Congestion Control through Improved Decentralized with Carrier Sense Threshold in VANETs

Hina Sheikh[1] , Prof. Ratan Singh[2]

[1]PG Scholar, [2]Head, Department of CSE

Abstract - with the constant increase in vehicular traffic, existing traffic management solutions have become inefficient. Urbanization has led to an increase in traffic jams and accidents in major cities. In order to accommodate the growing needs of transport systems today, there is a need for an Intelligent Transport System. Vehicular Ad-hoc Network (VANET) is a growing technology that assists in Intelligent Transport Systems. VANETs enable communication between vehicles as well as fixed infrastructure called Road Side Units (RSU). We propose a distributed, collaborative traffic congestion detection and dissemination system that uses VANET. Each of the driver's smart phones is equipped with a Traffic App which is capable of location detection through Geographic Position based System (GPS). This information is relayed to a remote server which detects traffic congestion. Once congestion is confirmed the congestion information is disseminated to the end user phone through RSUs. The Mobile App transmits the location information at periodic intervals. Using the latitude, longitude and the current time, the location of each vehicle is traced. Using location information, the distance moved by the vehicle at a given time is monitored. If the value is below a fixed threshold, congestion is suspected in a particular area. If many vehicles in the same area send similar messages, traffic congestion is confirmed. Once traffic congestion is confirmed, the vehicles approaching the congested area are informed about the traffic through display boards that are available in the nearest RSUs (traffic signals). The congestion information is also made available through the Mobile App present in vehicles approaching the congested area. The approaching vehicles may take diversion and alleviate congestion.

Index Terms: Vehicular Traffic, Intelligent Transport System, Road Side Units, Geographic Position based System.

I. INTRODUCTION

Transportation is an activity involving the movement of people or goods from one place to another in order to meet the perceived social and economic needs of a user. As these needs change, the transportation system itself evolves and problems occur as it becomes difficult to serve the public interest. One of the negative impacts of any transportation system is traffic congestion [1].Vehicular traffic congestion is a condition that occurs on road networks, which involves the increased queuing of vehicles characterized by increased trip times and fuel consumption. Traffic congestion occurs wherever demand exceeds the capacity of the transportation system and the most common problem is queuing up of vehicles near toll booths [2]. Vehicular traffic can be witnessed mainly on highways and major roads that connect industries. Metropolitan and cosmopolitan cities are found to have higher traffic congestion than other parts. Vehicular traffic congestion poses numerous threats and arises numerous problems to the vehicle drivers. Various industries that bank on freight transport lose a heavy sum of money annually due to traffic congestion. Various institutions, government bodies and organizations have undertaken surveys and studies to understand the causes and consequences of vehicular traffic congestion and also to provide efficient solutions to avoid traffic congestion. VANET also helps us to achieve car to car communications and perform simulations at a relatively low cost [3]. Recent efforts have placed a strong emphasis on VANET design implementations [4].

Thus a smart traffic congestion detection and dissemination system is developed to divert incoming vehicles and reduce congestion without human intervention. This system can be further enhanced by communicating the congestion information directly between vehicles using IEEE 802.11p protocol.

II. NEED FOR TRAFFIC CONGESTION

A. Management

The steady population increase in urban areas has led to an exponential increase in the number of vehicles on road. Vehicular traffic is one of the most important social and economic issues faced today resulting in congestion. With tremendous growth in industries, the need to reach the destination within a certain time is on-demand. Problem occurs when important destinations lie on the same route. A single technology park housing multiple companies with each company accommodating more than a hundred employees is one such example. In these cases, traffic becomes unavoidable and there is a need for a solution to avoid vehicular traffic congestion.

A smart transport system which will provide real time information about the traffic by p2p [5] is the need of the hour. The existing smart transport systems demand a need for the construction of expensive infrastructures or a change in the road structure. Although these systems prove to be very effective, they will consume enormous amount of time and cost to be deployed.

Nowadays, the roads within cities are well-connected and therefore there are numerous routes for a single destination. If one route is congested, an alternate route can be taken. A simple solution to traffic congestion is to gain knowledge about the traffic congested routes. Once this knowledge is gained, it is feasible to identify an alternate path and divert from traffic congested areas. This solution not only helps in vehicle diversion but also resolves traffic congestion at a minimal time.

III. PROPOSED METHODOLOGY

The main goal of the proposed method Improved Decentralized Congestion Control with Carrier Sensing Threshold (IDCCCST) is to ease the channel load, so that safety data traffic can be served on time. It is a cross-layer solution because based on channel state information (acquired using channel probing) PHY layer parameters are set in order to enhance the IEEE 802.11p MAC performance.

A. Algorithm

The algorithm of proposed methodology improved decentralized congestion control with carrier sensing threshold (IDCCCST) is performs in two phases as follows:

Phase I: Determine channel load being congested.

Input: A set of nodes N = {u_1, u_2,....,u_n}

Output: The aggregated channel load L_{r+1}

```
Begin
{
for (ui∈ N)
    {
      Li = Channel_monitoring(p, r, ρ);
      Li+1 = Objective_load(Lr-1,Lr,Lr+1);
    }
    Channel_monitoring(constra int p, constra int r, constra int ρ)
    {
      Li = C.(p/n).ρ.r.τ ;   // the channel load at t=iT
       return Li;
      }
    Objective_load(constra int Lr-1, constra int Lr, constra int Lr+1)
    {
      Lr+1 = αLr + (1−α)Lr−1 ;   // the channel load at t=iT
       return Li;
      }
}
End
```

where $L_i = C.\frac{p}{n}.\rho.r.\tau$ and $L_{r+1} = \alpha L_r + (1-\alpha) L_{r-1}$.

Phase 2: Resolve congestion case.

Input: Channel load

Output: Congestion free network

```
Begin
If(channel_load>fixed_congestion_free_load)
{
   In congested area, every node broadcast messages to all neighbors;
   Determine affected vehicle in congestion area on the basis of update flag_count;
   When affected vehicle is found then it is isolated from congested area;
   Isolated node is distributing channel_load in congested area;
   Isolated node maintains traffic with carrier sense threshold;
}
```

```
Else
Print "Congestion free VANET";
End
```

B. Flowchart

The flowchart of proposed methodology improved decentralized congestion control with carrier sensing threshold (IDCCCST) is performs as follows:

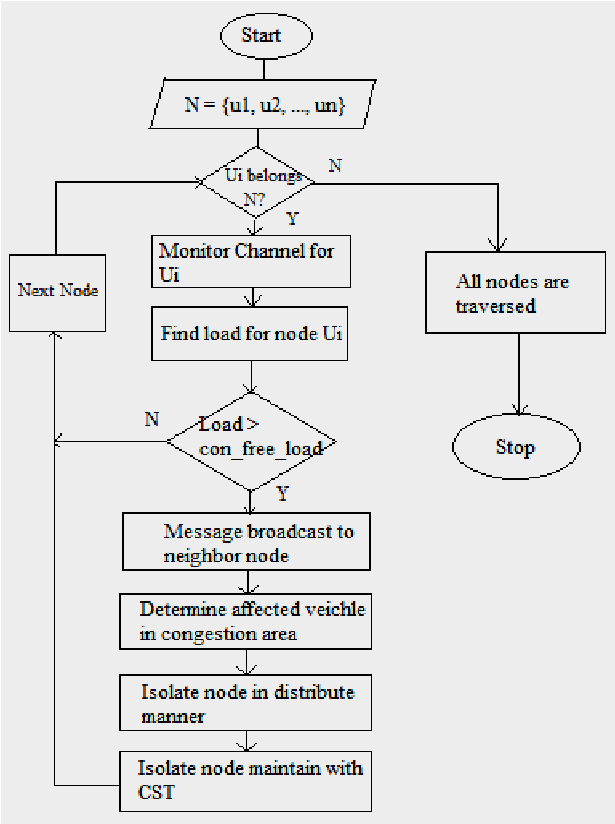

Figure 1: Flowchart of proposed work (IDCCCST)

IV. RESULT ANALYSIS

The implementation work performs on MATLAB R2013a. It shows simulation results of an individual node during the merging of two VANETs. In figure 2, the dynamic evolution of the simulated scenario is depicted. The situation displayed is the merging situation in the time instant t=100s. The performance indicators under study are:

(a) Awareness and Emergency Coverage Range vs Time: It shows the maximum transmitter-receiver distance vs time for QoS defined by probability of packet reception and deadline (PPR, Deadline (ms)).

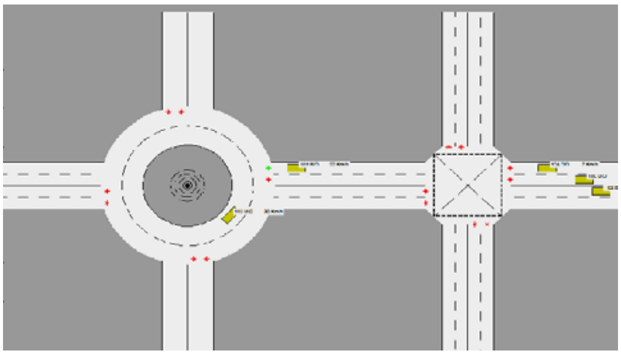

Figure 2: Simulation of Congestion Control in VANETs

Simulation Time (s)	DCC	IDCCCST (Proposed)
20	98	112
40	99	119
60	102	131
80	180	198
100	110	124

Figure 3: Compare Most Permissive QoS for Emergency Coverage Range (m)

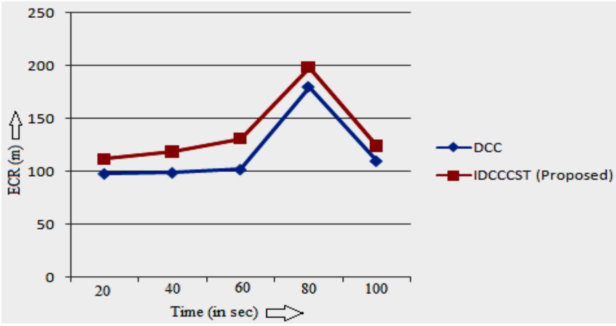

Figure 4: Analysis of Most Permissive QoS for Emergency Coverage Range (m)

Simulation Time (s)	DCC	IDCCCST (Proposed)
20	38	42
40	52	59
60	40	53
80	72	88
100	50	56

Figure 5: Compare Most Restricted QoS for Emergency Coverage Range (m)

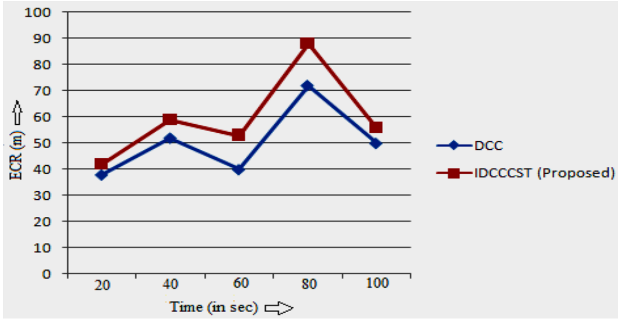

Figure 6: Analysis of Most Restricted QoS for Emergency Coverage Range (m)

(b) Empirical Cumulative Distribution Function of the MAC-to-MAC Delay: It depicts the percentage of the generated packets that ace a lower or equal MAC-to-MAC delay than a predefined threshold. Sticking to the aforementioned QoS restriction, the significant CDF level to be analyzed is the related to 100 ms deadline.

MAC-to-MAC Delay (ms)	DCC	IDCCCST (Proposed)
20	0.86	0.68
40	0.87	0.67
60	0.85	0.65
80	0.88	0.68
100	0.88	0.66

Figure 7: Compare Cumulative Distribution Function of MAC-to-MAC Delay

(c) Coverage Probability vs Coverage Range: It reveals the different reliability regions for each channel realization, based on the percentage of generated packets that were successfully received at different distances from the source.

Coverage Range (m)	DCC	IDCCCST (Proposed)
0	1	1
15	1	1
30	0.94	1
45	0.5	0.9
60	0.4	0.7
75	0	0.5

Figure 8: Compare Coverage Probability in different coverage range (Permissive Area)

Coverage Range (m)	DCC	IDCCCST (Proposed)
0	1	1
25	1	1
50	1	1
75	0.75	1
100	0.4	0.8
125	0.2	0.6
150	0	0.4

Figure 9: Compare Coverage Probability in different coverage range (Restricted Area).

V. CONCLUSIONS AND FUTURE WORK

This paper evaluates performance in between of DCC and IDCCCST VANET approaches as they are applied in road traffic congestion analysis. In VANET connected vehicles communicate through message broadcasts to detect congestion. In IDCCCST approach improves coverage probability 20%-40% in both area (Permissive and Restricted). Therefore proposed methodology is most effectively in congestion scenario. In future, To detect the congestion area using GPS with Genetic Algorithm, it helps to improve actual position of congestion in VANETs.

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