A Review of Congestion Control Techniques in VANET

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***Abstract* - The problem of congestion in Vehicular Ad-Hoc Network is a widely researched problem and draws attention of many researchers in recent years. Many effective algorithms have been proposed and implemented by the researchers and their merits and demerits have been discussed. The challenge lies in developing an algorithm which can effectively transfer the message between base stations and the vehicles. The paper presented gives an overview of the techniques used to solve the problem of message passing from one vehicle to the other such that the packet loss must be reduced. This paper also presents a comprehensive review of the various techniques and the advantages and challenges of those techniques. Finally the paper ends with the brief discussion about the optimal route calculation strategies for the vehicles which needs to be explored further.**

***Keywords* - Congestion Control, VANET, Optimal Route**

I. INTRODUCTION

Traffic on road is big problem today. Multiple hours and tons of fuel is wasted everyday by these vehicles jammed in traffic. This is a fact that, therefore million tons of fuel is going to wasted today due to the increase of traffic intensity. In Technology era all the vehicles themselves have an ability to compile and analyze the traffic data and communicate it to drivers in a layout which will let them to make smart decisions to the avoid congested areas. Communications between these vehicles can be obtained either through vehicle-to-vehicle communications or vehicle-to infrastructure. Vehicular ad-hoc networks are mobile ad-hoc networks that give the communications between adjoining vehicles or nearby fixed equipment[1]. The Congestion detection algorithms are planned that we can detect the areas which are of low speed and high traffic density. Each vehicle records and flow the information such as place and speed or route that information is received from other vehicles in network. Congestion detection is one of the multiple applications of VANETs or it didn't design to be used as means for an automated driving rather as tool to deliver information to driver which will help her/him make decisions to avoid the heavy traffic. Design traffic congestion detection system which will have good influence on budget, the surroundings or society in general letting us to spend less time stuck in the traffic or more time doing any creativity.

Figure: 1 VANET

The Vehicular Ad-hoc Network has been studied in various fields, since it has an ability to distribute a variety of services, such as detecting nearest collisions and giving warning signals to aware driver. These services are provided by VANET often based on association or among vehicles which are furnished with a relatively motion sensors and GPS units. Awareness of the specific location is vibrant to the every vehicle in VANET so it can provide an accurate data to aristocrats. At present, typical localization methods integrate the GPS receiver data and measurements of vehicle gesture. Although, when the vehicle passes via backgrounds that generate a multipath outcome, so these techniques are failed to produce high localization accuracy, which they attain in several open surroundings [3]. Unfortunately, the vehicles travel in an environment that cause multipath outcome, like areas with high buildings, tunnels, or trees. This research has been designed to minimize an effect of the multi path outcome with respect to localization accuracy of the automobiles in VANET. More so, the planned procedure firstly detects if there is any noise in vehicle place than it will estimate which is caused by multipath outcome which using the neural network procedure. It takes benefit of communications among VANET vehicles in order to attain more information from the vehicle's neighbours, like distances from the target vehicle and their places estimates [4]. The proposed method assimilates all the pieces of information with vehicle's own information and data or applies the optimization techniques in order to minimize the place.

Voting

In this, Disha Shrivastava et al. proposed the distributed congestion tracking and detection algorithm constructs or disseminates traffic congestion of information from data attained directly from the vehicles by forming the ad-hoc-network. This algorithm has developed in way that doesn't require the use of a unique vehicle ID which may be compromise location privacy [4]. The algorithm offers an efficient use of communications of channel by re-transmitting aggregated data or not retransmitting the location data for an every single vehicle.

A simulation environment for the VANETs: Built on the top of JIST/SWANS lets simulations of Vehicular the Ad-Hoc networks at all levels, from radio layer to application layer. A Simulation and Visualization Control Module, which interacts with simulation engine letting the researcher to observe the conditions of nodes of network either in real-time or as a playback of finished simulation run. This module lets the researcher to the control of simulation "time" and changes the properties of either environment or the particular nodes while simulation run.

Fuzzy clustering-based message aggregation

In this algorithm, N. Ahmed et al. [1] proposed the FCMA, that means the atomic messages are classified into the different message clusters by according to the measurement of difference between atomic message objects or their fuzzy similarity relations. The atomic messages in same message cluster can be aggregated.

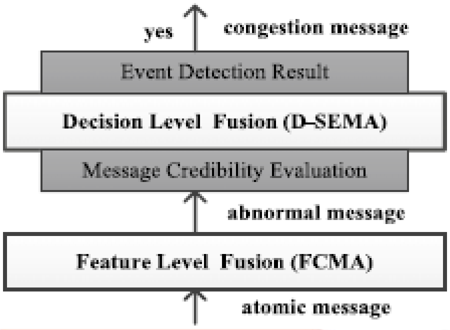

Figure: 2 Multi level information fusion procedure for road congestion detection.

The system architecture of FCMA is or the atomic messages are stored in buffer [1]. Once the timer was timed out, the message aggregator will be read the data from buffer, and push them into fuzzy clustering module that mainly contains the direct fuzzy clustering algorithm based on similarity relations.

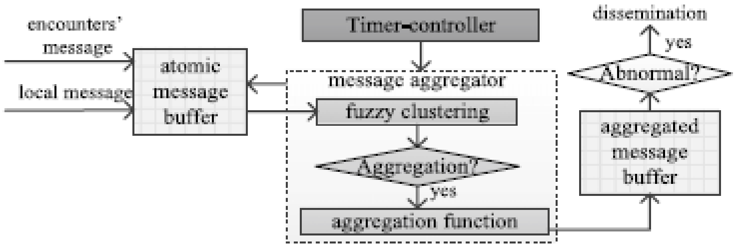

Figure: 3 System architecture of FCMA.

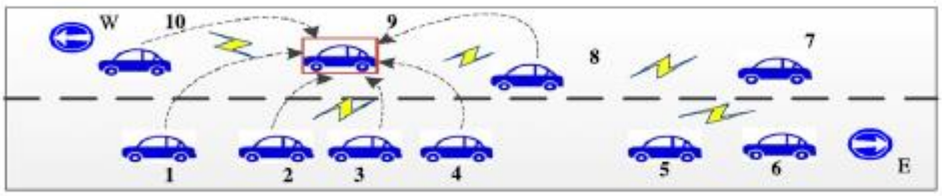

Figure: 4 Road congestion on a two-way lane.

In FCMA, with an aggregation function all the atomic messages in same message cluster has aggregated into one message that is called feature information.

Fuzzy clustering procedure

In the algorithm, S. Kanhere,[1] et al. proposed, an evolution process of the message clustering. The fuzzy clustering procedure normally divided into steps:

Create an initial data sample matrix. In VANETs, several aspects of the vehicle state information, which are generated by on-board sensors, like as vehicle speed s, brake frequency b, acceleration e, message creation time t, horizontal or vertical geographical coordinate (σ, ρ). This information can be indirectly reflected the road traffic situation, or it can be grouped into a one atomic message as its attributes. This vehicle 9 creates a 6×3 data sample matrix of the six atomic messages including three kinds of message attributes.

- Build the similar relationship matrix. With classic arithmetic average minimum technique, vehicle 9 generates a 6 × 6 fuzzy similarity relationship matrix.

- Get a cutting matrix. We can obtain a 6 × 6 cutting matrix when a parameter λ is set to 0.35. Here, a parameter λ can be selected from a ‘‘0’’ to ‘‘1’’.
- Build an adjacency list matrix. Vehicle 9 builds 6 × 6 adjacency list of matrix or the used method is elaborated.

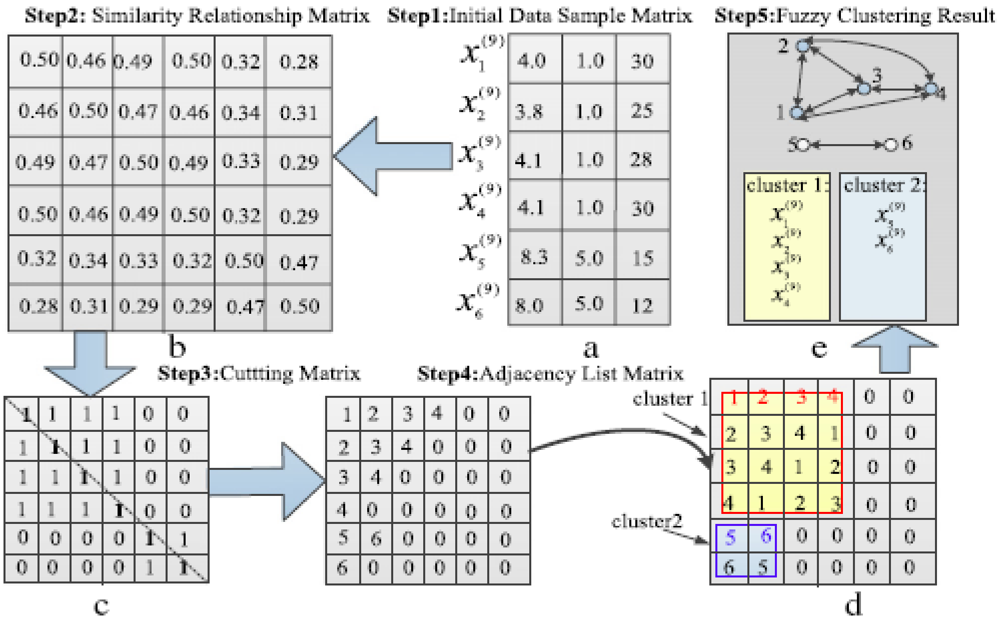

Figure: 5 Fuzzy clustering-based message aggregation.

The attained two message clusters correspond to the two distinct traffic features that reflect the real road conditions [6]. The number of starting messages is reduced to two. Then, use an aggregation function AF(·) to the process each message of cluster. The feature information is aggregated from a message cluster which is named as aggregation message. Apart from that, the importance of feature information is distinct, and names it as an abnormal of aggregation message if it used for road congestion detection later.

$$x_r^{(i)} = x_1^{(i)} \circ x_2^{(i)} \circ x_3^{(i)} \cdots x_n^{(i)} = AF(x_1^{(i)}, x_2^{(i)}, \ldots, x_n^{(i)}).$$

Replace the vertical and horizontal geographical attributes of vehicles with a geographical area D(i) r that contains all geographical coordinates of atomic messages in same message cluster. The newest attributes of aggregation messages are denoted by $x_r^{(i)} = (s_r^{(i)}, e_r^{(i)}, b_r^{(i)}, D_r^{(i)}, t_r^{(i)})$, and are computed as follows.

$$s_r^{(i)} = \sum_{k=1}^{l} s_k^{(i)}/l,\ e_r^{(i)} = \sum_{k=1}^{l} e_k^{(i)}/l,\ b_r^{(i)} = \sum_{k=1}^{l} b_k^{(i)}/l,\ D_r^{(i)} = \bigcup_{k=1}^{l} (\sigma_r^{(i)}, \rho_r^{(i)}),\ t_r^{(i)} = \max_{1 \le k \le l}(t_k^{(i)})$$

Where l is a number of atomic message in a message cluster

D–S evidence message aggregation

In this, Q. Fang [3] et al. proposed With the attained feature information, design the D-SEMA scheme to enhance the accuracy of an event detection by introducing with one message credibility assignment function or an enhanced D–S evidence reasoning theory. The system architecture of D-SEMA, the road congestion event is denoted as ‘‘A’’.

If a huge number of aggregation messages are used in a D–S evidence combination, and the computational overhead of the event detection will be unacceptable. Therefore, firstly set the two threshold values θa, θs for the message attributes a(ni) r, s(ni) r to reduce an amount of aggregation messages. Only all of the message attributes of an aggregation message has satisfied the following conditions can be used as a congestion feature evidence.

$$\begin{cases} 0 \le s_r^{(n_i)} < \theta_s \\ 0 \le a_r^{(n_i)} < \theta_a. \end{cases}$$

The Proposed Congestion Control Algorithm

In this method, L. J. Guibas [8] et al. proposed the research of congestion control algorithm which ensures a high reliability or time bases delivery of disseminating the event-driven safety messages. The propose of congestion control algorithm that can be divided into following two main parts: measurement-based detection and event-driven detection. The flowchart steps for congestion control algorithm are demonstrated

Measurement-Based Detection

In this, Darus, Mohamad Yusof [5] et al. proposed the measurement-based congestion detection that will monitor the CCH channel based on the packets of channel queue. The CCH channel is congestion if the number of messages in queue exceeds a defined threshold. It based on the research which is concluded that a queue with the length of five beacon messages that can be sufficient to used for 802.11p beaconing. In congestion control algorithm, congestion control discarded a packet queue much more than 5 beacon safety messages [9].

Event-Driven Detection

In this method, Darus, Mohamad Yusof [5] et al. proposed an event driven detection method that monitors an event-driven safety message or decides to intialize the congestion control algorithm. When an event-driven safety message is detected and generated. The congestion control will be launched immediately the queue freezing technique for the all MAC transmission queues that except for an event-driven safety message. Follow the order to send an event-driven safety message with minimum delay, the lower priority messages like as beacon messages emission has breezed. Presently, an event-driven detection method is used in existing of congestion control algorithm.

II. COMPLEX EVENT PROCESSING

In this, PM Dhanya et al. proposed the major goal of CEP system is to track and detect real world situations, known activities such as traffic congestion along a motorway. The CEP is based on the idea which an activity has been split in simpler ones. In this case, traffic congestion can be divided in various groups of the slow vehicles. In turn, each of the activities can be divided into sub activities with lower level of abstraction [11]. In the summing up, some are reflected as clouds of the interrelated rough events in lowest layer of an IS. In present scope, the target IS has own VANET. The CEP system gets as input of the rough events and creates a layered hierarchy of the events with individual levels of the abstraction to compose one and more complex of events which represent an initial real-world activity. These complex events can be sent to back-end system that performs some kind of actions or procedures.

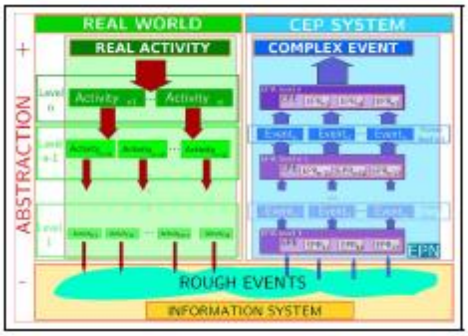

Figure: 6 CEP concept model

To do the CEP tries to search relationship, detailed as predefined patterns, among the events of IS. The patterns are described in the CEP system as the event-processing rules that comprise both of pattern definition and the action to be changed whenever pattern is met. It based on EPRs, the event processing agents are designed. An EPA is composed of EPRs which generate events of a particular level of abstraction. It contains an event processing engine [12]. This engine is charged while running the individual EPRs of EPA and performing their associated actions.

III. EDA FOR TRAFFIC CONGESTION

In this, H. Takagi [10] et al. proposed the EDA that acts as a middleware between network level that is in charge of VANET communications at low level, and higher level holds the back-end applications. The general structure of EDA takes beacon messages from a network layer as rough events, or the EPAs perform a CEP processing of afterward; more so, the EDA gets as input events from the data sources that state road environment.

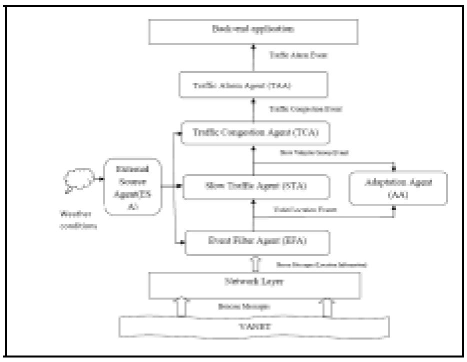

Figure: 7 EDA components schema

These data sources mainly inform the weather conditions on EgoV road. Such these events are merged with events that made up from the beacon messages; conversely, the EPAs works in cooperative way and a hierarchy has composed. In the conclusion, the EDA creates a traffic alarm when a traffic jam is detected or tracked. This event is sent to back-end application and they could be used, either to an alert both driver and passengers of the EgoV and to display a warning message on information panels of motorway depends upon, where the EDA is running.

A. Operation Mode

Each vehicle with the VANET capabilities can be indicated the lane where it is presently riving in an each of beacons. As far as when field is concerned, the EDA may be deal with two distinct situations [7]. In the simple case, vehicles in VANET can be accurately indicated the driving lane in its beacons. In the later case, vehicles cannot correctly estimate the driving lane because of various circumstances. It detects traffic congestions without bringing into account lane information from the received beacons.

B. EPA Goals

Each EPA performs a particular task or focuses on dealing with multiple events with a specific level of abstraction. In specific, the goals of each of EPAs are given as follows:

- An event filter agent reads Location events from the network layer, and charge of discarding events which are useless for remainder of the EPAs. In a conclusion, a newest stream of events valid place events is created.
- The slow traffic agent has fed with stream of the Valid Place events and monitors traffic conditions along with motorway. Periodically, it generates a Slow Vehicle Group event which contains a number of vehicles which are driving at very low speed.
- Traffic congestion agent continuously examines the stream of the Slow Vehicle Group events. When TCA detects a large density of slow traffic, it creates a Traffic- Congestion event. This event displays the activity which traffic congestion has been arisen in motorway.
- Traffic alarm agent gets as input the stream of the Traffic Congestion events or categorizes them into the three levels of congestion via a fuzzy classifier.
- The adaptation agent is in a charge of deciding that operation mode, where i.e., lane or raw, is most compatible at an every moment. The AA adjusts the inner parameters of EFA through heuristic.

IV. CONCLUSION

The paper gives an overview of various techniques used in recent years. Many bio inspired techniques are also used which works iteratively and reach the best solution after few iterations. The use of bio inspired algorithms and machine learning algorithms is encouraged by the researchers as the accuracy of finding the solution is far better than using simple techniques and gives optimal route results effectively.

In future many other machine learning algorithms will be used for the optimal route calculation and can be accessed on the basis of parameters like packet delivery ratio, recommendations of a certain route by other vehicles for further avoidance of Congestion and calculation of optimal route for both message passing and vehicular congestion.

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