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An Efficient Cluster Based Routing With Adaptive Transmission Power in VANET

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Abstract* - *Vehicular communication is an important and emerging area of research in the field of vehicular technology. The development of software and hardware in communication systems leads to the generation of new networks. In this paper cluster based routing is used to enhance the performance of information in vehicular Ad-hoc networks. Clustering in VANET is one of the control schemes used to make VANET global topology. This cluster based routing is presented with Adaptive transmission power control in VANET. In this work the transmission power is adapted. This adaptation is based on the distance between vehicles and cluster head. Therefore, VANET cluster schemes should take into consideration and parameters to produce relatively stable clustering structure. To achieve better performance, the used algorithm also consider the uncertainty of vehicle mobility. Also this work shows better throughput and lower transmission delay and enhances the overall performance. Better execution of results takes place with better criteria.

Keywords:* *Cluster, VANET, Adaptive Transmission Power , uncertainty of vehicle , mobility

I. INTRODUCTION

As Vehicular communication is defined as communication between the vehicles. The main objective of deploying VANET is to reduce the level of accidents. VANET become emerging research area. VANET is a subset of MANET where high speed and frequent changes are main characteristics [1]. Devices in Vehicular ad-hoc networks consist of on board units and Roadside units. Infrastructure is used for Road side unit to connect with network but when vehicle move on highway there is no roadside unit and hence difficulty in communication with RSUs. In this case infrastructure less mode is preferable over infrastructure mode [2].

According to the World Health Organization (WHO) the Road-Traffic Injuries statistics of all countries show that after 2000, road accident is a major cause of death. Hence, there must be a better traffic system to solve this problem. VANET is such an advanced network which mainly provides Intelligent Transportation System (ITS) services to the end users for providing fast data exchanges and safety. As there are various algorithms and routing criteria that is used in VANET. VANET is affected by many active and passive attacks. For that, many secure routing protocols are developed to save the systems from these attacks. One of the best solutions to VANET is cluster based routing. In this routing all the vehicles are divided into the cluster and communication takes place between these cluster and these cluster is handled by cluster head [3].The routing based on these cluster in IEEE 802.11p has been studied extensively [4], [5], [6], [7]. The main motivation behind this paper is that accidents and road fatalities are increasing day by day, people are facing problems and need safety. Transmission of safety message between vehicles is a fundamental issue for promising applications in such networks. Due to extraordinarily high mobility of vehicles in a vehicular network, frequent handover requests will be a norm, which initiates the demand for an effective and fast authentication scheme. Clustering is an important research topic in wireless networks, because cluster structures can facilitate resource reuse and increase system capacity. The advantage of cluster based routing is to reduce the transmission delay of safety message so that message exchange between vehicles takes place immediately with effective performance and also increase the packet delivery ratio. These cluster based routing are real time traffic applications which require short delay. By increasing the transmission range in sparse traffic condition we can also increase duration of communication links in VANET [8]. Hence by increasing the transmission range of cluster head we can increase the cluster size and connectivity between every cluster also increases. As a result packet collision probability will increase and decrease the throughput of VANET.

Hence to solve all the problems Adaptive transmission power control is used based on the cluster routing. This scheme is based on the distance of cluster member to cluster Head is presented in this paper. Clustering is done on connectivity based adaptive transmit power control to enhance the performance and the overall result of simulation presented. In this way Road safety is a major issue in present world and we make a better network to stop all the hazards that takes place on the road. For this best transmission of safety packets occurs between vehicles and this paper presents an efficient clustering method with execution of simulation results. The remainder of this paper is organized as follows. Section II presents the related works about cluster based routing protocol. The adaptive transmission power control scheme will be shown in section III. Section IV summarizes the simulation and performance of the proposed scheme. Finally, the paper is concluded in Section V.

II. RELATED WORK

The basic objective of transmission power in VANET is to facilitate communication of safety message in an adversary environment between vehicles. In this section, we presented some previous works related to cluster-based routing in IEEE 802.11p. A mobility-based clustering algorithm which focuses on cluster stability is proposed in [7]. By comparing minimum distance and minimum relative velocity between cluster head and its members cluster is formed and hence algorithm applied. Luo et al [9] presented a cluster based routing in which geographic area is divided into foursquare grids. Some work has been made to reduce the effect of high traffic density in routing protocol. One example is shown in cluster based vehicular Ad hoc network Model for simple Highway Communication shortly written as CBVANET.

CBVANET adjusts the cluster size based on the speed of the vehicle. When the density of node is high traffic is heavy and hence speed of the vehicle is slow, also area of the cluster is small and vice versa when speed of the vehicle is high. However when size of the cluster is small then results in long propagation path even though distance between two nodes is near as small size cluster means more cluster for the same number of nodes and hence more cluster head. Girinath et al in [11] presented how to reduce the effect of re-clustering by choosing predefined vehicles like buses or static nodes as cluster heads. This solution is suitable for urban area only, where there is relatively large number of bus and infrastructure mode is available in many place. The previous research in cluster based routing for VANET shows the necessity for an efficient transmission network in cluster based routing. This work is motivated by the observation of existing cluster based routing schemes [7], [9], [10], [11] did not consider the rapid changing topology of VANET and kept the transmission power of vehicle fixed. And this paper presents our study to enhance the performance of cluster based routing by using adaptive transmission power of vehicle in IEEE 802.11p.

III. ADAPTIVE TRANSMISSION POWER CONTROL

The proposed model is appropriate for vehicle to vehicle communication on highway where the topology-changes are highly dynamic. Cluster based Routing in VANET is Particularly useful for applications that require better routing and scalability to hundreds or thousands of vehicles . The behavior of Vehicles Mobility determines the architecture of the cluster. The movement of vehicles are constrained by Roads and influenced by traffic lights. Hence by using these entire criteria vehicle's movement can be used as a cluster. In this paper vehicle cluster is a group of vehicles that are moving in same direction on the same road. In cluster based routing each cluster consists of cluster head and cluster member. Cluster member consists of ordinary vehicles on the road. To maintain the cluster structure every cluster head needs to update their cluster table and ordinary vehicles are required to connect to cluster head. Also mobility awareness deals with sudden changes in topology by responding against malfunctions in routing. Some of mobility metrics are considered for cluster construction in order to form a stable cluster structure.

This study is motivated by the fact that the distance of every ordinary vehicle and the cluster head is different. Thus, if fixed transmission power is applied to each vehicle, there are many overlapped transmission range in a cluster. Due to this, in congested traffic where the distance between vehicles is very close, the overlapped transmission range will create adverse effect such as high packet collision probability. We can optimize the link quality between vehicles by adjusting the transmission power of each ordinary vehicle based on the distance between ordinary vehicle and cluster head. As shown in the example in Fig.1 and Fig.2, if we adjust the transmission power based on the distance between ordinary vehicle and cluster head the overlapped transmission range region will be reduced. It is assumed that the GPS service is available in every vehicle to determine the vehicle position. The proposed scheme requires that the cluster head constantly advertises cluster information and includes its position within the advertisement. The cluster member can then calculate the distance to cluster head and update the transmission range. When distance is observed the transmission power is adjusted according to the distance. In this way we can see that with fixed transmission power there are many overlapped transmission range and with adaptive power overlapped range not occurred. Hence clustering routing takes place with enhances performance. So clustering formed over connectivity to increase the network capacity so that transmission delay comes out minimum and safety message reaches to destination effectively. Therefore, VANET clustering schemes should take into consideration, multiple parameters to produce relatively stable clustering structure. Tests performed in the simulation environments show that the routing performs better than the popular classic approach.

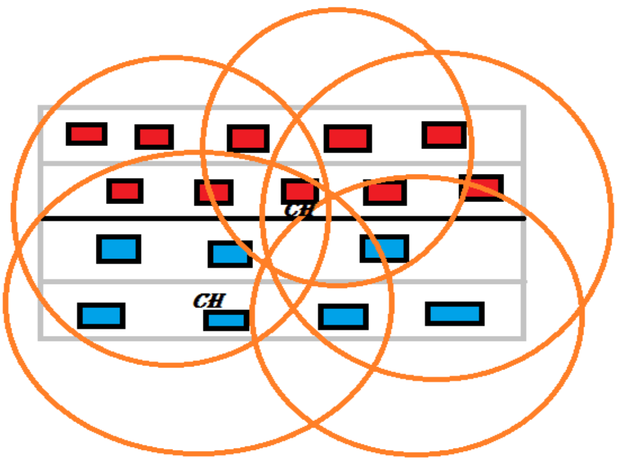

Fig.1. Overlapped transmission range

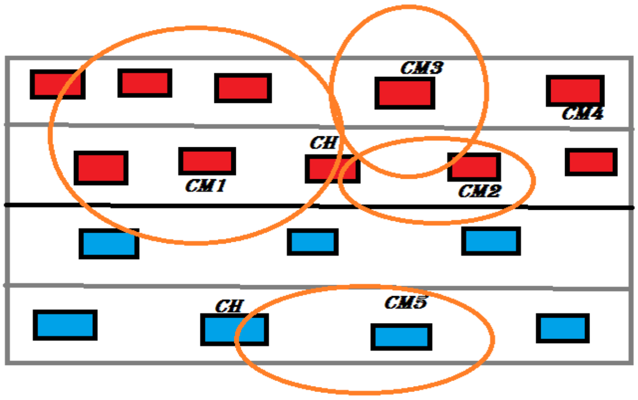

Fig. 2. Adaptive transmission range.

As distance is obtained between the vehicles and accordingly transmission power adjusted so that a better environment takes place and for this a look up table is updated. We use an updated lookup table from [8] in Table 1 to map the transmission range into transmission power. In this distance is given and the transmission power adjusted accordingly. Transmission power used in dbm and distance is in meter.

TABLE I TRANSMISSION POWER LOOKUP TABLE

Distance (m)	Transmission Power (dbm)
0-99	4
100-209	6
210-299	10
300-379	14
380-449	17
450-549	20
550-649	24
650-749	27
750-849	29
850-929	31
930-1000	32
>1000	N/A in DSDV

But when VANET topology changes rapidly than sometimes Cluster head can get out of the range because of the change of Cluster head velocity and direction. In this case a sufficient Action takes place to adjust the transmission power easily. And by increasing the frequency would reduce the efficiency resulting in reduction of actual data transmission. As distance measurement is necessary between vehicles to estimate transmission power. Hence uniformly accelerated motion model to estimate the distance between two vehicle is shown below in the figure.

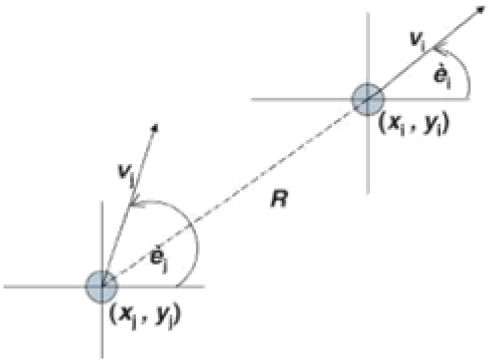

Fig. 3. Uniformaly model to estimate distance

Using the model in [12] as shown in the figure 3 above consider i and j are two vehicles. Distance between them is R. Their speeds are v_i and v_j with coordinates (x_i , y_i) and (x_j , y_j) respectively. The velocity angles are θ_i and θ_j respectively. Now the predicted distance is

$$s = \sqrt{(a + ct)^2 + (b + dt)^2}$$

Where $a = x_i - x_j$, $b = y_i - y_j$

$c = v_i \cos \theta_i - v_j \cos \theta_j$

$d = v_i \sin \theta_i - v_j \sin \theta_j$

Algorithm 1: Adaptive Transmission Power
Require: Periodic cluster advertisement containing position, velocity, and direction of Cluster head (CH)
while ("Cluster advertisement are arrived at OV") **do**
Calculate distance to CH;
if *Distance* < *d* **then**
assign transmission power corresponding to distance using Table 1;
estimate future distance to CH;
if Future distance range at time *t* ≠ current distance range
then
schedule interrupt at time *t* to update transmission power using Table 1;
else
maintain current transmission power; end if
end if
else
ignore the cluster advertisement; end if
end if
end while

Algorithm 2: Retransmission Power Control
while ("packet arrives from higher layer to be sent") **do** Send packet
if Failed packet transmission **then**
cancel power adaptation interrupt ;
increase transmission power;
retransmit packet;
else
maintain current transmission power;
end if
end while

However it should be noted that the velocity of each vehicle tends to be very high on highways so that vehicles can adjust its transmission power rapidly. As velocity high due to which distance of vehicles changes significantly. In this case these are the algorithms that used in the topology. Hence we can see that by using clustering performance of the network increases. Now the simulation results are taking out. The overall results of connectivity and clustering are presented in the next section.

IV. SIMULATION RESULTS

For simulation results of the algorithm discussed above, a model is implemented using ns-2 simulator. By network simulations, an analytical view of the connectivity and clustering based adaptive power control algorithm is obtained.
Simulation Setup: In order to evaluate the performance of the system, a scenario has been implemented in the ns-2 simulation environment. An overview of the relevant simulation parameters employed in the network is given in Table 2. For each node, a standard network protocol stack consisting of User Datagram Protocol (UDP), and IEEE 802.11 MAC/PHY (Medium Access Protocol/PHYsical layer) is implemented. According to the standards of DSRC, the operating frequency is kept 5.9MHz. The simulation time of the network scenario to work is kept 10 seconds. The messages, i.e., safety and non-safety messages are routed throughout the network based on DSDV (Destination-Sequenced Distance-Vector) routing protocol.

Table 2. Simulation Parameters

Parameters	**Value**
Physical layer	OFDM
Topography dimensions (X,Y)	1600, 1000
Routing Protocol	DSDV

Radio Propagation Model	Two Way Ground
Frequency Band	5.9Ghz
Transmission range	250m
Simulation Time	10sec

GRAPHICAL ILLUSTRATION:

The section provides a brief description of the graphical representation of the network performance. The performance of the network is evaluated in terms Packet Delivery Ratio (PDR), Throughput and Network delay.

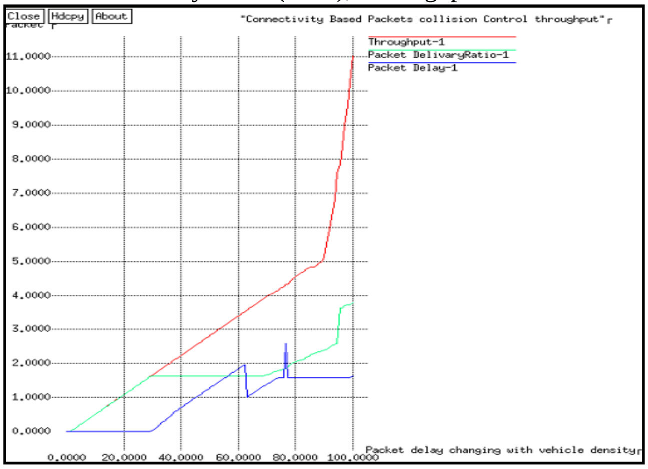

Fig. 4 Connectivity based power control algorithm

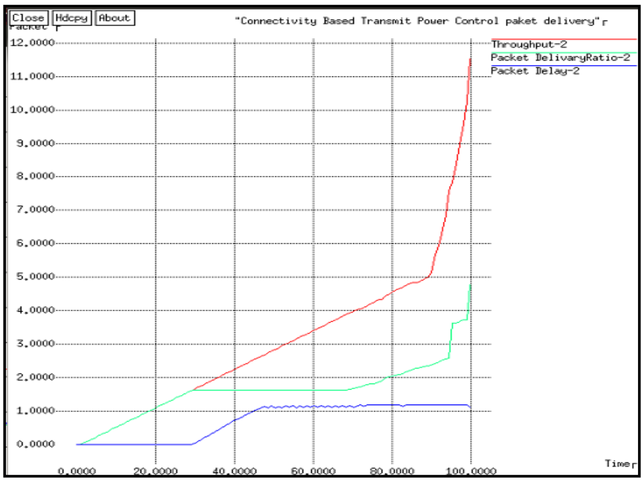

Fig.5 Cluster based adaptive power control algorithm

A comparison between Figure 4 and 5 clearly depicts that the network performance in terms of PDR, throughput and network delay considerably improves when cluster formation is included in the network as here the cluster head is responsible for transmitting the messages and, hence, chances of collision reduces to a great extend.

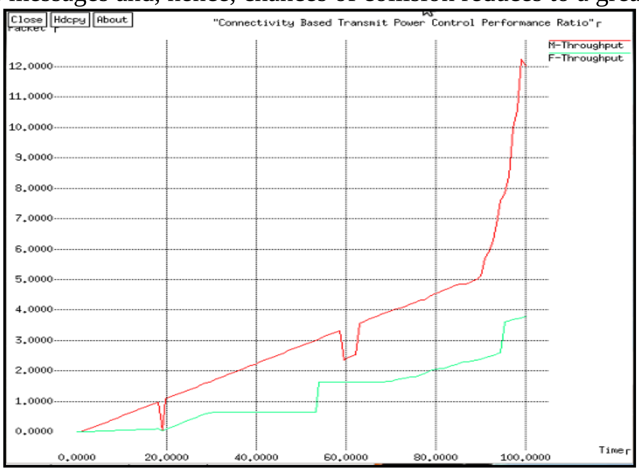

Fig. 6 Comparison Between Fixed and Modified Adaptive transmit power algorithm

Figure 6 shows the comparison between fixed and modified, i.e., cluster-based adaptive transmit power algorithm. The figure clearly depicts that the network performance significantly improves with increase in number of node density when adaptive power control algorithm is applied, in contrary to the fixed transmit power network where all the nodes are assigned the same transmit power.Hence these are simulation results of the network that is based on connectivity and enhance the performance when clustering is applied.

V. CONCLUSION

In this paper a new solution has been proposed that can be effectively utilized on highway. Here adaptive power is in use. As connectivity introduced transmission power and then clustering routing is applied to enhance the performance. And overall simulation results have been presented. Clustering is the basic topology that is used and DSDV is the basic protocol. In presented work also distance is measure and adjusts the power accordingly. The algorithm is power-adapted, which is an added advantage. Also the performance of the routing is evaluated in NS-2 environment. Simulation results showed that the adaptive transmission power using clustering offers better throughput and lower transmission delay.

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