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VANET Traffic Congestion Detection and Avoidance

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ABSTRACT
The main objectives behind the development of congestion detection algorithms are to detect areas of high traffic density with low speeds. Each vehicle captures and disseminates information such as location and speed and process the information received from other vehicles in the network, which can be possible through VANET. Vehicular Ad-hoc Networks are self-organizing networks established among vehicles equipped with communication facilities Due to recent advancements in vehicular technologies vehicular communication has emerged. Multiple approaches have been proposed to implement congestion detection in VANET. Traffic congestion is a very serious problem in big cities. With the number of vehicles increasing rapidly, especially in cities whose economy is booming, the situation is getting even worse. In this paper we are presenting Detection of Traffic Congestion using proposed approach and analysis of result.

Keywords: VANET, VANET; Car Agent; Signal Agent; Traffic Congestion Avoidance

Introduction

The past decade has witnessed the emergence of Vehicular Ad-hoc Networks (VANET), specializing from the well-known Mobile Ad Hoc Networks (MANET) to Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) wireless communications. Vehicular networking is nowadays very hot topic within the research field of telecommunications. Lot of different approaches exists, although the standard approach called IEEE 802.11p is gaining the majority of interest. Motivation of VANET communication is because of different application areas of VANET like Traffic Safety application, Traffic Monitoring, Traffic Congestion Detection and Avoidance. The best suitable method for Traffic Congestion Avoidance is to detect the Traffic Congestion areas and give the details to other vehicles coming on the same tracks. We can avoid traffic congestion by suggesting optimal path to vehicle. Most current navigation systems are static and do not provide traffic information. Route selection is based only on static map data which leads to the system that fails to give the driver the most efficient route towards his/her destination. Collision avoidance systems are designed to detect a traffic incident in real-time and quickly pass on this information to nearby vehicles to prevent a traffic collision.

Related Work Congestion Detection

Developing a traffic congestion detection system will have tremendous impact on the economy. System is not itself for automated driving or intelligent driving but it provides intelligence to driver. Numbers of navigation systems are available but they can only provide static details of roads not the current traffic details.

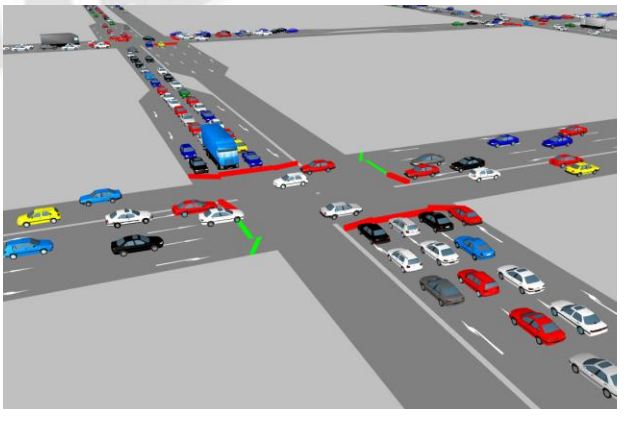

Fig.1. Car Agent (CA) as Traffic Congestion Controller

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A. System Constraints

We have to consider some of the constraints in Traffic Congestion Detection System like Participation of vehicle, Privacy, Security, and Bandwidth.

Participation of vehicle: In VANET all vehicles are equipped with transceiver, which can transmit and receive necessary information to the other vehicle and end node. It depends on a node whether it wants to participate in network or not. If size of traffic data is less vehicle will propagate it but if size of traffic data is large then selfishness comes into the picture.

Privacy of Vehicle: Sometimes it is required to hide details of some vehicle from others. But if we share details of all the vehicles among all other then privacy of vehicle may be compromised.

Security: Security is mandatory for real-world systems. There is a need to detect malicious node in the VANET network, before they harm the system. Here we have to protect user from false congestion detection messages. So as a part of security we have to register vehicle node and need to authenticate before permitting it to transmit any kind of data to other nodes of VANET.

Bandwidth Limitation: Bandwidth is limited and it must be efficiently used. For better utilization of bandwidth different filtering techniques can be used for reducing in transmission data.

B. Basic steps to detect congestion

One important characteristic of congestions is that vehicles move relatively slow and the vehicle density is high. We will use this as an advantage when designing our system for congestion detection and propagation. When vehicle detects congestion, it informs to nearby vehicles. When RSU receives this type of messages by more number of nodes then only it will consider it as congestion and broadcast congestion message. When developing a congestion detection system, we can either rely on some central network and data gathering infrastructure or we can use hardware equipped in the vehicles to collect, analyze and disseminate these information. Basic steps to detect congestion are: Data Gathering, Data Sharing, Data Finalization, and Data Propagation. In Data Gathering data are collected from the environment. Vehicles equipped with VANET device are enough capable for communicating with each other. They can gather data of their current position, speed, and details about number of neighbours. In Data Sharing collected data shared with other vehicles. Gathered data will be useful only when it is shared with others. During Data Finalization step, from the collected shared data, information is generated. In Data propagation, finalized data will be propagated in the network.

C. Roll of VANET in congestion Detection

As we can see in Fig-1in VANET two main entities are Road Side Unit (RSU) and On Board Unit (OBU). We consider here each cross signal has RSU and consider it as a Signal Agent (SA) and each vehicle equipped with OBU and consider it as Car Agent (CA). SA and CA can communicate with each other. CA generates query for finding different route and SA give response with optimal route.

Traffic Congestion Detection and Avoidance Through SA And CA

A. Proposed approach

The main aims behind the development of Congestion detection algorithms are detect areas of high traffic density with relative low speeds. Each vehicle captures and disseminates information such as location and speed and process the information received from other vehicles in the network. If the vehicle's own speed is below a certain percentage of the posted speed limit, the vehicle creates a congestion area containing only itself and it starts listening for location and speed information transmitted by nearby vehicles in order to determine total congestion area. At this point this is only a tentative congestion area is detected by node itself and it will not be broadcasted to other vehicles.

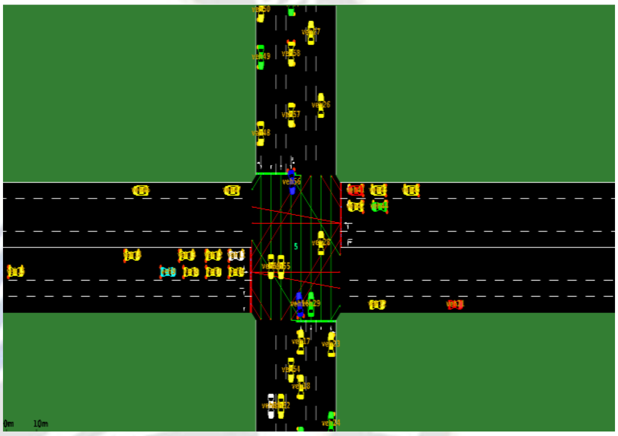

Fig.2. Cross Road with RSU and OBU

If the receiving vehicle is not in congestion, it simply collects the received congestion information and stores it into its own memory. If one or more no. of vehicles receiving congestion then they share their congestion area with others and find total congestion area. A vehicle that is or believes to be part of congestion builds its congestion area from data received from other vehicles and congestion agreement counter will incremented by one . if the transmitting vehicle is also going slow it is said to be in agreement and the congestion area is expanded to include the transmitting vehicle. If in the other hand, the transmitting vehicle is

going at normal or above normal speed it is said to be in disagreement in which case, the In Disagreement counter is incremented. Based on the counter value area of congestion can be tracked. This information will be broadcasted to other vehicles which contain current congestion area and no. of vehicle in congestion.

Step 1: Check If current speed is less then minimum speed then declare SelfCongestion.

Step 2: Check the Congestion Status from neighbor vehicles. If neighbor detect congestion then set CongestionStatus="True"

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Step 3: Find the Total no. of vehicle who detect congestion. Based on received feedback increment TotalCongestion every time.

Step 4: If TotalCongestion is grater then Thresholdvalue then declare total area as a congestion Area.

Step 5: OBU manager will Broadcast the congestion detected message with CongestionArea, Congestion Time, Congestion Affect No Of Vehicle, Approximate Congestion Release Time)

Signal Agent (SA) will get the details of each vehicle enter in its range. We are assuming here that each Signal Agents can communicate with other SA. Car Agent (CA) can communicate with Signal Agent (SA), whenever it enters in the range of Signal Agent (SA). CA can send the details of Car ID (CID), Current Position (CP), Current Speed (CS), Maximum Speed (MS), Number of Neighbour CA (NCA), Road Block ID (RBID). SA will maintain the counter for each Road Block Whenever CA enters in the range of SA, counter will be incremented by one and when vehicle goes out of the range of SA, counter will be decrement by one. By doing this we can get the details of Vehicle Density on each and every road block segment. For each road, one threshold value is set based on type of road, number of lanes and length of road. At regular interval of time SA will send the details like number of vehicles and road block wise average speed of vehicle. Flow of proposed approach we can see in Fig-3.

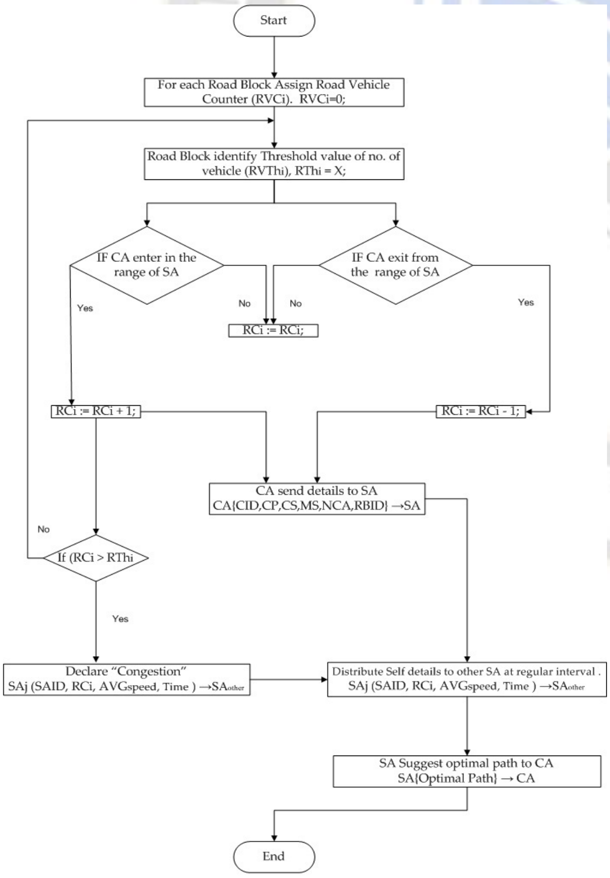

Fig. 3. Steps to Proposed Approach

B. Simulation Environment

As shown in Fig-4, we design structured approach for city area of total 25 km2 . Four roads are connected with cross signals. Each Traffic signal are work as a Road side Unit (RSU).Entire road is divided into no. of Road Blocks. Length of each Road Block is 1 km and each has two no. of lanes.

We deployed 2500 no. of vehicle in entire structured scenario. Each vehicle supports 802.11P. Each vehicle are consider as On Board Unit(OBU). Each vehicle is equipped with On Board Unit (OBU). Here we run this simulation scenario in normal/regular condition without using any intelligence. Then we run this simulation in the presence of Car Agent and Signal agent. Car Agent can provide intelligence to Car and communicate with traffic Signal Agent (SA). Whenever vehicle enters in the range of Signal agent (SA) at cross road, communication can be possible between CA and SA. We run the simulation for 5000 square meter area, with 2500 of Car Vehicle for 2200 second. Transmission range for OBU is 100 meter and RSU is 250 meter.

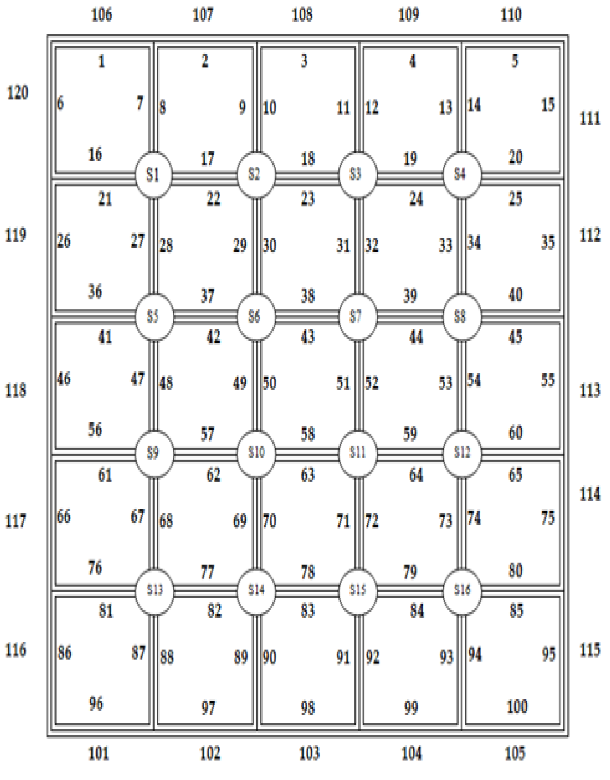

Fig.4. Structured Approach

Result Analysis

Here we analyze result in two different ways. First one is the analysis of entire simulation area and another is analysis of specific area which has heavy traffic. Result is represented using two graphs. Fig-5 representing Graph of Time wise Number of vehicles in the scenario and Fig-6 present the Graph of Time wise Number of vehicle on particular

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road block which has a heavy traffic.

From the Fig-5 we can analyze that Number of cars are added gradually in the road network so traffic is increasing and when cars reached to their destination at that time road traffic is decreasing in both the modes i.e. with Car Agent and without Car Agent mode.

In Car agent (CA) mode vehicle will getting feedback from Signal Agent (SA). Based on given feedback CA will choose optimal path to reach at destination, so congestion is reduced compared to without CA mode. It will not follow the path which already congested by other vehicles. As we can see from the Fig-5 in both the modes, car increasing rate remains same but due to congestion aware routing, we can see much reduction in terms of Number of vehicle in With Car Agent (CA) mode. After refereeing the entire road block, we want to do analysis of particular Road area. We have selected set of road block which has high traffic compare to others.

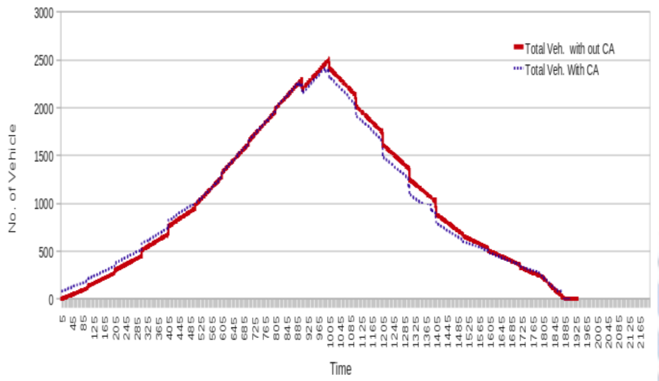

Fig. 5. Time wise Number of Vehicle Traffic in Entire Road Block

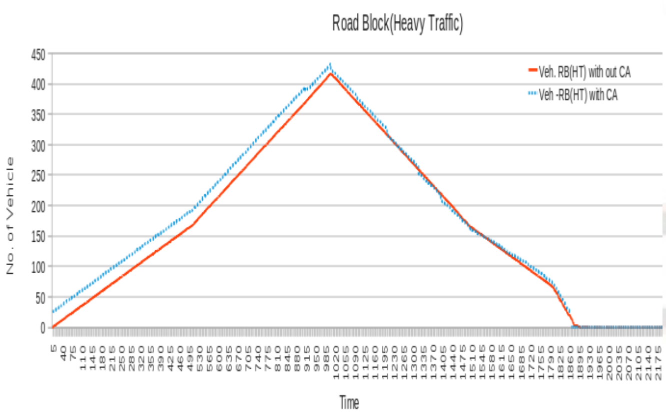

Fig. 6. Time wise Number of Vehicle Traffic in Heavy Road Blocks

In Fig-6 traffic of particular set of road block with heavy traffic is represented. Here we can consider that if total number of vehicles exceeds than specific threshold value then we can declare congestion for that area.

Conclusion

We implemented Car Agent (CA) and Signal Agent (SA), which can do the communication with each other. SA gathers traffic information from vehicles traversing through the given road segment and can suggest optimal path to other CAs. SA computes vehicle density and average speed periodically (every 15 seconds) of particular road block. In this paper we have considered homogeneous vehicles in simulations and assumed that all the vehicles are VANET enabled. We have considered lane-based traffic for vehicle mobility. In future we plan to analyse our approach for heterogeneous vehicles and lane-less traffic movement which is more realistic for representing traffic in developing countries.

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