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A Cluster Approach in Vanet Using Collaborative Learning Automata-Based Routing

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Abstract: Vehicular Ad hoc Network (VANET) could be a taxonomic category of Mobile Ad hoc Network (MANET) where vehicles are simulated as mobile nodes. VANET is an emerging new technology which has some unique characteristics that differs from other ad-hoc network. Aiming at the performance degradation in Vehicular Sensor Networks (VSNs) it causes delay in receiving the emergency alerts. In order to address this problem collaborative learning automata-based routing algorithm (a clustering formation) is proposed for sending information to the intended destination in an effective manner. This approach consists of dividing whole region into completely different clusters, based on which an optimized path is selected using collaborative LA having input parameters such as vehicle density, distance and delay. Performance can also be obtained from the above parameters. The values of these parameters are passed on to the neighboring vehicles based on reward/penalty action. In the reward function, high cumulative weight is assigned for every successful transmission. In penalty function the cumulative weight is decreased for every unsuccessful transmission. The solution of a route depends upon the output produced by LA (Learning Automata) with minimum delay and maximum throughput.

Key words: Congestion control, Learning Automata (LA), performance evaluation, routing, Vehicular Sensor Networks (VSNs)

INTRODUCTION

Now a day's Vehicular Ad Hoc Networks (VANETs) have gained a lot of popularity due to its usage like safety messages alerts in case of emergency etc. Various government and private agencies have invested a lot of money in different projects to improve safety and comfort of the passengers in the vehicle. In all these applications, messages have been broadcasted for various effective operations.

Most of the earlier solutions may work well for low density areas but with an increase in the density of the region under investigation, particularly in dense urban regions, it would be a challenging problem to route the packets due to the congestion in the network. Hence, there is a requirement of an optimized solution which is adaptive with respect to the topological changes due to the high velocity of the vehicles and generated alerts at constant intervals.

Keeping in view the challenges and drawbacks in the existing works which is shown in Fig.1. We propose a CLA based routing, help the community of people to use the rescue operations. In the proposed approach, an automaton learns from its environment and learns the parameters such as vehicle density and distance from Road Side Units (RSUs). Treating these parameters as input variables, the automaton produces an output. The values of these parameters are passed on to the neighboring vehicles in a collaborative manner. The selection of a route depends upon the output produced by the LA by taking into the consideration the vehicle density and distance from the destination in that region.

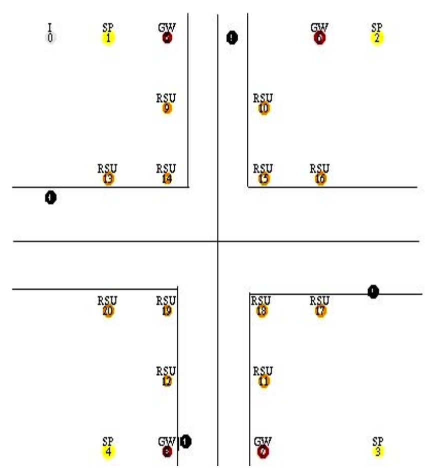

Fig. 1: Existing system model with 12-RSU, 4-Gateway, 4-Service provider and 55 nodes using NS2

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Survey on vanet: Routing in VANET depends upon a number of parameters such as velocity of the vehicle, density of the vehicle, direction of the vehicles etc. These nodes (vehicles) can be considered as a source or destination during routing process and also various other standards have been built to gain this task of routing. With the growing needs of users to access various resources during mobility, efficient techniques are required to support their needs (Dua *et al*., 2014).

Clustering in VANET: As, the vehicles have dynamic nature, vehicular network needs to face many stale entries and congestion. When clustering process is introduced then it reduces all the stale entries and congestion in the vehicular network. It also improves the connectivity in the network (Daeinabi *et al*., 2011).

Mobility based clustering schemes: It considers the mobility, position, direction, speed etc., as the characteristic of the vehicles (Camp *et al*., 2002).

Non-mobility based schemes: The clustering scheme selects the network gateway nodes dynamically according to network topology change in heterogeneous MANET environment. Cluster head takes the decision whether to select or wait for a network gateway node to be selected. Oscillation may occur between two adjacent clusters. In order to avoid this the waiting period will be calculated by comparing its own network address with its neighbouring network address (Harri *et al*., 2006).

Certificate based schemes: The protocol which uses the clustering scheme for certificate generation or revocation approach is classified under certificate based schemes.

Connectivity in interactive vehicles: The techniques improve connectivity to an individual base station. A protocol which reduces disruptions in Wi-Fi connectivity to support interactive applications from moving vehicles (Balasubramanian *et al*., 2008). We find that Wi-Fi minimizes disruptions in connectivity between moving vehicles and a network of BSes. We focus on improving the underlying link-layer connectivity and also improve their user-perceived quality.

Target environment: The characteristic of the design of Wi-Fi is as follows.

Diversity: Moving vehicle will send a packet to the other moving vehicle; it can also be heard by multiple base stations. This leads to the fundamentals for leveraging base station diversity.

Bandwidth-limited communication: The base stations will be able to communicate among themselves whereas in inter base station communication it tends to be relatively thin broadband links or a multi-hop wireless mesh so it is bandwidth constrained.

Caching for data dissemination: There are two regions for data dissemination: sparse and urban. In sparse regions, the connectivity is less among the vehicles due to a minimum existence of infrastructure support. In urban regions, the density of the vehicles on the road is high, so large amount of data is transmitted among the vehicles and infrastructure. In such urban regions, vehicles are required to provide a number of services to the users for road safety, e.g., lane changing warning, signal violation warning. All these services require efficient data dissemination among the vehicles and infrastructure so that it can be transmitted to their destination without delay and transmission error (Fallah *et al*., 2011).

Techniques in caching: To avoid congestion and to reduce the load on the network, caching is widely used (Kumar and Lee, 2014). P2P technique for urban vehicular communication environments is proposed.

The information among vehicles in the network is shared in a P2P manner. The vehicles share the information of taking routing decisions and this information is cached in an efficient manner. The results show that this scheme has reduced the congestion and query delay.

VADD: Vehicle Assisted Data Delivery: Most of the works are limited to one-hop or short-range multihop communication (Aravindhan *et al*., 2014). Network density of the vehicle is related to traffic density which is affected by location and time.

The proposed Vehicle-Assisted Data Delivery (VADD) is based on carry and forward process where nodes (vehicles) carry the packets and forward these packets to the destination. Being different from existing approaches, it makes use of predictable mobility and it is limited by traffic pattern and road layout.

Data forwarding in straightway and destination modes: If there is no vehicle available in the road to forward the packet ahead, the current packet carrier afore mentioned to carries the packet. The packet carrier may decide to take the intersection behind as the target location. Packet switches to the destination node below a predefined threshold (Aravindhan *et al*., 2014).

Cooperative vehicle safety system: Early CVSS solutions work well in low utilization cases at high penetration and for crowded highways, the performance of a CVSS significantly degrades due to DSRC channel congestion (Huang *et al*., 2010).

We analyze how controllable CVSS tracking application parameters such as frequency and range of transmission affect the performance of a VANET and how control schemes based on these parameters can be designed.

Vehicle tracking in broadcast-based vanet: Active safety applications such as collision warning require that a subject vehicle has a good estimation. To this safety tracking purpose, each vehicle is equipped with DSRC radio, GPS and on board sensors. The neighbouring vehicles track the movements of the sender, based on the information they receive over the shared channel. It has been shown that message generation rate can significantly be minimized while still achieving the same tracking performance in non-crowded networks (Huang *et al*., 2009; Kumar *et al*., 2013). In such methods, each vehicle runs a local copy of the remote vehicles estimator of its own position and message generation is based on the perceived error at remote stations.

We focus on the design section more on the effect of different range and rates of transmission, where affect the rate of information delivery to vehicles at different distances from the sender. The first step in designing transmission logic control algorithms is to quantify the effect of range and rate of transmission on the CVSS tracking application (Eriksson *et al*., 2008).

However such an analysis requires including vehicle dynamics and micro level driver behaviour models as well as networking issues that arise from different choices of the rate and range of transmission. Since the overall performance of CVSS, in providing accurate tracking has to be measured, considering all intended receiving vehicles, at different nodes, should be combined to derive a single measure that quantifies the success of the CVSS broadcast application.

MATERIALS AND METHODS

Existing approach

Collaborative learning automata based routing: Most of the earlier solutions work well for low density areas but with an increase in the density of the region it would be a challenging problem to route the packets due to the congestion in the network a requirement of an optimized solution which is adaptive with respect to the topological changes due to the high velocity of the vehicles and generated alerts at constant intervals (Kumar and Kim, 2013).

Table 1: Symbols used

Symbols	Meaning
θ^{old}	Old distance vehicle from RSU
θ^{new}	New distance vehicle from RSU
J^{old}	Old density of the vehicle
J^{new}	New density of the vehicle
L	Current route set
R	Total number of vehicles
Δmp	Transition function

In the proposed approach, automaton learns from its environment and learns the parameters such as vehicle density and distance from Road Side Units (RSUs). The values are passed on to the neighbouring vehicles in a collaborative manner.

The selection of a route depends upon the output produced by the LA by taking into the consideration the vehicle density and distance from the destination in that region (Table 1).

Network formation: The roadmap which serves as a scenario for the warning dissemination, has an important influence in the effectiveness of the process. Therefore, demonstrate the impact that the roadmap will have, over the performance of dissemination processes in VANET's. An urban topology is a graph where vertices and edges represent junction and road elements is considered. Select different roadmaps from real cities using Open Street Map, representing environments with different street densities and average street lengths. Let K= {K1, K2, ..., Kn} represents the current location set of the vehicles; θ = {I1, I2, ..., In}, represents the distance from the neighbouring RSU; J = {J1, J2, ..., Jn} represents the vehicle density set; and L = {L1, L2, ..., Ln} represents the current routes set. GPS can find the current location of the vehicle at any time. Transition function is used to make a flow from one state to another and it is represented by:

$$\delta mp{:}y \rightarrow L \tag{1}$$

where, y = (K, θ, J) are input parameters, $1 \le m \le n$, $1 \le p \le n$. The RHS of Eq. 1 contains the possible routes and ämp is a stochastic function it acts according to the input parameters. Suitable route will be mapped by using the current location, the distance from the RSU and the density. Density of the vehicle is calculated by the number of vehicles in a particular cluster/the total number of vehicles at any instant and is calculated by Eq. 2 as defined in the following:

$$D=\sum_{m=1}^{n} RSm/\sum_{m=1}^{n} ni \quad (2)$$

Where:

RSm = The number of vehicles in cluster
m and ni = The total number of vehicles

For computing the number of vehicles in a region a predefined threshold range of 300m is assumed.

Route establishment: A packet containing the parameters is transmitted to the intermediate node having information about the vehicle's current position, distance, density and total delay incurred in a particular region (Lu *et al*., 2010). This phase is completed by the automaton and corresponding to each action taken by the automaton, it is penalized or rewarded by some constant value based upon which the automaton decides its next action. In the reward function, if the current node is the destination, then cumulative weight is updated. Otherwise, the transition function is used for updating the cumulative weight. Wi(t) is the cumulative weight of these paths as follows:

$$Wm(t) = (1/R\,(n\_q)) \sum_{p=1}^{R(n\_q)} W(p)$$

Where:

n_q = Represents the number of paths from source to destination
R(n_q) = Represents the number of times weight along that path has been computed
W(p) = Represents the weight of an individual path

Similarly to the reward function, a penalty is also associated and it decreases the cumulative weight for every unsuccessful transmission. Along with that, if the newly arrived packet has lower distance and density that has been received in the past, then this packet is accepted by the automaton. All the previously found paths are discarded and the newly found path is considered for inclusion in the final path.

Route selection: Once the route establishment phase is completed, the next step is to select the best neighbours from the routing list using an LA-based approach. Each node learns about its best neighbour which has the minimum value of the parameters so that routing packets can be sent to these neighbours. The estimation of the density of a vehicle in a particular time interval is required so that LA can intelligently select the best path.

Performance evaluation: Here in this section it illustrates the performance evaluation of the proposed scheme.

Table 2: Simulation parameters

Parameters	Values
Nodes	55
X-axis	800
Y-axis	1000
Simulation duration	200 sec
Packet interval	0.1 sec
RSU	12
Number of iterations	10-15
Period of traffic lights	60s
Velocity of vehicles	10-100 km h^{-1}

RESULTS AND DISCUSSION

Proposed approach: In this approach an algorithm which improves the performance of data access through secured cooperative caching technique for VANET whose nodes, exchange data items in a peer to peer fashion is used. A secured caching scheme (technique) is used to reduce the network overhead and also the query delay has been reduced. The cache (available resources) can be efficiently utilized.

When compared to other schemes this technique is different and more efficient. Request a query by vehicle, fg: Query contains vehicle id (fid) and data item id, [id(dic)] = [id(dic), [fid(fic,g)]] where fic, g = {fg |request(dic), g A^dic B}. Where, A = no. of data items, B = no. of vehicles. Reply forwarded to the query source (fg) by the data item provider (fo): [id(dic), [fid(fic,o)], tic,g, T1]] where T1 = [hiTs, M(hi- 1Ts | m)] and tic, F = access time of dic by dy.

Simulation environment: The simulation results show that this system out performs than previously used methods. The proposed scheme was done on Network Simulator and its performance was evaluated. Each vehicle's movement pattern was determined by a Hybrid Mobility Model.

The interval of a packet generations from the vehicles is considered to be an exponential distribution with a mean of 0.1 sec; packets were dynamically generated from 55 nodes in the road network. And then the simulation duration considered to be 200sec in the study is described in Table 2.

By considering the whole network region, nodes will be compared with the Packet Delivery Ratio (PDR). Number of delivered data packet to the destination (Fig. 1). Delay represents the duration from sender to the destination, transmission time that has been taken by the packet after delivery. The delay will be calculated by subtracting the sending time and the receiving time by the nodes (Fig. 2). The ratio between the speed of the nodes (vehicles) and the packet that has been delivered among the nodes. Number of delivered data packet to the destination (Fig. 3).

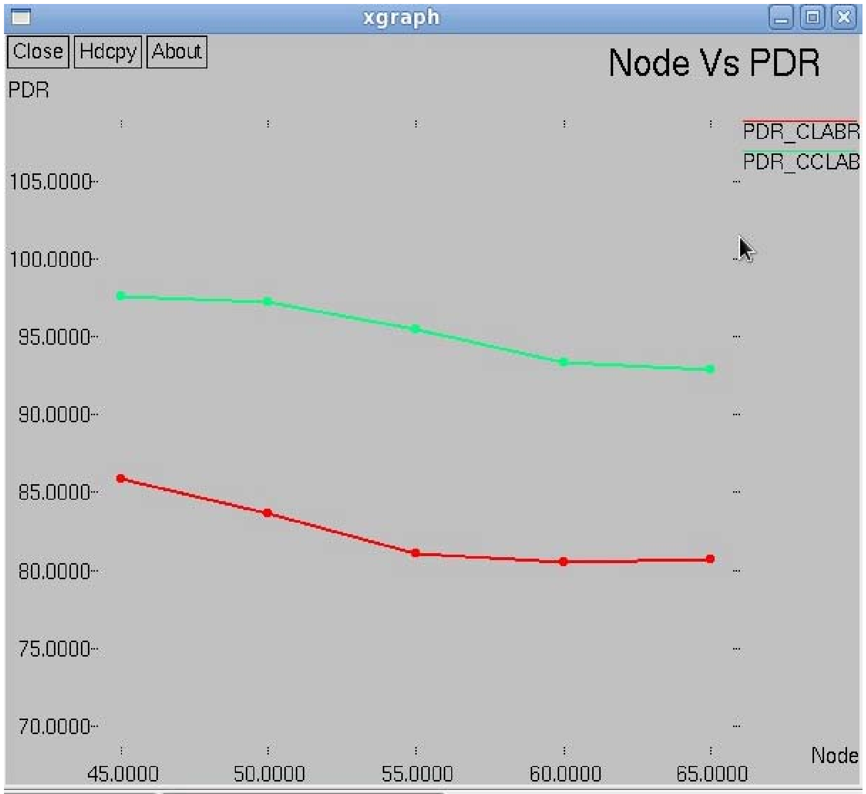

Fig. 2: Node vs. packet delivery ratio

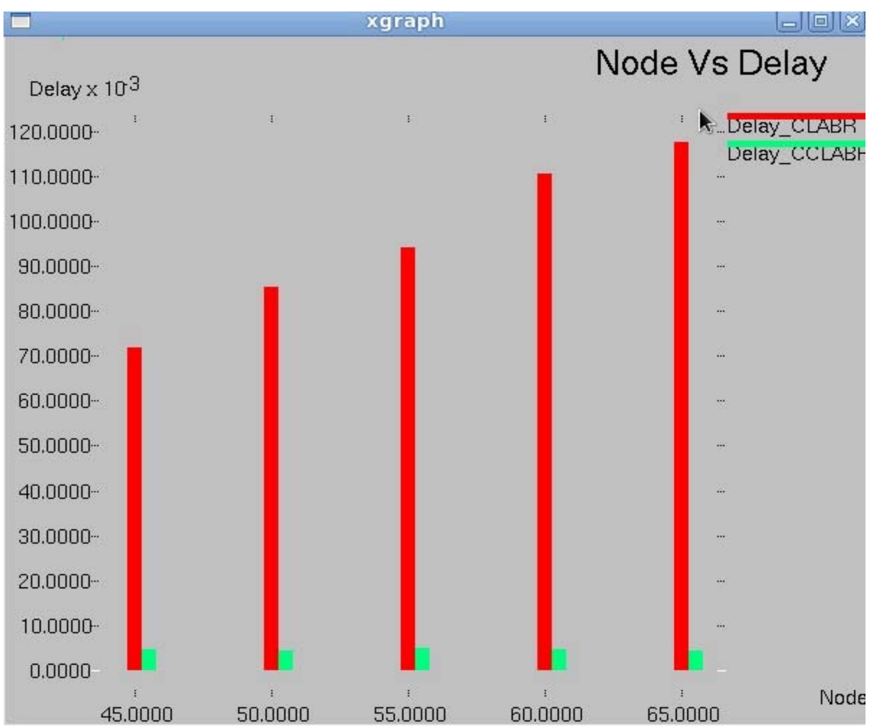

Fig. 3: Node vs. delay (transmission time after delivery)

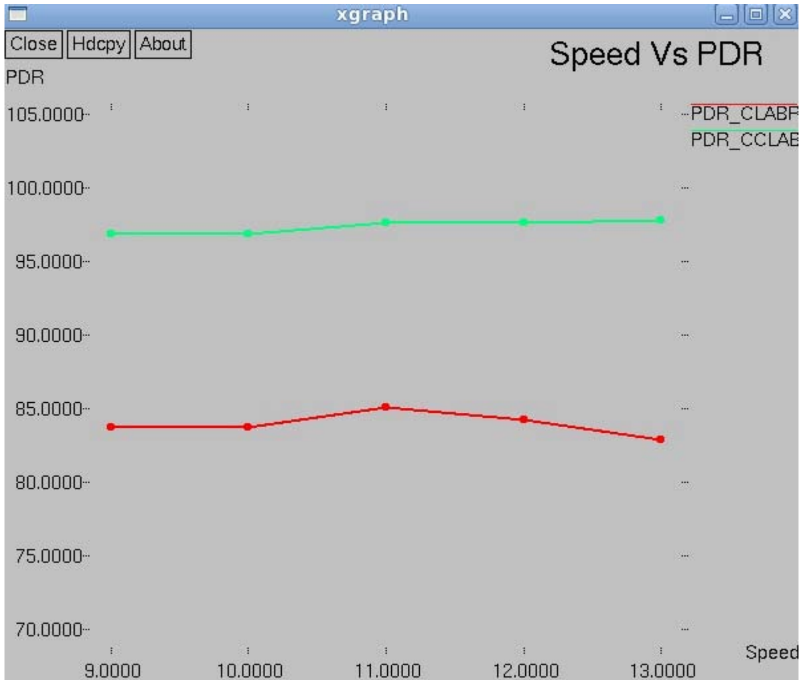

Fig. 4: Speed vs. packet delivery ratio

Fig. 5: Speed vs. delay (transmission time after delivery)

Delay represents the transmission time that has been taken after the packet to be delivered among the speed of the nodes (vehicles). The delay will be calculated by subtracting the sending time and the receiving time by the nodes (Fig. 4 and 5).

CONCLUSION

This study is concluded by the emerging performance metrics of packet delivery ratio and packet delivery delay. Vehicles communicate with one another in a collaborative manner in order to share the information about these variables and intelligently select the best route to reach the final destination. LA selects the best path from the available ones. In the future scenario, effectiveness of the proposed solution, cache consistency and maintenance for adaptive data dissemination in VANET has been explored.

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