Collision Avoidance on a Curved Road in VANET

Mr. Abhinav Pareek[1], Mr. Rahul Agrawal[2]

[1]Department of Computer Science Engineering and Information Technology, Government Engineering College Bikaner, Rajasthan.
[2]Asst. Professor Department of Computer Science Engineering and Information Technology, Government Engineering College, Bikaner, Rajasthan.

ABSTRACT

VANETs use advance technology to reduce number of road accidents. Mostly accidents occur because critical and necessary information for drivers is not available in appropriate time. Generally, it is assumed that higher frequency of safety packets can prevent collision, even for high speed and dense traffic which is not true. There are many solutions that have been proposed to avoid collisions [1] [5] in the hilly areas, where problems of blind cross section frequently occur. One such approach, proposed by R. Miller and Q. Huang [5]uses GENETIC ALGORITHM (GA). This report explains, how to minimize the low sightedness at curved road area using GA based approach. It is analysed by the authors that, before the curved section of road, traffic density of vehicles is more than after that. This approach also emphasizes on best location of VANET infrastructure, so that maximum area can be covered at minimum cost.

1: INTRODUCTION

The Institute of Transportation Engineers of USA explains traffic engineering as “the use of technology and scientific rules to the planning, functional design, working, and management of facilities for any type of transportation in order to provide for the safe, rapid, comfortable, convenient, economic, and environmentally compatible movement of people and goods” (Pline, 1999). The main goal of, in these definitions and other such explanations is how to maximize the road safety. Studies by the U.S. Department of Transportation (1999) [2] [11] reveals that the major types of road accidents are:

Rear-end

A **rear-end accident**, is a traffic accident wherein a vehicle crashes into the vehicle in front of it. Typical scenarios for rear-ends are a sudden deceleration by the first car (for example, to avoid someone crossing the street) so that the car behind it does not have the time to brake and collides with the first. [10]

Intersection

A **intersections accident** (road junctions), may involve head-on impact when one vehicle crosses an opposing lane of traffic to turn at an intersection, or side impacts when one vehicle crosses the path of an adjoining vehicle at an intersection. [10]

Road departure

A **road departure collision** is a type of single-vehicle collision that occurs when a vehicle leaves the roadway. Such scenario mostly occurs when driver loses the control on vehicle or miss-judges a curve. [10] This comprises of about 75 % of all road accident. There is another revealing about road accident is that these accidents is caused by inattention of drivers. According to, AHSRA report, 65.1% of crashes occurs only due to lack of forward view (AHSRA Japan, 2001) [2] [11]. Based on Adler (2006), different studies explain that in 69% of cases, accidents occur due to lack of critical and necessary information for drivers in appropriate time [2]. Older collision avoiding devices like camera vision and radars cannot produce appropriate information about situations beyond other vehicles. In this case, there is no need of any infrastructures like road side units (RSU) VANET nodes to communicate between vehicles.[4] [13].

Type of message communication in VANET

There are three type of message communication strategies, which are used in VANET technology:

Vehicle to Vehicle (V-V) communication:

Vehicle to Vehicle (V-V) communication implies multi-hop multicast/broadcast to transmit traffic related information over multiple hops to a group of receivers. It is assumed that, vehicles are only concern about road ahead not about posterior side. [4]

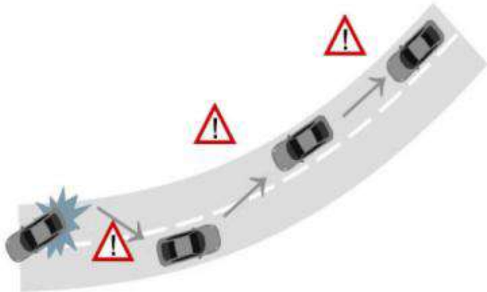


Fig 1(a): Vehicle to Vehicle communication [4]

Message forwarding technique:

In vehicle to vehicle communication, there are different approaches used for

2: PROPOSED ALGORITHM

GA-based planning algorithm:[1] [5][13]

This section explains about how to reduce the deployment cost of infrastructure (RSU) with the help of a GENETIC ALGORITHM based method in VANET. This GA based method is very useful in deciding the number and location of RSUs along the road, where sight distance is very low, to get maximum coverage.

The GA–based method is contains three parts:

1. Pre-processing
2. Calculation of Right number of antennas
3. Best positioning of antenna.

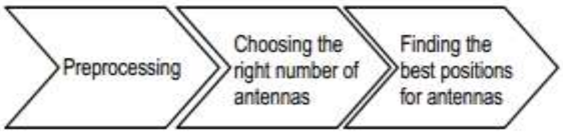


Fig 2(a): Steps of the proposed genetic algorithm based planning algorithm [1][5][13]

Pre-processing

In this subsection, authors analyse the map of the given road which consists of curvature. The map is analysed according to height of antenna. Height of antenna plays a very important role due to transmission of information. We have to select the height of antenna in such way that it is neither very long nor so short. Because if the height is less, many obstacles may come in propagation path of information and if height is more, a large amount of energy is dissipated in transmission of data. Both cases are avoidable.

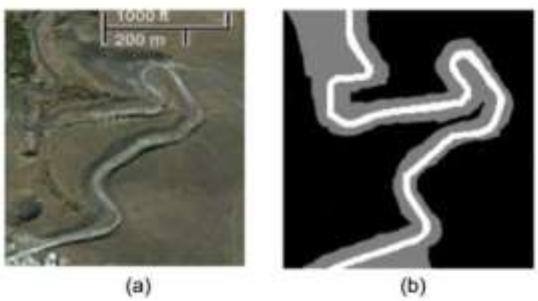


Fig 3(b): the selected curved road for coverage and the entrance road [1] [13]

For a given height of antenna, the map of road is divided into three coloured parts.

a) black for regions in which signals cannot propagate
b) grey for roadsides which do not disturb dissemination,
c) White for the road area that must be covered by direct signals of antennas.
After pre-processing of selected curved road image, it is fed into simulation software. With the help of simulation software, simulation is to be done on different parameter.

Right number of antennas

In this section, author deals with the exact number of antennas which are suitable for direct transmission of data between vehicles. Since we deal with curved road where connectivity is very low so we established the antenna in such no. that propagation of information can easily traversed. For this there is need of map of concerned road and coverage area of antenna. Using omnidirectional antenna can reduced the cost, because in this case we only concern about propagation radius of antenna and location of antenna.

Finding of cost function:

With the help of factors, like maximizing the coverage area and ignoring the overlapped regions as possible, authors define cost function C, [1] [3] [5] [13].

$$C = \min\left(\alpha \sum \vartheta + \beta \sum \psi\right)$$

Where α and β (α ≤ β) are weight of summation of uncovered points and summation of covered overlapped points respectively. To select best antenna, we can apply GA based methods which are powerful, robust, and flexible optimization tool and can be easily refined for different problems and bears noisy functions.
The raw data for GA are **genomes** and **a fitness function**.

Genomes

Contains location of established antenna. In this function we have coordinate value X (k) and Y (k) for a specified antenna.

X_1	Y_1	X_2	Y_2	...	X_n	Y_n

Fig 4:Common structure of the used genomes[1] [13]

Fitness function:

Used for finding that establishing of antenna are how such good. For this we use cost function.

Best positioning of antenna:

In this section, we concerns about location of antenna. We consider which place is select so it cover maximum region. For best location of antenna, we can follow either of two approaches.

a. Location can be obtained on analysing the received information from the second step of selection of antenna.
b. Comprises of two steps, first find the required no. of antenna and then found the best location among them using GA method.

Simulation of GA method:

In this section, authors take some parameters to simulate the GA based algorithm and then discuss the performance of the approach.

Simulation setup parameters:

To test the effectiveness of GA based approach, authors consider the image shown in above Fig. 7, taken from Google image. The processing of the image was done using simulation tool which operate some selected parameter which is listed below.

They considered that the height of antenna is about 3 meters from ground and then processed the image with the help of simulation tools.

The different parameters for GA algorithm: [1] [13]

1. α: uncovered area 1,1,3
2. β: covered area 1,3,1
3. Maximum no. of simulation 10
4. Maximum population size1000
5. Maximum generation size 1000
6. Maximum no. of iteration
7. Crossover probability
8. Mutation probability 0.003
9. Selection function roulette wheel

Authors studied the effect of α/β on number and placement of antennas and after that, They observed the following conclusion about α/β:

1. More value of α/β, means uncovered points plays important role than overlapped covered point in establishing of antenna.

2. More value of β/α, means overlapped point plays more important role than uncovered points in establishing antenna.
In GA based algorithm, parameter is controlled by changing mutation size.
Mutation size is changed using following approaches:

Adaptive approach: In this case, value of mutation size is kept fixed to 0.003.

Primary approach: In this case, value of mutation size is decided dynamically using the following formula: [1]

Pm = init Pm + N (0, σ(t))
Where,
σ (t) = 1-0.9t/T

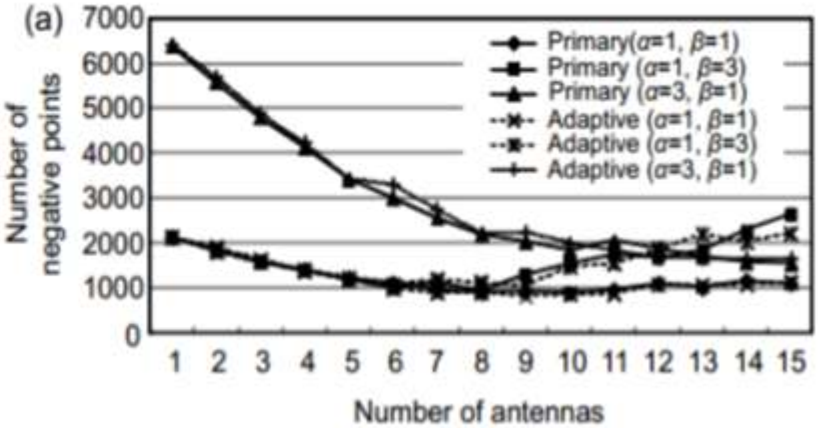
Here, **Pm**is the mutation probability, **init Pm**is the initial mutation probability (equal to 0.03).

N (0, σ(t), is the normal distribution function with mean zero and standard deviation σ, **t** is the current generation iteration number varying from 1 to T, and **T**is the maximum generation iteration number(say 1000 in this case).

3 ANALYSIS ON CURVED ROAD

Coverage of curved road:

For performance evaluation, we have changed the antenna's propagation radius from 100 m to 300m with a step of 100 m. Following Fig. 5 gives the result of calculating the antenna locations with minimum negative points. On analysing the trend of the simulated results in the graph, it is found that it is neither smooth nor uniform. This happens because of, GA prepares only suboptimal results.



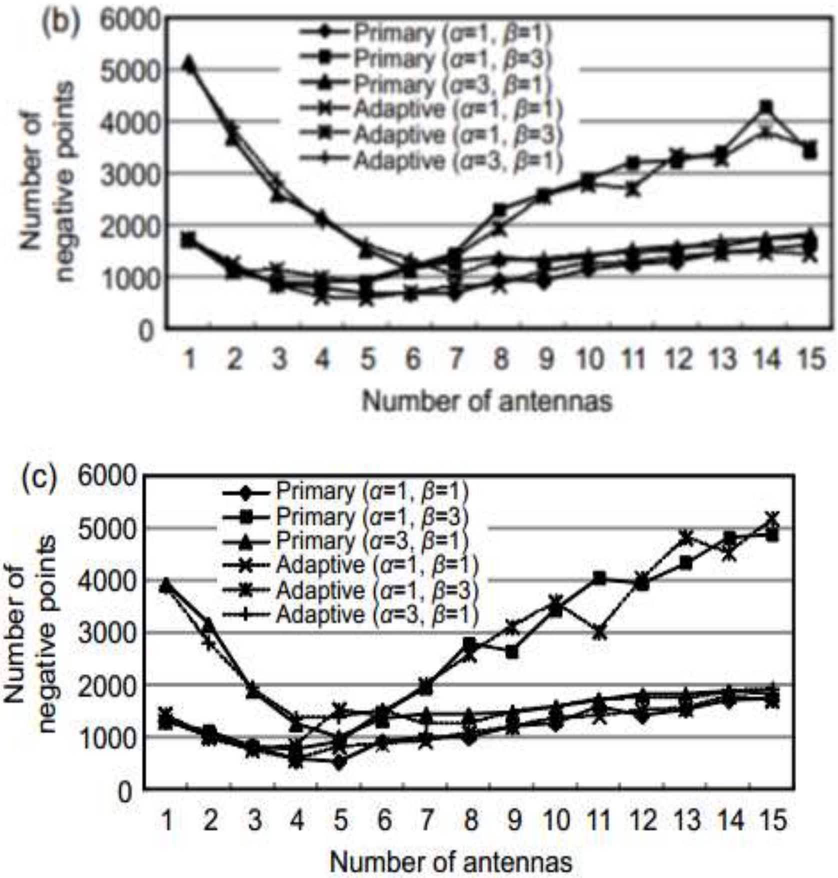


Fig. 5: Results of selecting the best places using antennas with a 100 m (a), 200 m (b), 300 m (c) [1]

CONCLUSION

The main objective of ITS and VANET is, to avoid collision son road. This report explains how with the help of GA based method one can minimize the cost of infrastructure and can increase its effectiveness in VANETs. In this case, using road side unit we can achieve direct

communication between vehicles which results in avoiding of collision. With the help of such infrastructure along the road side the problem of short sightedness is resolved and we achieve a scenario in which we can avoid road accidents on curved road.

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