road line crossings, environmental warnings, traffic data and road hazards. Interestingly the risk of lateral collisions and dense traffic for vehicles can be avoided by accomplishing fast data dissemination i.e. warning alerts by event detection. Vehicular technology which supports the safe mode of transportation is growing faster due to the deployment of new automated technology in the intelligent transportation system (ITS). The different scenarios used in vehicular communication are Vehicle to Vehicle (V-V), Vehicle to Infrastructure (V-I) and Vehicle to Internet. Some of the important characteristics of vehicular communications are the mobility, frequent changes in topology, varying transmission power of antennas, intermittent connectivity. ITS providing the solutions for most critical transportation issues and inspiring the researchers for the betterment of road safety. In this paper, we propose a multi agent based safety information dissemination scheme for vehicle to vehicle communication. The proposed algorithm performs the safety information dissemination with help of intelligent agents by optimizing the channel access techniques, message encoding and selection of intermediate nodes. Here the communication between source and destination is achieved with fever number of intermediate links by selecting the nodes in the special zone. Short interval codes which represent safety information are effectively transmitted in the intermittent nature of wireless connectivity. This proposed work describes the details of algorithm with associated network environment, multi agent functions and dissemination mechanism to illustrate the improvement in end to end delay, PDR, energy constraints etc. This method reduces the problem of broadcast storm by delivering the information to intended node. Simulation of the proposed work gives the improved results on PDR, latency and connection overhead.

Index Terms: V2V Communication, Safety Information Dissemination, Multi-agents, Vehicle Manager Agent (VMA), Region of Interest (ROI) etc.

1. Introduction

Vehicular Adhoc NETwork (VANET) is arguably an advent move in the wireless networking to claim the safety of the vehicles on the road. In the transportation system combat operations in critical times using synergistic area of sensor networks, helps to reduce the damage and improve the road safety. Vehicular networks create a space for the research to face the challenges. Many academicians, industrialists shown the interest for the future vehicular networks in the area of Intelligent Transportation System (ITS). Indeed, the concrete ITS applications in commercial sector has a vital role in the development of underlying technology. ITS system such as VANET, assist the drivers for safe transportation by providing the information like conditions of the road, accidents, vehicle density, traffic information at the junctions, resources available across the road. The vehicles can share this information among themselves to cooperatively build the solutions for the transportation. The tremendous changes in the automated technology such as Internet of Things (IoT) and vehicle with inherent features of data collection on the road side will jointly creating the venture model for road safety. Many authors proposed the V2V communication with unified routing techniques, message compression, allocation of large bandwidth, finding the traffic free route etc. These communication methods achieve better Packet delivery ratio and congestion free route calculations but they suffer with poor promised end to end delay. The stringent requirement for safety data delivery is faster end to end delay and reduced packet overhead is addressed in the proposed scheme. This V2V technology provides an alert message to the drivers about the potential hazard, extreme traffic density and road conditions using Dedicated Short Range Communication (DSRC) standard. The role of the routing scheme in V2V communication for the information dissemination under the presence of congestion is discussed in [1]. Bulk data retrieved timely from the cloud from all nodes in V2V communication for safety information is discussed in [2]. Recording previous vehicle positions and Path history, path prediction is done to know the current position of vehicle in addition to vehicle crossed during the known time interval. This mechanism is used for the detection of congestion free path which leads to quick dissemination of data is quantified in [3]. When the vehicles are moving in straight paths only a smaller number of data points is required for the path history but it requires more data points for vehicles moving in curved paths. Future projector for dissemination in straight road is tending to be high while curvature needs the geometric map for the potential hazard detection [4].

GSM based Pattern for Information Dissemination and Evaluation of Income Level among Rural Dwellers is discussed in [5]. Here hach packet is recorded with time of arrival to count down the TTL value in order to detect the connectivity. This mechanism also provides the feature of varying TTL thresholds that can be set to work with the variable network traffic. This is implemented in the control layer of the Media Access Control (MAC) in each node that participates in the communication. This significantly reduces the channel waiting time for fast delivery of the information. A Store and forward based algorithm dissemination scheme aims at the handoff mechanism at the different levels in the network layer. This follows the unicast type of communication scenario i.e. peer to peer predefined packet rate between source and destination is initiated [6]. Data validation method and performance analyses of congestion control algorithms for event-driven safety messages is proposed in [7] for different congested scenarios. Many ITS system have developed the data collection for monitoring purpose for regular assistance for the drivers which intern work using DSRC for beacon dissemination.

2. Related Works

Many researchers presented their ideas towards the mechanism of dissemination employing suitable algorithms. Some algorithm functionalities are designed based on the segment's coverage network area where the dissemination process and its efficiency are affected by the number of segments that forms the network [8]. These different techniques have been explained in different studies. In scheduled safety information dissemination method, vehicle to vehicle scenarios creates a broadcast storm, where large density of vehicles exchanging the safety related information with multiple hops [9]. All vehicles validate the transmitted data before disseminating it to avoid the redundant data transmission. The information transmitted by every vehicle should be anonymous not having any personnel identity. This method of dissemination reducing the payload overload [10, 11]. The destination nodes are identified by the node discovery method using the specially made hello packets and synchronization packets thereby establishing the path before transmission [12]. The agents are used for the simplified approach of data collection and manipulation during the communication. Cognitive agents are used for the effective data dissemination is suggested in [13, 14] there by achieving the control over few parameters like bandwidth, latency, push full decision latency etc. By employing common data security communication standards V2V interoperability among the automotive manufactures has been achieved.

Data dissemination by reading digital warning indicators along the road to drivers for the potential risk management is discussed in [15] where lane change warning is a safety application intended to provide a warning to the drivers about when to attempt the lane change. The usage of Wireless Access Vehicular Environments (WAVE) and Dedicated Short Range Communications (DSRC) making the VANET more vulnerable in dynamic environments which has one of the characteristics of ITS. Working of LINE Messenger as a transport layer, to be distributed to an instant messaging partner is API technology of instant messaging application can be utilized to build a system that has functioned as a transport layer to send a cross platform message instantly [16].

In the state of current trends, VANETs are probably witnessing the exponential growth in the E-commerce section of the transportation. A GPS receiver that provides the accurate positioning and time synchronization information. This information is used to *find the* contention free channel [17]. In [18] the information dissemination about the availability of parking space for the nearby approaching vehicles is discussed. By the digital signboards on the place which records the parking lot occupancy. The network resources play the vital role in data dissemination with least number of resources for the data delivery [19]. The V2V scenario where the infrastructure co-operated information sharing for the data validation and transmission by the nodes is discussed in [20]. Here the intermediate nodes acting as fast relaying candidate for the connectivity. The opportunistic data dissemination where each node collects the mobility pattern for the distant nodes of their vicinity and selects the next forwarding node. This mechanism avoids the intermittent connectivity and increases the packet delivery ratio [21,*22*].

The work presented in [23] resembles implementation and evaluation of a safety data model is used which helps in decision making to prevent loss of lives and properties. It did so by developing a method for building metadata through a data chain, mining this metadata and representing it in such a way that a consumer of the data can judge the integrity of the data. Map assisted vehicle routing is used for the selection of forwarding node to reach the destination node [24]. The multiple layers routing protocol is implemented in network and transport layer. This reduces the overhead or redundant information presented in the data packets. Recording the arrival time of the packets, then decision about validation is made based on the defined priority scheme to carry out the dissemination to improve and enhances the network parameters and QoS [25]. The trajectory based dissemination scheme alleviating the dissemination by limiting the amount of retransmissions and utilizing lesser bandwidth during transmissions [26]. Trajectory is time based arrival of data packets to increase the relay capability compared to existing flooding techniques. Grouping of vehicles (named as cluster) during vehicle movement on the road is done dynamically without having actual physical connection [27]. This mechanism helps to incorporate the efficient usage of bandwidth and scalability. The PHY layer parameters have been optimized for different topologies. The performance investigations have been carried out for different frequency band and data rate and different bandwidth (BW) in each of standard topologies [28].

The work suggested in [29] directs the presence of contention window to avoid the noise and collisions thereby reducing the broadcast storms to raise the dissemination rate. Information centric and packet centric data packet forwarding is used to impose the traffic load on transport layer protocols to manage the dissemination process effectively. Reliable radio channel for the DSRC have the characteristics of adopting the transport layer protocols to segregate the active and dumb nodes. Fairness index in the dissemination process is achieved by uniformly distribute the network load by controlling the topology of networks using local data exchange [30,31]. This mechanism is based on game theory of Nash bargaining scheme. The objective of this scheme is to maximize the rate related utility by considering the user fairness and load balance. Two player and multi player bargaining scheme with aid of optimally grouping the base stations are used to improve the fairness index. The discussion in [32] uses the three different approaches unicast, multicast and geocast for the evaluation of protocol in these scenarios. These protocols are tested under wide variety of node densities with different simulation tools. Fair evaluation is done on each case using the large set of collected data [33]. The delay tolerant networks communicate between the nodes with pre-defined hello packets for communication establishment. This technique plays its role in the less dense network. Most of the communication is performed through the exchange of beacon messages. The periodic exchange of data among the vehicles using beacon message is discussed in [34].

The broadcasting schemes during dissemination of safety message uses the set of persistent scheme and orthogonal codes and the retransmissions are triggered with one hop transmission. Selection of node free from congestion factor is selected as the cluster head which later co-ordinate the data exchange with neighborhood nodes. The capability of cluster head and its congestion factor is shared with the nearby RSU to decide the handoff process during critical dissemination. The data packets are accumulated and stored in buffer and packet forwarding is done at a later time when the congestion free path is established by the MAC protocol [35]. The application of intersection moment access helps the drivers to respond quickly to avoid the potential crashes. The vehicle passing intersection gets the warning message by the neighborhood [36]. The work presented in [37] highlights the authenticated routers for the vehicular networks based on authentication by the public key infrastructure and requires predetermined cryptographic keys to access the topology using distance vector kind of algorithms. The authenticated nodes participate in the data packet forwarding process during warning message exchange [38].

The concept of Service CHannel (SCH) and Control CHannel (CCH) is used at bifurcated timing intervals to handle the emergency traffic. Here the clock based events are recorded and based on the emergency factor two channels serve for the dissemination process. The packet contains the channel number data rate power level. In the multihop broadcast connectivity scheme, author suggested to deploy multiple transmissions over the multiple road segments which can estimate the forwarding capability of the node presented in all segments depending on the past experience of vehicle density. The concept of real time traffic aware protocol is used based on the forwarding capability obtained by real time traffic conditions assessments [39]. This results higher adaptive capability and better delivery performance. These techniques of dissemination algorithms for safety information used the random multihop data forwarding methods. Some effective algorithms building by consuming minimum transmission power with large throughput. Due to the large number of vehicle collisions that causes the road traffic creation, accidents, it is needed to find the root cause and finding the solution by sharing of safety data among the vehicles [40,41]. The probability of rebroadcasting the message and its delay is dependent on the computed rebroadcast degree. If the vehicle not receives the rebroadcasted alert message from another vehicle within the TTL time, the vehicle rebroadcasts the alert message with the rebroadcast probability [42].

The above-mentioned dissemination algorithms mainly used the number of nodes and information size as their design parameters. In this paper we are creating the virtual segments based on the transmission range of source node and performing routing using nodes in ROI (Region of Interest) to perform the dissemination with less end to end delay.

3. Safety Information Dissemination Scheme

The dissemination has to consider the following features for the efficient safety data dissemination: The vehicles are moving with relatively a variable velocity; vehicle has to follow the road lanes and traffic signs; vehicles are equipped with GPS facility with inherent road map providing the road information; topology variation at the time scale; distributed operation; segmentation of moving vehicles based on the signal strength. Traditional safety data dissemination uses the scheduled beaconing by the multiple hops with successive intermediate nodes at the direction of communication. In the intelligent safety information dissemination, the communication area is divided into segments based on the Radio Signal Strength (RSS) levels incurred, and selection of intermediate nodes from the special zone i.e region of interest, achieves the target node communication with fever hopes by utilizing the transmission capacity of the radio interfaces. The source tries to establish links with far end nodes present in the ROI, forms the strong consistent successive links at the direction of target. Hardware requirement for the implementation are onboard unit in the vehicle comprises of FPGA: PCI, serial ports and soft-core CPU 2.5/5 GHz 802.11 radios modified for DSRC RT sync, GPS time sync, GPS and DSRC sync, sensor fusion/timestamp CVIS sensor and M5 card, GPS and DSRC antenna, Mobile router and Gigbee gateway.

3.1. Our Contributions

In the present era Vehicular adhoc networks (VANETs) are providing vast services for the transportation sector preserving the human life with safety and comfort. The safety message delivery under wireless communication scenarios are challenging to meet the performance requirements. This work is motivated by the existing drawbacks in dissemination algorithms such as multiple hop and hop transmissions, packets squeezing, frequent link failures. The following contributions are made towards the safety data delivery under promised delay. Proposed scheme consists of static and mobile agents to perform the better connectivity between the nodes. It considers the parameters such as radio range of source node, logical segment size, TTL value of packet. The macro sensors and embedded system situated in vehicle perform the safety information dissemination in the following ways.

- Segment formation based on the radio range of the source node and identifying the region of interest (ROI) using the GPS co-ordinates.
- Identification of next relaying node based on the parameters of mobility and distance from the source.
- Data dissemination in the selected neighbor relaying node using the wireless technology by multiple transmissions in the close proximity. The sensory and processing unit with GPS capability unit is embedded in each vehicle.
- Conversion of the information in to short interval predefined codes which will be disseminated during the critical events in the presence of intermittent connectivity.

Our contribution includes the following. (1) Broadcasting of the safety information is initiated by the source node. Proposed protocol reduces the broadcast storm by performing limited hand off communication through the boundary nodes in terms of outer communication range. (2) This is achieved by locating the intermediate nodes at the outer area of transmission range. The results namely end-end delay, energy consumption, PDR are inevitably 20 percent better compared to the existing safety information dissemination techniques. (3) Our proposed algorithm uses the segmentation technique which predominantly reduces the end to end delay with significant rise in the throughput compared to other algorithms. The contribution of this paper is to perform the safety information exchange to the intended device using the fever hops and compact coding of information. Organization of rest of the paper is as follows. Dissemination scheme is described in section III, result analysis is presented in section IV and finally section V concludes the paper.

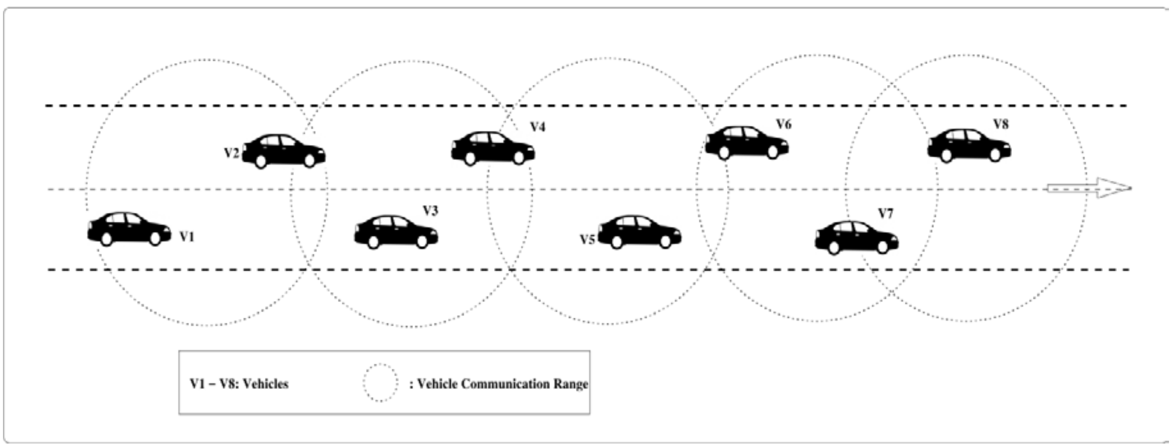

Fig.1. V2V communication scenario in VANETs

3.2. Software Agents

A software agent is a computer program that acts for user or other programs in the relationship of agency. The different actions are initiated for the execution of a task. It works with other agents or with the protocol. In the present discussion of safety dissemination scheme in vehicle-to-vehicle architectures, the system using multiple agent schemes static and mobile agent type for the collection and processing of data packets. This consists of a Knowledge Base (KB) which is a centralized storage system about vehicle dynamics, Vehicular Manager Agent (VMA) which is static agent and Far End Node Selection Agent (FENSA) which is of mobile agent. It is considered to be having similar kind of agent system in the other nodes that participates in communication.

3.3. Network Environment

We consider a V2V communication scenario in VANETs by the two lane urban high way scenario with the moderate traffic on the road. Each vehicle is equipped with the micro sensor unit for the hazard detection forming safety information, GPS facility with the live location finding capability. The road distance of 5000 meter is considered with average velocity of vehicles 10, 20, 30 meters/sec. The two lane road scenario consisting of logical segments based on the range of transmission signal intensity. For simplicity we considered only three logical segments during the simulation. The network scenario with the location of vehicles is as depicted in Fig. 1. Vehicles (V1-V8) communicate among their neighbor vehicles within the communication range by using IEEE 802.11P (DSRC/WAVE).

3.4. Multi Agent System Operational Sequence

In this study it is assumed that all the participating nodes namely source, sink and intermediate nodes are provided with an inbuilt embedded system having the capability of recording GPS coordinates and processing of sensor generated information about the vehicle dynamics. Each Vehicle has communication range of radius R. The system consisting of static agent VMA and mobile agent FENSA and knowledge base (KB) which combinely identify reliable far end node at different logical segments as a intermediate nodes for safety information dissemination.

- **Knowledge Base (KB)**: It is the centralized location of the system where sensor generated data collection by the multi agents are stored. This KB comprises of recorded data about packet Time to Live [TTL] value, GPS coordinates, traffic density and conditions of the road, network strength, node id with sequence numbers, mobility pattern and limited set of predetermined encoded warning messages. The inbuilt safety warning messages represented by short codes are shown in Table I. VMA and FENSA are relatively in synchronization with knowledge base. The discussed agency components and its relation is described in the fig. 2.
- **Vehicle Manager Agent (VMA)**: The database stored in the knowledge base is developed by VMA, which can intern trigger FENSA. VMA is a static agent responsible for finding the relevant distant far end node in every logical segment. This task will be performed in coordination with the FENSA. The possible ways to handle the different circumstances are if VMA unable to find the far end vehicle in the logical segment within the available TTL duration, then on expiry of TTL which can further ignites FENSA for latest updates about vehicle information. Then VMA assist the source node for channel contention process in the next successive logical segment and intensively searches for the node in ROI which will be considered as reliable intermediate node to perform the dissemination.

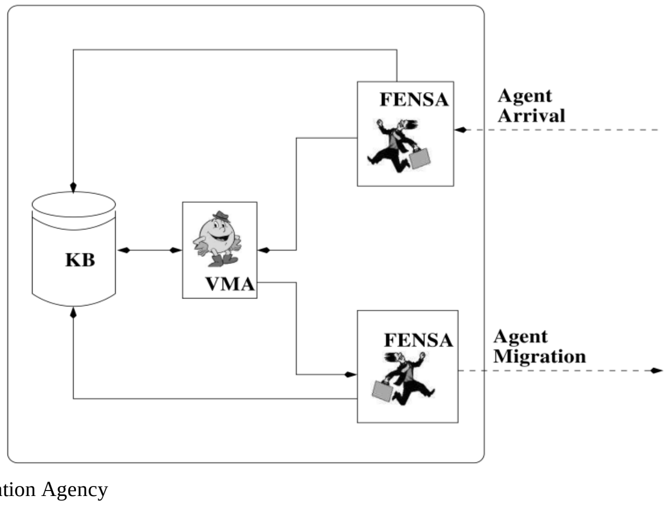

Fig.2. Safety Information Dissemination Agency

- **Far End Node Selection Agent:** It is a mobile agent that reaches all nodes to get the information about vehicle dynamics and report to VMA. It is triggered by VMA whenever there is significant change in the network and updates the knowledge base for every trigger about far end node availability in coordination with VMA.

Table 1. Typical Built-in Safety Information Types

Built in Code	Predicted Information	Built in Code	Predicted Information	Built in Code	Predicted Information
EF	Empty Fuel	EF	Extreme Fogg	BR	Bad Road
SA	Severe Accident	UA	Unknown Area	EC	Extreme Congestion
MA	Medical Assistance	HA	Heavy Rain	MA	Map Assistance
AA	Accident	FA	Fire Assistance	TA	Toll Assistance

Operational sequence of the proposed system is described as follows. (1) VMA creates and maintains the data base or knowledge base about the forwarding nodes in the connecting path, relative changes along the time axis will be updated by VMA. VMA triggers FENSA (Far end node selection agent), on initiation FENSA can moves in and out of the connected segments to locate the optimum far end node considering the location services of GPS. (2) The vehicle presented in the ROI is embarked with the parameters like Time to Live, GPS co-ordinates, mobility. The vehicle mobility and velocity parameters of node help to decide the relaying candidate. (3) The FENSA is mobile agent which virtually moves around the connected topology by the radio network and thus upgrades the knowledge base in coordination with VMA. (4) The source considers the knowledgebase constituted by VMA and FENSA, which are solely responsible to disseminate the pre-determined coded messages using minimal network resources to achieve shorter end to end delay.

3.5. Mathmatical model

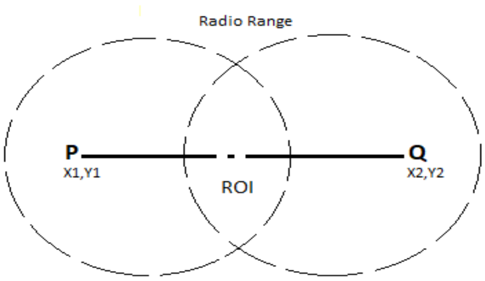

Fig.3. Representation of region of interest

The multi agent triggered safety information dissemination scheme uses static and mobile agents to design the system for reliable data delivery. The VMA (static agent) and mobile agent (FENSA) updates the knowledge base frequently at the rate of 120 sec or any significant change in the network dynamics whichever occurs early. The successive logical segments present in the network scenario (Fig.4) are namely (X), (X-1), (X-2) and (X-3) with reference to the position of source node. Every logical segment has specially covered area which is ROI where the presence of nodes which participates in the communication results in effective dissemination. Let P and Q are the nodes present in the neighbor clusters whose communication range is represented with dotted circle shown in Fig.3. Considering P and Q have the two dimensional coordinates (X_1,Y_1) and (X_2,Y_2) respectively, then expressing the mid overlapped point using two dimensional section formulae described by the equation (1) which is given by

$$P = \left(\frac{X_2+X_1}{2}, \frac{Y_2+Y_1}{2}\right) \quad (1)$$

where P is the midpoint between two end nodes P and Q assuming both nodes moving with same velocity, then the mid overlapped region with radius R named as ROI can be defined using the equation of circle having (h,k) coordinates at center and (x,y) are the points on the circle, then ROI with radius of coverage R is expressed in equation (2) as

$$ROI = R^2 = [(x-h)^2 + (y-k)^2] \quad (2)$$

Here h,k are the two dimensional planes with h = $\frac{X_2+X_1}{2}$ and k= $\frac{Y_2+Y_1}{2}$. Once the ROI is defined then source vehicle transmits the control packet which includes the logical segment of ROI co-ordinates under consideration. All the moving vehicles on the road can autonomously detect the real time GPS coordinates of its own by its self equipped GPS navigational facility. The correlation of location coordinates between the moving vehicle and stored ROI in real time vehicle movement indicates the presence of vehicle in the ROI as far end node which will be informed back to source node by setting control bit which will be used to trigger the dissemination process.

Here Friis equation is used to calculate the total power in watts that is required to reach receiver node present at different distances with radius R. Due to the existence of multiple logical segments along the coverage radius R and associated ROIs we need to deliver variable power density to reach node in ROI along the direction of communication. Then the power density p (in Watts per square meter) of the signal incident on receive node at distance R from the transmit node is given by Friis transmission equation (as mentioned in equation 3), transmission power is as follows

$$P(Txn) = \left(\frac{\lambda}{4\pi R}\right)^2 \left(\frac{1}{G_t G_r}\right) \tag{3}$$

Where Gt = Transmitter antenna gain, Gr = receiving antenna gain, R = distance between antenna in meters. Calculating the transmission power for different value of R, we can reach multiple nodes in ROI for the different logical segments which are shown in Fig.4. By this, transmission power is evaluated for all logical segments such as (X-1), (X-2), up to (X-N) w. r. t their relative radius of coverage range. Finding the relation between P (T_{xn}) and logical segments P (fr) provides the identification of reliable intermediate nodes. Let node in far segment X be f_i= X i.e., probability of finding the far end node, for the next segment far end node $f_{(i+1)}$= (X-1), similarly node in last segment will be defined as $f_{(i+n)}$ = (X_n). Since f and region (X_n) decide the transmission range, fi is a function of distance. By tuning of source vehicle transmission power, various ROIs can be reach which are shown in equation (4) as

$$P(T_x) = \frac{P(f_i)^{-j}}{G};\ \text{where}\ j = 1,2,3,\ldots,n \tag{4}$$

P (Tx) is the transmission power, P(fi) is the distance from the source and J is the range of values based on the logical segments ex;for neighbor segments J takes the value n, whereas for far end logical segment J takes the value 1. G is the attenuation factor in percentage and is given by equation (5) as

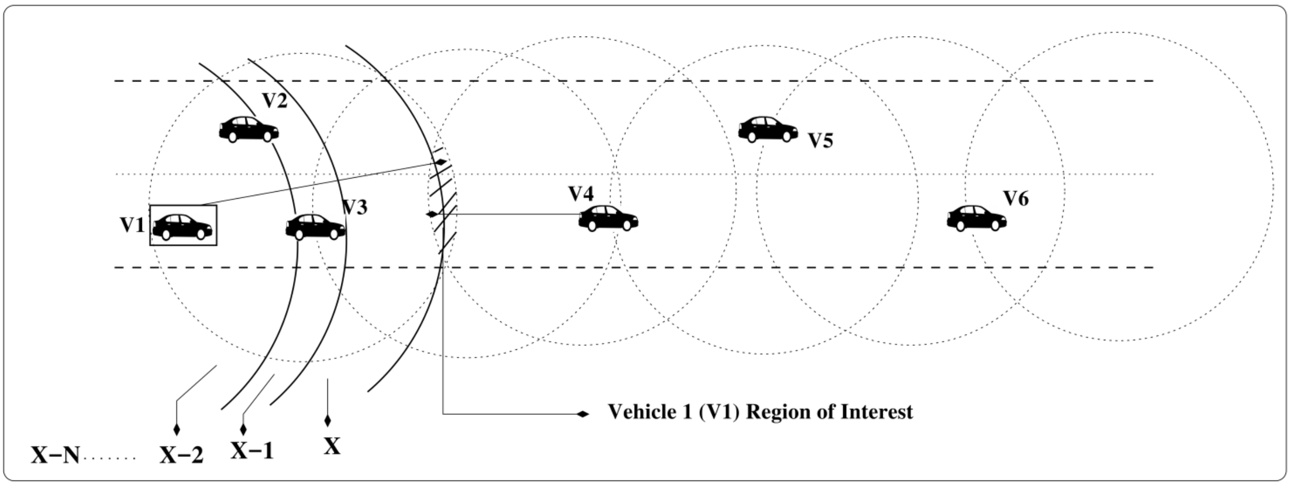

Fig.4. Identification of Region of Interest

$$G = \left[1 - \frac{P1}{P2}\right] \tag{5}$$

Where P_1 is the transmitted power and P_2 is the received power. $P_{(Tx)}$ in equation (4) defines minimum transmission power which is required to reach neighbor segment nodes, whereas maximum transmission power is needed to reach the far end segment. Each node consumes certain amount of energy for processing the information bits. The energy consumption of system includes the processing bits and transmission of bits. Energy consumption in the following scheme is given by equation (6).

$$En = \left[\alpha\left(E_{ij}(t) + E_{ij}(p)\right)\right] \tag{6}$$

Where E_{ij} (t) is the energy consumption in transmitting information bits from node i to j, E_{ij} (p) is the energy consumption in processing of bits at nodes i and j. α is the multiplication factor and is given by equation (7)

$$\alpha = \left(\frac{\text{packetsize}}{\text{bandwidth}}\right) \tag{7}$$

Thus the effective end to end energy consumptions for the different logical segments is given by equation (8).

$$En = \left[\alpha\left[\left(E_{ij}(t) + E_{ij}(p)\right)\right] + e^{\beta}\ \text{where}\ \beta = 1,2,3,\ldots,n \tag{8}$$

Where β is the additional energy consumption incurred due to switching of logical segments. The switching of segments takes place due to absence of node in ROI for the segment under consideration. The typical values of β for the logical segment (X), (X-1), (X-2), (X-n) are represented in equation (8) the β value will be increasing exponentially as it involves the switching overhead thereby additional energy needed to perform the effective dissemination. If n is the node having coverage range of radius R, with two dimensional coordinates' h1 and k_1 similarly for the next node with n2, radius R and coordinates h2, k_2 .etc. To achieve reliable communication path for improved dissemination process needs an efficient intermediate nodes. The following equation (9) helps to identify such nodes in ROI and is given by

$$ROI = R^n = [(x - h_n)^2 + (y - k_n)^2] \quad (9)$$

Node available in the exterior region could be the far end node since there will be multiple nodes in the region of interest (ROI), choosing the reliable node improves the latency. This criterion is based on the velocity of the nodes e.g., vehicles1, 2, 3, and 4 moving with the respective velocitiesV1, V2, V3 and V_4 in the direction of forward transmission. Since nodes moving with slower velocity leads to give stable connectivity, the selection of node in the ROI has the criteria as shown in equation (10).

$$ROI = R^n = \lim_{v \to 0} [(x_{v1} - h_n)^2 + (y_{v2} - k_n)^2] \quad (10)$$

Where Xv1 and Yv2 are the relative velocity of two adjacent nodes X and Y

3.6. Limitations of the Proposed Work

Some of the limitations of the proposed disseminations schemes are as follows (1) All the vehicles in the network are considered to be intelligent and configured with GPS and enough buffer to store inbuilt messages. (2) We are finding the far end node for limited number of segments which can reduce the coverage range. (3) The nodes in the networks are agreed upon holding and authenticating the standard inbuilt messages to decode the critical events. This helps for quick delivery of critical data with intermittent connectivity.

4. Simulation

In order to evaluate the performances of our model we created a mobility model to simulate the vehicle behaviors in the road. This mobility model and associated parameters are implemented and simulated using the C++ developer software. The events are captured for the different node density, available resource during the communication set up. We evaluate the dissemination protocol under various conditions using three levels of mobility metrics. Finally, each vehicle is equipped with the agency scheme for deriving an database for the decision making during hand off at ROI regions. In this section illustration of results are discussed for the proposed scheme, considering the controlled conditions of average traffic. The built in safety messages and far end node connectivity improves the performance. The packet delivery ratio and energy consumption parameters are evaluated in the system.

4.1. Simulation Inputs

The simulation input parameters are summarized in Table II. The simulation procedure for the proposed scheme is as follows.

- Create a road scenario for two way highway model with moderated vehicle density up to 80.
- Create the segments based on the maximum transmission range. Configuring the nodes for auto recording of GPS state information during hopping interval.
- For the given node density apply mobility factor of variable range of 10, 20,30 meters/sec.
- Use static and mobile agents to select the far end node in the given segment and update the far end node segment at regular intervals.
- Compute the performance of the system under varying mobility conditions.

Table 2. Simulation Parameters

Parameter	Value
Highway range	5KM
Number of nodes	100
File size	5Kb
Number of segments	4
Transmission range	75m-100m
Antenna type	Wireless
vehicle density per segment	10
TTL of packet	60 sec
Traffic type	moderate
connection establishment time	2000ms
Vehicle mobility	10m/s,20m/s,30m/s

4.2. Performance Metrics

Packet delivery ratio: It is defined as the total number of packets received to the total number of packets sent in defined time interval. We considered one TTL duration as the maximum time interval to record the PDR. It is measured in percentage.

Energy consumption: It is defined as the amount of energy required during the connection set up and packet transfer. It is expressed with respect to individual node and is measured in mili Volts (mV).

Computational power: It is the amount of power required to process the data present in the knowledge base to trigger the dissemination. It is measured in mili Watts (mW).

Number of collisions: It is defined as the number of packets dropped or unacknowledged during packet transfer between source and destination.

Far end node selection delay: It is the amount of delay involved in selection of node present in the ROI during channel access phase. It is measured in milliseconds (ms).

Success rate: The amount of successful detection of nodes in the exterior segment to reduce the connection overhead. It is with respect to connection establishment. It is measured in percentage.

Delay: It is the additional time to be considered if far end node is not detected in the first segment. It increases with the higher numbered segments. It is also called connection overhead delay. It is measured in ms.

4.3. Result Analysis

The proposed dissemination scheme is implemented from the developer C++ code. The set of parameters intended for the improvement is achieved with help of intelligent agent schemes. In the proposed schemes, the communication range is limited to 100 meters/segment and this kind of segmentation can cover up to the road distance of 5000 meters accommodate around 100 vehicles. All the timing intervals are presented in ms and transmission power levels in mw. This scheme uses self triggered intelligent agents and channel is accessed using an adaptive scheme which avoids idle times of the node. The proposed scheme operates better compared to the existing schemes because of the following points. The limited safety messages are stored with the compact codes which can increases the throughput under intermittent nature of wireless connectivity. The end to end connectivity using the far end node reduces the latency.

- Fig.5 shows that the packet delivery ratio in the proposed dissemination scheme predominantly rising with respect to the density of the nodes. The increased density of nodes on the road can locate the nodes with large probability in the region of interest. In comparison to the HI-CAST safety dissemination scheme [42], the PDR is increased by 16 percent in high density network.
- Fig.6 shows that the energy consumption for the proposed scheme is less due to the reason of connection establishment using fever hops covering only nodes of ROIs. In comparison to the HI-CAST algorithm [42], the proposed system consumes 6mW less energy since in probabilistic HI-CAST algorithm it has large idle factor for which energy consumption graph is higher for high density node.

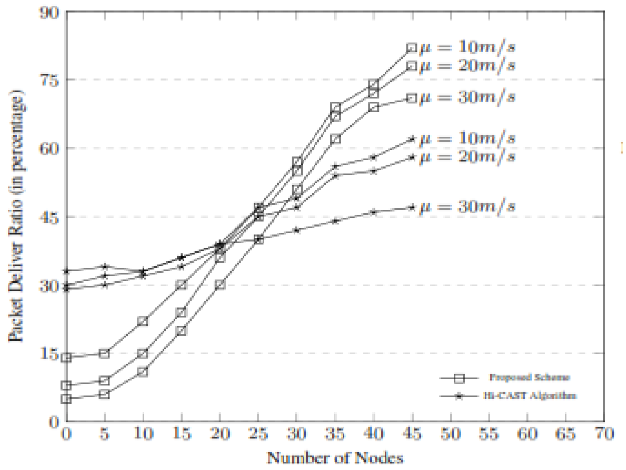

Fig.5. PDR Vs. Number of Nodes

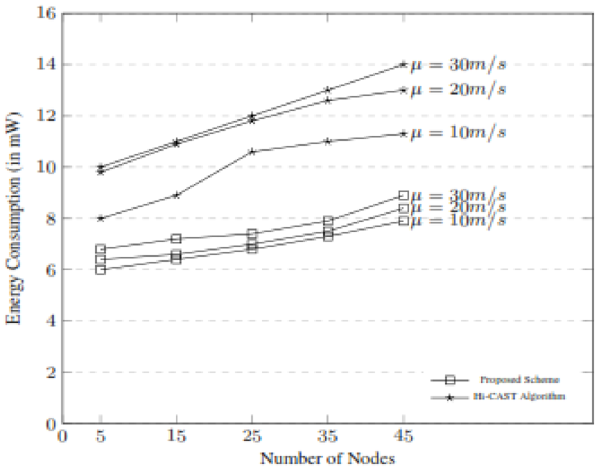

Fig.6. Energy Consumption Vs. Number of Nodes

- Fig.7 shows that the reduction of 8mW in computational power in comparison to HI-CAST algorithm due to the representation of packets using compact codes and constant bit rate of Packet size. The results are extracted for the varying mobility of 10, 20,30 meters/sec. Due to the relative mobility of nodes in the network, there is the presence of little adverse effect on performance parameters.
- Fig.8 shows that the number of collisions with respect to the network density, where for the high dense network nodes in the ROI and compact representation of messages produces the low traffic on the network hence fever collisions in the proposed scheme.

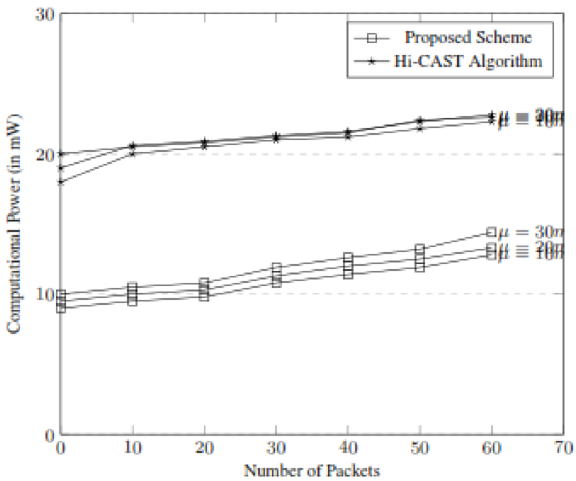

Fig.7. Computational Power Vs. Number of Packets

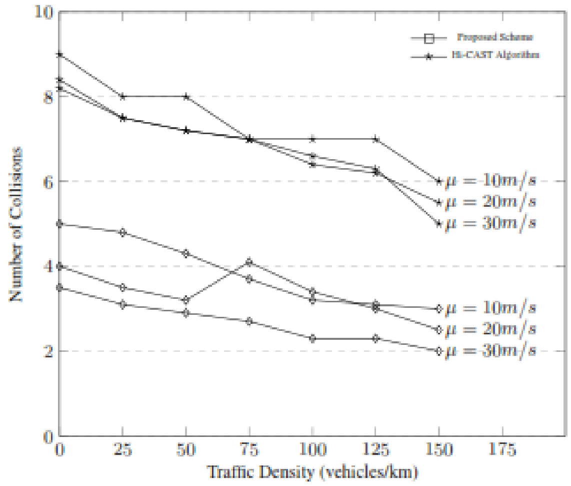

Fig.8. Number of Collisions Vs. Traffic Density (vehicles/km)

- Fig.9 shows that Far end node selection delay reduces at higher numbered segments because source always tries to access the exterior segment rather than the neighbor segment from the source.
- Fig.10 shows that success rate in the proposed scheme is negligibly varying throughout the radius of ROI region because radius of ROI region is the farthest region which inherently produces lesser hops. The success rate will be increased by 42 percent in comparison to HI-CAST algorithm.

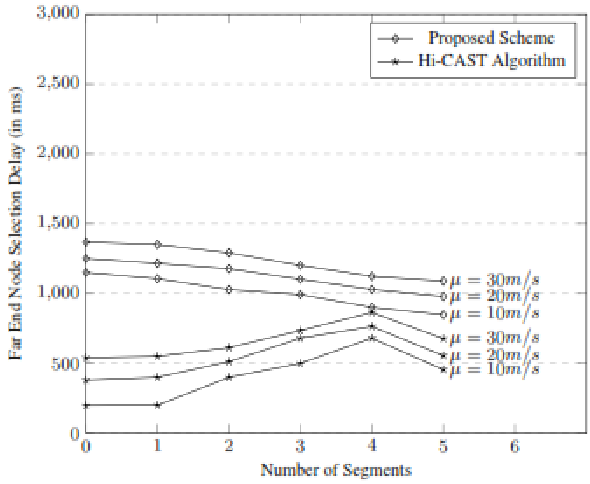

Fig.9. Far End Node Selection Delay Vs. Number of Segments

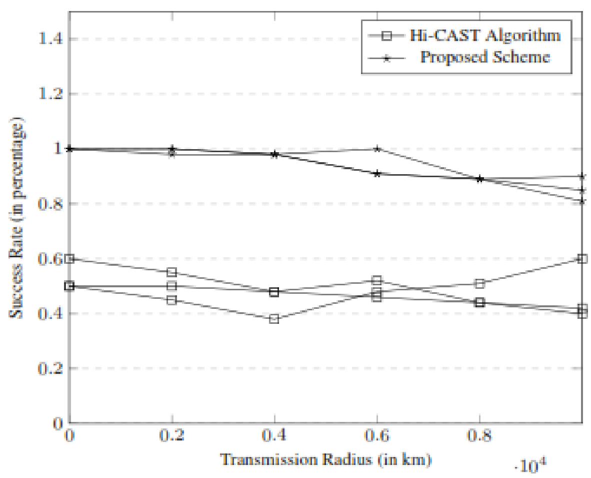

Fig.10. Success Rate Vs. Transmission Radius

- Fig.11 shows that the delay for end to end transmission reduces at higher node density for the proposed scheme compared to the existing dissemination scheme because the increased node density always creates room for ROI node connectivity.
- Fig.12 shows that the number of collisions gradually reduces as the radius of the transmission range increases. Since higher radius selects the node in ROI.

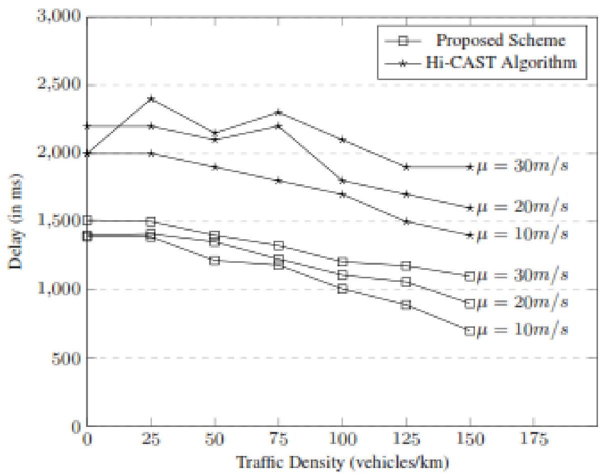

Fig.11. Computational Power Vs. Number of Packets

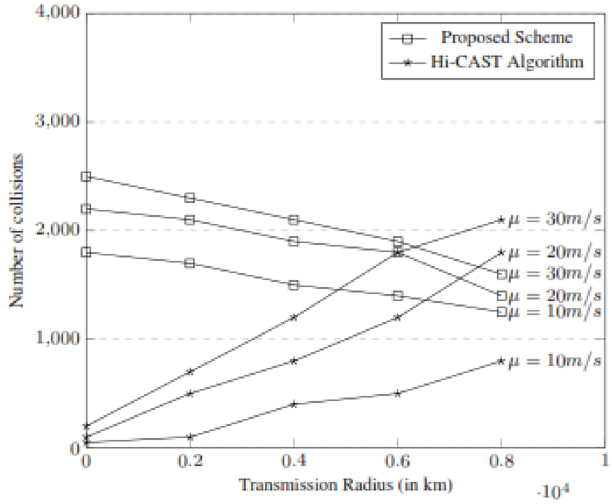

Fig.12. Number of Collisions Vs. Transmission Radius

The HI-CAST dissemination scheme uses the rebroadcast degree from other nodes and waiting time for rebroadcast is higher comparatively to our proposed scheme. So, the performance of the proposed system is evaluated and found that it is improved by 20 percent with respect to success rate which is verified through simulation and compared with that of HI-CAST dissemination scheme [42]. Thus, the proposed dissemination scheme is superior and reliable in sending safety information.

5. Conclusion

In this paper we addressed the VANET issue of frequent connection failures during the information dissemination using static and mobile agents by considering the V2V scenario. In the proposed work the selection of far end node in different segments establish the connection between source and destination with minimum end to end delay. It uses adaptive channel access method along with the GPS facility to establish seamless connectivity. The on-board sensor detected safety information triggers vehicular manager agent (VMA), which uses knowledge base to initiate dissemination process in variable transmission radius. The limited set of critical information built in messages stored in knowledge base improves the PDR of the dissemination process. The creation of segments in the proposed scheme helps to improve the energy considerations. Main contribution of the proposed research work is to provide the seamless connectivity in the dense network with minimum consumption of energy and to perform the safety information dissemination process effectively.

The proposed work is tested on Developer C++ platform with different set of realistic data and simulation results are much promised on critical parameters and found considerable improvement when compared proposed algorithm with different dissemination algorithms.

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