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Vehicle Obstacles Avoidance Using Vehicle- To Infrastructure Communication

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Abstract: *VANET is a technology where vehicles are considered as mobile nodes to create a mobile network. In the existing model, vehicle obstructs the communication between other vehicles will not be considered as an obstacle. Due to existing model the impact on the LOS (Line Of Sight) obstruction, received signal power, packet reception rate could not be analyzed. This can be resolved by introducing the proposed model of vehicle to infrastructure communication where vehicles are modeled as physical obstacles*.

Keywords *- VANET, Vehicle-to-Infrastructure, simulation, signal propagation modeling, Global positioning system (GPS)*

I. Introduction

Now days, the frequently occurring accidents causes enormous number of death and injuries. To increase the safety of vehicle and in addition to traditional passive safety technologies. Seatbelts, and airbags, new vehicular communication technologies can be implemented for achieve safety application used to be developed. In vehicle –to –vehicle communication, a vehicle that is not able to communicate with the other vehicle means, in such cases the vehicle to infrastructure communication is possible. For that vehicle search the nearest base station with in the particular range. Then the follower vehicle sends a message to the base station and then the base station forward to its leader vehicle. Few examples are cooperative forward collision warnings. Emergency breaking and hazardous location vehicle -to -Infrastructure notifications. The initiation to create safety efficient and more comfortable driving conditions used a strong support from both government and car manufactures. Vehicle –to –Infrastructure communications, which an important role, which enabling the safety, traffic efficiency and infotainment [1].

II. Related work

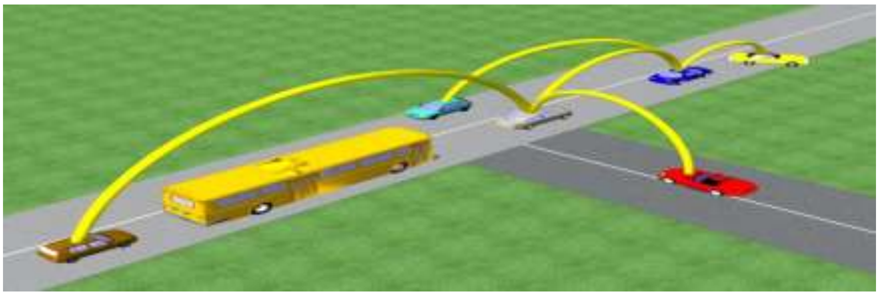

Fig 1:Existing Model Architecture

Vehicle-to-vehicle communication is the communication between one vehicle with another vehicle. If there is any vehicle obstacle then the communication is affected. By implementing vehicle-vehicle models is the obstacles can be overcome in the existing system.

In a particular area where the source vehicle could not communicate the destination vehicle because there is no intermediate vehicle in between them; so this would serve as a drawback in the existing system. Various drawback of the existing system includes some of the multiple obstacles. Affecting the vehicle-vehicle communication are the vehicles blocking the communication.

The collision between the vehicles some of the signals are obstructed by the buildings, hills located in-between's these might include some of the estimated drawbacks of vehicle-to-communication.

One of the realistic fact about the existing system is, it is highly dynamic network and too expensive, also a mobile obstacles which makes the device too complexive usage. Some of the simplified stochastic radio models do not provide good accuracy and there models are too expensive which cannot be implemented in VANET simulators [2].

III. Design & Architecture of Proposed Model

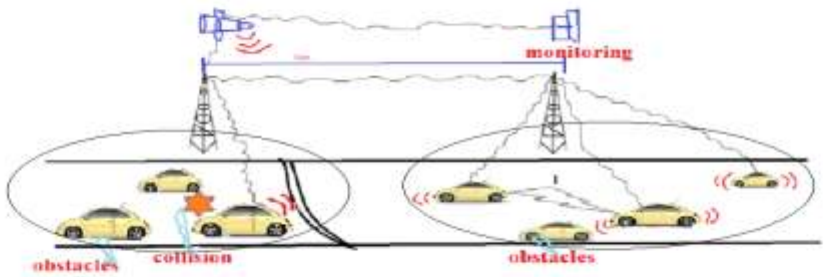

Fig 2: Proposed Model Architecture

The proposed model in urban areas include the VANET allowing the cars with approximate distance of 100 to 400 meters creating a wide range of network, where as in the rural areas this model can be impacted with the help of vehicle-to-infrastructure communication. This communication is done with the help of GPS.The impact of vehicles as obstacles of vehicle-to-vehicle communication in terms of LOS obstruction in order to obtain more realistic results.

The model encompasses calculation of LOS obstruction, as well as a simple signal propagation model to characterize the effects of obstructing vehicles on the received signal power and the packet reception ratio. We confirm the validity of the results by performing empirical V2V measurements. The implementation in VANET various environment (like urban, suburban, highway) with any vehicle density, location independence, suitable compatibility with VANET for static obstacles (E.g.-buildings, foliage etc.)The implementation of this method is cost effective [2].

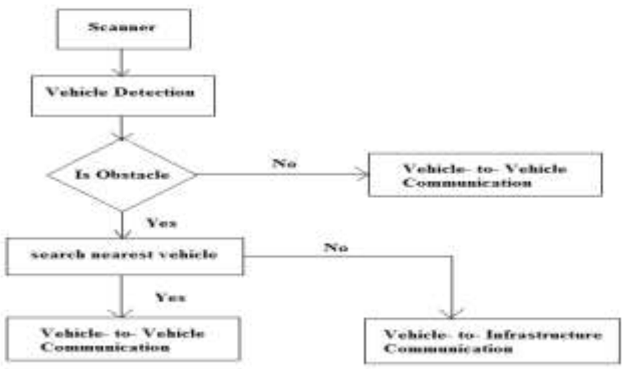

Fig 3: Functioning Sequence for Proposed Model

IV. Modules Of Proposed Model

4.1 Inter-Vehicle Spacing Analysis

To investigate vehicle obstruction problem we performed packet delivery measurements for different distances *l* between the vehicles without obstacles – LOS measurements, and on the same road for the same distances with obstacles between vehicles – passing cars and trucks. Experiment was performed from 25 to 350 m for LOS and from 25 to 250 m NLOS cases [10].

LOS is the calculation of Distance between two vehicles without obstacles and NLOS is calculation of Distance between two vehicles with obstacles. The measured inter- vehicle spacing is used to analyze the impact of vehicles while they are moving. Here *l* – distance between vehicles [3].

Fig 4: Analysis of Spacing between Vehicles

4.2 Vehicles Speed Analysis

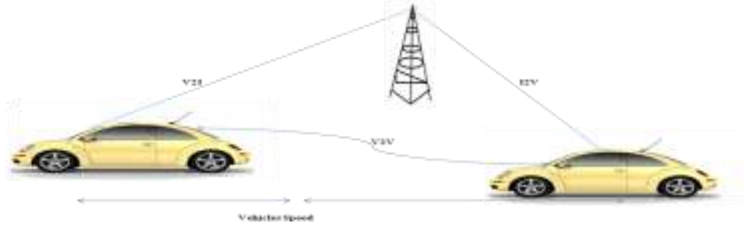

Fig 5: Vehicle Speed Analysis

Vehicles speed is used to calculate the measure of exact location of vehicles and the inter-vehicle distances. Vehicle speed is calculated because communication range depends on vehicles speed. Vehicle location is changed depend ending on vehicle speed. The measured speed is used to analyze the impact of vehicles while they are moving [4].

$$\theta_B = \tan^{-1}\frac{y_2 - y_1}{x_2 - x_1} \text{ - (1)}$$

$$speed_B = \frac{\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}}{t_{bi}} \text{ - (2)}$$

In Expression (1), with vehicle B's current position, (x_2, y_2), and the position one t_{bi} (t_{bi}, Beacon Interval) before, (x_1, y_1), vehicle B can get the theta angle B between vehicle B and X-axis. This information reveals the moving direction of vehicle B. Moreover, by utilizing the two coordinates and t_{bi}, we can figure out the velocity of vehicle B by Expression (2).

$$x_n = x_n' + speed_n \times (t_1 - t_0) \times \cos(\theta_n) \text{ - (3)}$$

$$y_n = y_n' + speed_n \times (t_1 - t_0) \times \sin(\theta_n) \text{ - (4)}$$

By placing the result of Expressions (1) and (2) into (3) and (4), we can predict the positions of vehicle B's neighbors in the coverage. The coordinate (x_n, y_n) stands for the nth vehicle found in the coverage. With the result of Expressions (3) and (4), we can select a vehicle to forward the packet to vehicle D [4].

4.3 Vehicles Dimensions Analysis

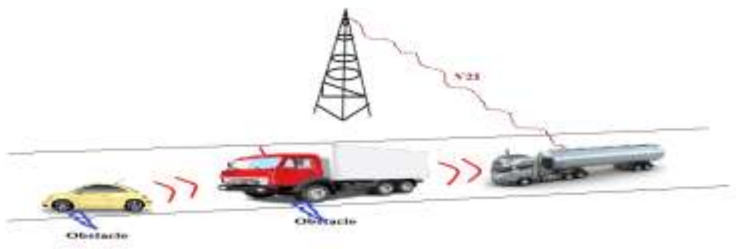

Fig 6: Vehicle Obstacle Analysis

In Existing system the Communication between vehicles depending on vehicle's height and width. For example a vehicle which is small vehicle like car and another which is large like a van. These height and width of the two vehicles varies. Here vehicle to vehicle communication is not possible. Because the transceiver of small vehicles does not support the receivers of large vehicles. Therefore a small vehicle cannot communicate with a large one. In proposed system vehicle communications is does not depend on vehicle's size. In vehicle communications if any vehicle obstacles is occur then there vehicle to infrastructure communications is possible [5].

4.4 Locating Infrastructure

Locating infrastructure concentrates on vehicular relay networks with a maximum hop count of two hops to ensure high communication quality and reliability between a node and a base station. The two- hop vehicle- to- infrastructure (V2I) real world VANET application sceneries and analytical approach uses a generic communication channel model and derives the exact close form equations of access and connectivity probabilities, not the asymptotic results, which valid only when the number of nodes in a network is very large.

4.5 Message transmission through V-I-V

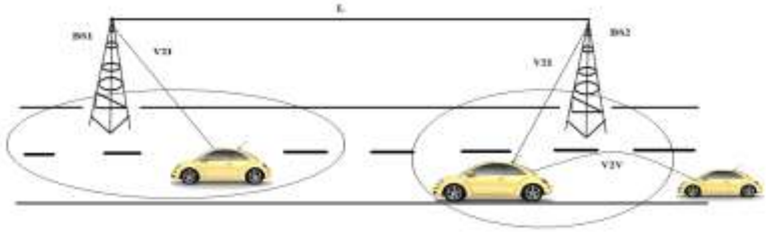

Fig 7: Infrastructure Analysis

In vehicle- to- infrastructure communications vehicle is communicate with Base station or Infrastructure within base station range. Suppose that vehicle's Position is out of range then Vehicle –to- Infrastructure communications is not possible. After that the vehicle is searched the some other vehicle which is near to it, then the Vehicle- to- Vehicle communications is possible[6].

V. Geocast Routing Protocol

Geocast Routing Protocol is a networking protocol using geographical positions for addressing and routing. It supports the addressing of individual nodes and of geographical areas. Core protocol components of Geocast are beaconing, location service, and forwarding. With beaconing, nodes periodically broadcast short packets with their ID, current geographical position, speed and heading. The location service resolves a node's ID to its current position based on a flooding request/reply scheme. Forwarding basically means relaying a packet towards the destination: Geographical Unicast provides packet transport between two nodes via multiple wireless hops. Geographical Broadcast distributes data packets by optimized flooding, where nodes re-broadcast the packets if they are located in the geographical region determined by the packet. Geographical Anycast is similar to the broadcast scheme but addresses a single (i.e., any) node in a geographical area.

VI. Protocol for Proposed Model

In the proposed protocol we use five parameters. They are msg, rad, loc, pos, infra. msg parameter functions in the same way as of existing protocol's msg parameter.
loc parameter is used to identify the Infrastructure. Here the communication takes place between the Vehicle and Infrastructure.

rad parameter denotes the Radius. It is one of the parameter which is used to identify the infrastructure's range. Communication between the vehicle and infrastructure can take place only within a specified range and radius parameter is used for calculating this range.
pos are the Position parameter. It is used to identify the Vehicle's Position in Vehicle- to- Infrastructure (V2I) Communications [9].

Algorithm 1: Message passing between Vehicles
start_broadcast (msg) of node u
; u is a Source node, loc is a Location of Infrastructure,
pos is Position of u , infra is an Infrastructure
for all v £ N_u do
send BROADCAST (msg, loc, pos, infra) to v
end for
On u's receiving BROADCAST (msg, loc, pos, infra)
; u is a recipient of a BROADCAST message
deliver (msg)
for all v £ N_u do
if v satisfies conditions C1 and C2 from loc then
send BROADCAST (msg, loc, pos, infra) to v
end if
end for

Algorithm 2: Identification Location of the Infrastructure
start_ radius_ geocast (msg, rad) of node u
; u is a Source node, loc is a Location of Infrastructure,
pos is Position of u , infra is an Infrastructure
for all v £ N_u within rad from loc do

send GEOCAST (msg, loc, pos, infra) to v
end for
On u's receiving GEOCAST (msg, loc, pos, infra)
; u is a recipient of a GEOCAST message
deliver (msg)
for all v £ N_u do
if v satisfies conditions C1, C2, C3 from loc then
send GEOCAST (msg, loc, pos, infra) to v
end if
end for

VII. Implementation of Proposed Model

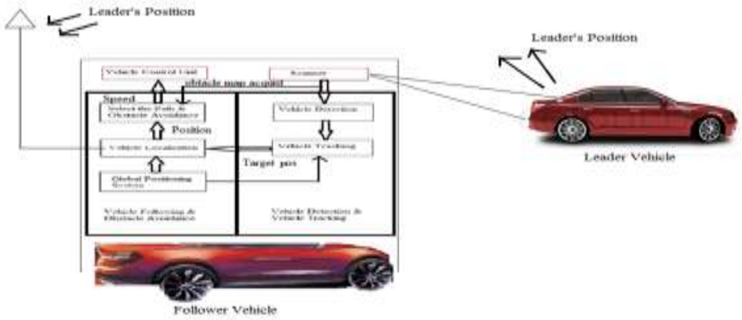

Fig 8: Functioning of Proposed Model

To calculate $P(LOS)ij$, i.e., the probability of LOS for the link between vehicles i and j, with one vehicle as a potential obstacle between Tx and Rx (of height h_i and h_j , respectively), we have:

$$P(LOS|h_i, h_j) = 1 - Q\left(\frac{h-\mu}{\sigma}\right) \qquad (5)$$

$$h = (h_j - h_i)\frac{d_{obs}}{d} + h_i - 0.6r_f + h_a. \qquad (6)$$

Where the i, j subscripts are dropped for clarity, and h denotes the effective height of the straight line that connects TX and RX at the obstacle location when we consider the first Fresnel ellipsoid. Furthermore, $Q(\ )$ represents the Q-function, μ is the mean height of the obstacle, σ is the standard deviation of the obstacle's height, d is the distance between the transmitter and receiver, d_{obs} is the distance between the transmitter and the obstacle, h_a is the height of the antenna, and r_f is the radius of the first Fresnel zone ellipsoid .

- The leader vehicle

The leader's position is broadcasted to the follower vehicle through RF transmitter.

- The follower vehicle

In system architecture for follower vehicle has two modules. They are

- Vehicle detection &tracking module
- Vehicle following & obstacle avoidance module
- Vehicle detection

It is used to detect the nearest vehicles for communication.

- Vehicle Identification

In laser scans the width of the rear part will be divided into segments. This segmentation process is done by using Hough transform and line fitting algorithms. The leader vehicle is identified by knowing its width and by using 3 indicators which describes the width.

- Length of a segment

The segments are projected into Cartesian coordinate which uses standard polar to Cartesian transformation equations and then the length of the potential line is identified. Throughout the segment its length is calculated by finding the sum of the distance between the neighboring points. The width of a loading vehicle and length of the target segment should be equal. Some tolerance may be accepted due to low laser angle resolution.

➢ Total range points in a segment

With the help of inter vehicle distance, the total number of later points from the leader vehicle can be calculated because width of the leading vehicle is time invariant.

➢ Average relative angle difference

From the later scan a straight line segment which is nearer to the leader vehicle is expected, an indication will be given by the segments when the average relative angle difference for the consecutive scan points exhibits the property of straight line. The above mentioned three conditions along with the threshold obtained must be satisfied so that a segment can be classified as a vehicle. If the above conditions are not satisfied then certain obstacles in work environment can be recognized as lines.

➢ Vehicle tracking and retrieving

The vehicle on board localization unit tracks the leading vehicles. This is then set in a search window in the navigation co- ordinate frame. Target re- tracking algorithm has been developed to track the leading vehicles when the follower vehicle path is lost due to unavailable reasons like non- tarmac road. This algorithm has two stages: self- retrieval and remote GPS aided retrieval.

Self- retrieval method is used in normal conditions when the leading vehicle is in line- of- sight

Remote GPS retrieval method is used when the vehicle identification algorithm fails to track the leading vehicle in few attempts. Remote GPS data from the leader vehicle will be used as the global position of the leader vehicle until this is again within the FOV of the laser scanner [7].

VIII. Experimental Results

Parameter	**802.11p**		**802.11b/g**
Channel	180		1
Center Frequency (MHz)	5900		2412
Bandwidth(MHz)	20		20
Data rate (Mbps)	6		1
TX power (setting, dBm)	20		18
TX power (measured , dBm)	10		16
Antenna gain(dBi)	5		3
Beacon frequency (hz)	10		10
Beacon size (Byte)	38		64

In the simulation graph we have taken distance in meters on X axis. In Y axis, the scale is time in milliseconds. In the existing results distance between vehicles is large which indicates the vehicle communications time is large or the time has increased. Therefore, vehicles communication depends on distance between communicable vehicles and the timing for vehicles communications.

In proposed results we have taken the distance, same as the existing system but we have reduced the communications time taken by the vehicles [8].

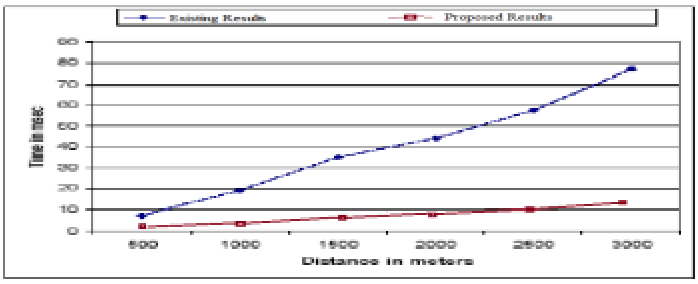

Fig 9: Simulation Results of Existing and Proposed System

IX. Conclusion

In this paper we have experimentally evaluate the impact of obstructing vehicles on vehicle- to- infrastructure communication. The implementation in VANET various environment (like urban, sub urban, highway) with any vehicle density, location independence, suitable compatibility with VANET for static obstacles. Location of the infrastructure is one of the most important data for vehicle- to- infrastructure communications. The effect of static obstacles such as buildings, hills and physical obstacles was also analyzed. Instead of geocast routing protocol, any other protocol can be used for better performance and that may be considered for future work.

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Author's Profile

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P. Soundeswari completed her undergraduate degree at cherraan's arts and science college, kangayam and has also completed post graduate level courses Msc at cherraan's arts and science college , kangayam, India, and is currently pursuing her M.Phil in Computer Science at Dr. G.R Damodaran College of Science, Coimbatore, India.