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CELL DENSITY BASED TRAFFIC INFORMATION SYSTEM ON VEHICULAR AD HOC NETWORKS

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***Abstract* – Vanet is an upcoming interesting domain over the last few years.It is gaining popularity due to wide variety of interesting applications .The rapid increase of vehicular traffic and congestion on the highways become a nuisance for the safe and efficient movement of traffic. Consequently the rate of car accidents began to increase in most of the countries.Therefore this paper presents a new system in which accidents and congestion can be avoided and helps the people to reach the destination safely.**

***Index Terms*- Infrastructure less traffic estimation,Vanets cell density,Vehicular ad hoc network.**

I. INTRODUCTION

Vanet is an active research domain which is having wide range of applications. Its applications include safety applications, traffic monitoring, smart parking, route guidance. Data/information can be collected either by vehicle-to-vehicle communication (V2V), vehicle-to-infrastructure communication (V2I), or a combination of both. The VANET architecture can be broadly classified into three categories namely Cellular, Ad Hoc, and Hybrid. Cellular or WLAN based VANETS are usually designed to support infotainment related applications such as, web browsing, news, parking information, and traffic statistics. However, it requires fixed infrastructure that is not always available. To address this issue, ad hoc networks are used that do not require fixed infrastructure support for propagation of information. Cellular and hybrid network based VANETS rely on a centralized architecture in which traffic information is collected from the roads through access points. These access points are responsible to process the acquired information and make it available to the driver. The high cost of fixed infrastructure, in terms of hardware, installation, and maintenance is one of the major bottlenecks in the centralized approaches. Moreover, the centralized solutions only provide coverage up to areas, where the access points are installed. To overcome the deficiencies of centralized approaches, decentralized traffic information systems are used. Information systems are best suited for ad hoc network based VANETS, where each vehicle is a source, destination, or intermediate node that relays the packets toward the destination. In this paper, we present distributed method for road traffic estimation named "Cell density based traffic information system (CBTIS)". It is exclusively designed for city environment and considers two-way multi-lane roads, their lengths, and junctions to precisely estimate the road traffic density. The working of the system can be divided into two tasks. that is cell formation and density calculation.

II. OVERVIEW OF EXISTING SYSTEM

The Road oriented traffic information system density estimation scheme is based on fixed cell size. Therefore, if different road lengths are considered that are not multiple of 500 m, then vehicular traffic density is not calculated accurately as the cells do not fully cover the road segments or overlap the segments of other roads. Consequently, the estimated density is either under calculated or over calculated.

Problem Formulation:
If we formulate the cell formation scheme of ROTIS, then the following derived equation can be used to determine the number of cells for a particular road length.

$$T_C = R/(2 \times T) + 1$$

where, T_C is the number of cells formed, R is the road length and T is the transmission range of the vehicles. To find the cells' position on the road segment, let n be the cell number, D_o be the cell overlap, and T_o be the default transmission range of vehicle without the overlap. Using these variables, the position of each cell can be calculated .

$$T_o = T - D_o$$

$$P(n) = (2 \times n \times T_o) - T_o$$

where, $0 > n \leq T_C$

Problem Verification:
Assume roads of length 2,650 and 5,850 m. The number of cells and their positions can be calculated. It is clearly evident that some area remains uncovered.
For roads of length 2,650 and 5,850 m, the uncovered area is 134 and 334 m, respectively. Hence, by increasing the road length, uncovered area will also increase except for scenarios where the road length is a multiple of 500. Similarly, on decreasing the road length, extra cells will be formed that may overlap area of cells on other road segments. Consequently, extra vehicular density will be calculated that is not a part of same (identical) road.. Similarly, for road lengths of 3,200 and 1,100 m, extra road length of 316 and

416m is considered, respectively. Thus, decreasing road length also provides inaccurate vehicular traffic information.

III. CELL DENSITY BASED TRAFFIC INFORMATION SYSTEM

Cell density based traffic information system(CBTIS) is based on road length that are multiple of 500m.In this system first the road network is created,After creating the network the road is divided into different cells.After the cell formation the vehicles will be created and their movement.Then vehicle will route from source to destination. Every vehicle will choose its own path to move in case of traffic jams or any accidents. There are different path to reach the destination.Each cell density will be calculated.And these cell density will be vailable to every vehicle.So that when vehicle reaches the junction it will receives the messages about the cell density and it can move through different path.

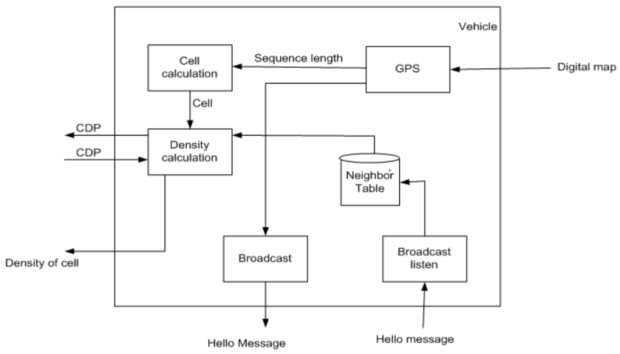

Figure 1:Overview of cell density based traffic information system.

Fig 1 illustates the working of cell based density information system. In this system first the road network of given length wll be created. After creating the network the road will be divided into different cells. And these cells will be having different number of vehicles. Then the cell demsity information that is the number of vehicles in the cells will be calculated. and these information will be broadcasted in the form of cell density packet.Each and every vehicle will be having GPS and digital map and information will be stored in the neighbour table of the vehicles. And these messages will be available to other vehicles. The working of this system can be divided into two tasks. That is cell formation and density calculation.

IV. CELL FORMATION

CDTIS is designed to form cells of any size considering the road length. In CDTIS, vehicles are capable of changing their transmission power to form cells of different sizes. Therefore, during the vehicular traffic density estimation phase, each vehicle adjusts its transmission range according to the road length to fully cover the road segment .

The algorithm steps are explained as follows:

Step 1: Get variable values

The algorithm gets road segment length (from a digital map), default transmission range of vehicles (250 m), and overlap distance that is used to connect cells and fully cover the road segments (16 m).

Step 2: Calculate total number of required cells

To fully cover a particular length road segment, required number of cells is calculated using the following equation:

$$T_C = R/(T_o \times 2$$

where, T_C represents the required number of cells, R represents the road length, and T_o is the default transmission range of vehicles.

Step 3: Calculate cells radius

Using default transmission range, the calculated number of cells may not cover the road segment accurately. Therefore, new cell size (radius) is calculated using the following equation:

$$C = (R/T_C) \times \frac{1}{2}$$

where, C represents radius of the cells.

Step 4: Adjust transmission range

Due to change in the cell size, the transmission range of the vehicles must also be changed accordingly to avoid over/under density estimation issues. This is achieved using the following equation:

$$NTR = C + D_o$$

where, NTR represents the new transmission range,and D_o is the overlapping distance. Here, the maximum value of $C \leq T_o$, because the new transmission range cannot exceed the default transmission range.

Step 5: Form Cells

In this step, the road segment is virtually dissected into defined number of cells, in order to ensure make each vehicle can become part of a particular cell. To find the location of cells, the following equation is used:

$$P(n) = (2 \times n \times C) - C$$

where, n represents the number of cells that varies from 1 to T_C, and $P(n)$ represents center points of the cells.

V. CELL DENSITY CALCULATION

After the formation of cells, the next step is to calculate the cell density. Therefore, within each cell, one vehicle is elected as a group leader (cell leader) based on cell centre. The group leaders are responsible for estimation of cell density that is performed by consulting the neighbor table. The number of vehicles in neighbor table represents the vehicular traffic density of the respective cell. Group leaders are also responsible for forwarding the CDP to other cells (via group leaders) of the identical road segment.

The main parameters of CDP message are shown in Table 1

Cells density data packet		
Direction (optional)		
Road ID	Transmission time	Cell ID
Cell's center position	Cell's total density	Cell's directional density (optional)

Table 1: CDP message format

CDP message consists of road ID, transmission time, list of anchors (cell's center position), cell ID, new transmission range (NTR), and cell's total density (that is calculated by the group leader of each cell). The cell's directional density is an optional parameter that is used to measure the vehicular density in specific direction based on the required application. When a vehicle enters a road segment, it calculates the number of cells and their positions *P(n)*, as per proposed method . By doing so, the vehicle becomes aware of the cells' positions, and can declare itself as a group leader upon reaching the center of a particular cell. To calculate the total traffic density of a road segment, a vehicular node (*F*) (group leader of the first cell) generates a CDP. The group leader updates the total density (T_d) and directional density (D_d) parameters of the CDP by consulting its neighbor table and forwards it towards the end of the road segment (junction J_e). When the CDP researches second cell, the packet is updated again and the process continues unless it reaches the last cell of the road segment. The group leader of the last cell calculates the mean and variance of the cells' density and propagates the estimated density to all the vehicles around the intersection. To do so, it searches for a vehicle (*V*) (within its neighbors *N*) that is moving towards the J_e. If such vehicle is found, it forwards the CDP to the vehicle (*V*) that broadcasts it around J_e. Otherwise, the group leaders of the last cell carry-forwards the packet and broadcast it upon reaching J_e. Consequently, the vehicles at the junction become aware of the road segment density by receiving the CDP message

VI. PERFORMANCE EVALUATION

Performance Evaluation of ROTIS and CBTIS is calculated based on its runtime as shown in the Figure 2. To evaluate the performance metrics we have to estimate the total road density and number of nodes . demonstrates the total traffic density of a road segment . Result illustrates that the ROTIS estimated traffic density is very close to the real traffic curve, proving that ROTIS caters to the highlighted issue. On the other hand, the estimated traffic density of ROTIS varies from the real traffic curve to a large extent. The reason is that in ROTIS some area is left uncovered due to the flaw in cell formation technique. Consequently, the vehicles present in uncovered area are not counted, which ultimately results as wrong estimation of traffic density. At any given time, the ROTIS density estimation error depends on the size of uncovered area and number of vehicles present in that area. So to check the effect under high vehicular traffic, we explicitly increased the number of vehicles in this simulation ranging from 240 to 265 vehicles. It is evident that CBTIS is more accurate compared to ROTIS.

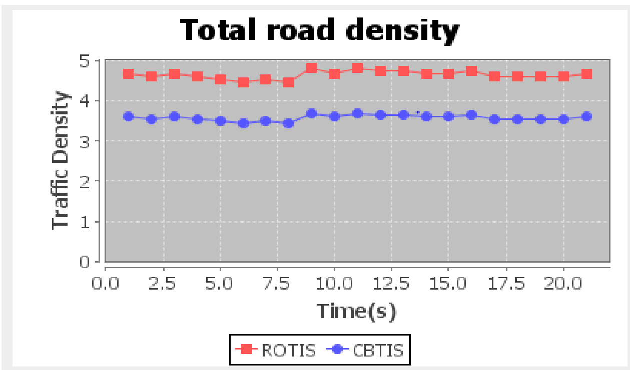

Figure 3:Performance graph of total road density

The Figure 3 shows the effect of CBTIS on packet delivery ratio of E-GyTAR routing protocol that is originally implemented using ROTIS scheme. The result demonstrates that the packet delivery ratio of E-GyTAR improves with CBTIS scheme. Moreover, it shows that the packet delivery ratio increases by increasing the number of vehicles. The increase in the packet delivery ratio of E-GyTAR (CBTIS) is due to optimal cell formation, which increases the neighbor tables' consistency and enables E-GyTAR to make accurate routing decisions.

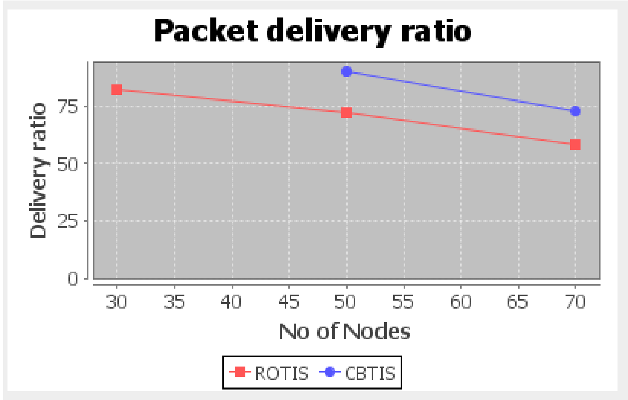

Figure: Performance graph of Packet delivery ratio

The figure 4 elaborates end-to-end delay of E-GyTAR protocol. The result shows that end to- end delay decreases by increasing the number of vehicles. It is a fact because high number of vehicles improves network connectivity and reduces probability of network partitioning. Here, E-GyTAR (CBTIS) performs well because it makes optimal routing decisions due to precise density information and suffers less from the carry-forward issue due to optimal cell formation.

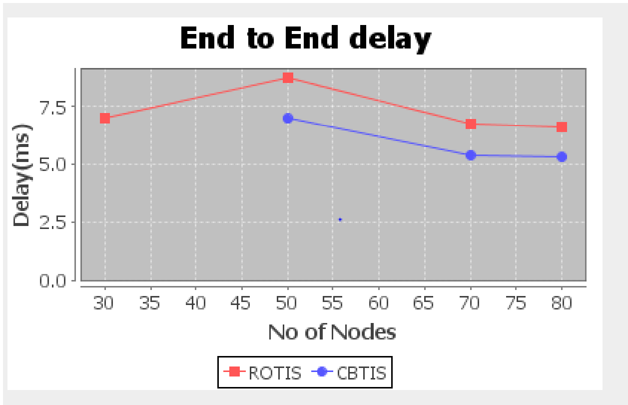

Figure 4: Performance graph of End to End delay

VII. CONCLUSION

CBTIS is based on dynamic cell formation technique that fully covers the road segments and every vehicle becomes a part of a cell. CBTIS uses variable transmission power to form cells of different sizes that varies according to length of the road segments. The simulation results reveal that CBTIS density estimation mechanism is more accurate, especially when the road segments are of variable lengths. Apart from ROTIS in CBTIS there are multiple paths in a network. So by considering the road traffic density the vehicle can reach the destination through different paths. So if any traffic jams or any accidents occur the vehicle will get the information and it can go through some other path.

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