

# AODV Extension using Cuckoo Search and Support Vector Machine for Scalable Routing in VANETs

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**Abstract**— Vehicular Ad Hoc network (VANET) creates a network in which a number of vehicles are interconnected through wireless medium. The area of communication of every vehicle is defined with particular distance of approximately 100 m to 300 m. If any of the vehicles goes out of the coverage area, the vehicle came out from the network. The concept of internet over protocol is integrated as the use of internet is increases day by day. The problem on road such as traffic, heavy loads, accidents are becomes the main problem. For the transmission of data from one vehicle to another vehicles, vehicles used sensors that are implemented on board unit and thus with the help of internet the data is transferred. In this research, the network is also protected from the malicious node. As we know that the VANET is an unplanned network, which is formed by the moving vehicles on road and is designed to enhance road safety along with driving condition. In this research, a vehicular network is designed by using 'N' number of vehicles using a network area of dimension (1000\*1000) height \* width. A routing algorithm named as AODV (Ad hoc On-Demand Distance Vector) is used to form a route between source vehicle and destination vehicle. If the performance of the network is degraded it means that there is an occurrence of malicious node in the network. To provide security to the network CS (Cuckoo search) along with SVM (Support vector machine) is used to optimize the route and to detect the malicious vehicle. After finding malicious vehicle, the vehicle is removed from the network and the network is secure.

**Keywords:** VANET, AODV, MATLAB, SVM, PDR, Throughput

## I. INTRODUCTION

VANET is an emerging technique which is growing by integrating the wireless capabilities of network and is used to provide a variety of applications such as traffic monitoring, to control traffic flow, prevention of road accident [1]. VANET is a type of MANET aims to provide useful communication between the arbitrary collection of vehicles in which vehicles are located. Rapidly changing network topology and varying communication terms very rapidly are difficult conditions for routing protocols in VANET [2-4]. The general architecture of VANET of transmitting data between vehicles is depicted in Figure 1.

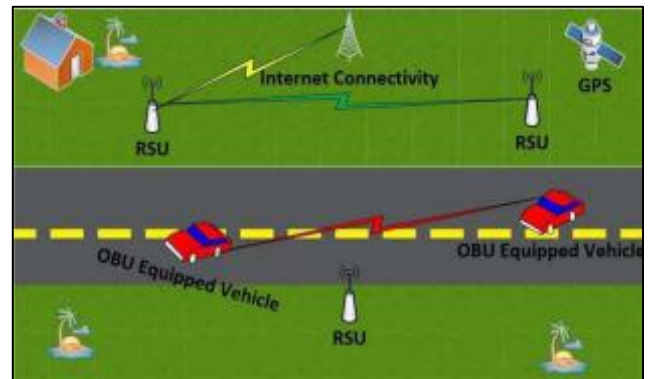


Fig. 1: VANET Architecture [5]

Since the vehicles are changing their position continuously and hence their topology is changed due to this varying nature of VANET, the formation of route becomes a difficult task [6]. The routing algorithms that are based on position and geography are the better methods utilized for inter vehicle communication. These methods lack in the case when the deployment of nodes or vehicles in the network is more complex and are distributed in small random fashion [7]. Therefore, to resolve such problems, we have created route by using the concept of cuckoo search as an optimization scheme with AODV as a routing mechanism. The route between vehicles is formed using AODV as a routing protocol and the best route is selected using a better healthy function of CS algorithm [8].

## II. RELATED WORK

Darwish et al. (9, 2018) have presented a reliable traffic aware routing (RTAR) protocol for the selection of next hop on the road structure. The neighboring units or vehicles on the road received signal strength as well as the information related to the mobility of the vehicle. The performance in terms of PDR, end to end delay has been determined. The routing protocol RTAR is used to take decision while the information packet reached at the intersection area and the decision has been taken to select the best route for the data transmission.

Deepak Rewadkar et al. (10, 2018) have presented Fractional glow worm swarm optimization (FGWSO) an an optimization scheme for VANET. The main aim of this research is to determine an optimal route with minimum traffic delay, which is possible by selecting an appropriate fitness function. The data has been transmitted with a minimum delay of 6.6395 s.

Sergio Correia et al. (11, 2017) have proposed a SDN structure which is based upon VANET. The main objective of this research is to increase the performance of the VANET when the interconnection fails in the presence of a permanent SDN controller. The results have indicated that the proposed work has been performed better in contrast to existing routing protocols, provided that the SDN controller

was not associated with it. With the advancement of the telecommunications industry and the automotive industry, it has emerged that growth in the IT industry is important for VANET. SDN has prioritized the UTS by providing software and convenience for the network through a logical centralized management network with a network-wide view.

Penglin Dai et al. (12, 2016) have proposed a VANET infrastructure that comprises of Road Side Unit (RSU) for the transmission of information and the data of RSU's have been updated by using the V2I (vehicle to infrastructure) scheme. Multi objective evolutionary algorithm has been designed to resolve the problem of Pareto and also the requirements for the system has been examined.

Kulla et al. (13, 2018) have presented a VANET structure in which the route formation is performed using AODV as a routing protocol. The main objective of this research is to find the most appropriate route based on the lifetime of links. The designed algorithm has determined the interconnection lifetime between the two running vehicles. The value which is predicted on the basis of relative speed among the vehicles is used to determine the route lifetime and the route is selected. Using AODV routing protocol, the RREQ packet is responsible to carry out the speed information whereas the RREP packet is responsible to carry the lifetime information. At last, the parameters such as PDR, throughput of the network have been calculated.

### III. PROPOSED WORK

In the proposed work, Cuckoo Search Algorithm along with the SVM has been introduced to achieve better performance as compared to the other protocols. AODV [14] is used as a route formation algorithm and the route is optimized using CS algorithm which is then selected using a classification technique SVM and then data transmission takes place. Hybridization of the SVM along with the CS [15] has been performed in order to minimize the problem related to the routing protocols and also to reduce the energy consumption rate of the simulation work. Following steps are performed to establish route and then for data transmission.

1) STEP 1: To design a network on the basis of certain width and height of the network.

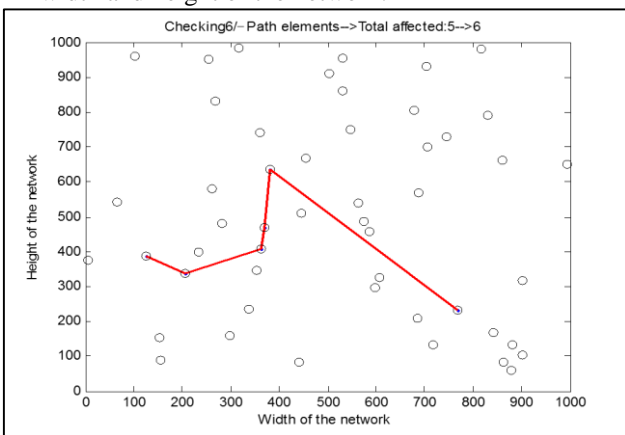


Fig. 2: VANET

The network for VANET has been designed with 1000 square meter of width and 1000 square meter of height as shown in Figure 2.

- 2) STEP 2: Initialize the V number of vehicles within the network
- 3) STEP 3: Define source vehicle and destination vehicle from the initialized vehicles.
- 4) STEP 4: Set the coverage area for each vehicles to define the transmission range.
- 5) STEP 5: Develop a code for routing protocol to create a route from the source node to the destination node using AODV as a routing mechanism.

#### A. AODV Mechanism

Using AODV routing mechanism three types of messages are used (i) route request, (ii) route replay and (iii) route error as a control message.

When the source vehicles want to communicate with other vehicle, it broadcasts RREQ message, if the nearby vehicle has the address of its destination vehicle then it send back a RREP message otherwise forward message to its nearby vehicle. In this way, final vehicle is found out and route is formed.

During the route discovery process, AODV floods the entire network with numerous controls packets and, therefore, find many unused routes between source vehicle and destination vehicle. This is a major drawback for AODV as it consumes more bandwidth, energy and hence increased overhead.

To overcome this problem an optimization scheme named as CS algorithm has been used. This method is responsible for the selection of best route among the multiple routes on the basis of energy consumption and delay [16].

6) STEP 6: Analyze the performance of simulation work on the basic of QOS parameters if required the optimized the path using the Cuckoo Search Algorithm.

#### B. Cuckoo Search Algorithm

CS has been developed by Yang and Deb in 2009. They get inspired by natural behavior of cuckoos, special the obligate brood parasitism of some cuckoo species by laying their eggs in the nests of other host birds. According to the rule, every egg in the nest indicates a candidate solution. Thus in original form one candidate can lay only one egg in their nest but in general, multiple eggs representing a set of solution. The main aim of CS is to provide a better solution in the current net population. On the basis of objective function their quality has been measured.

7) STEP 7: Set the objective function of the Cuckoo Search Algorithm according to the requirement [17].

8) STEP 8: On the basis of the hybridization of the Cuckoo Search Algorithm along with the SVM, the route is optimized and the best and optimal route for the data transmission in VANET has been determined.

#### C. SVM

SVM is a supervised machine learning approach, which is used to select route among the best optimized route. In this technique, every data is plotted as a point in n-dimensional space. The point comprises of the feature value of every point. The feature values are optimized by using CS algorithm in this case. A hyper plane is drawn between the data points in order to determine the classes of every data point [18].

9) STEP 9: At last, we will calculate the performance parameters of proposed simulation work and compare with existing work.

The designed algorithm is written below.

Algorithm: Hybrid Routing Protocol

Required Input: Number of Vehicles (V), Source Vehicles ( $V_S$ ) and Destination Vehicles ( $V_D$ )

Obtained Output: Optimized and validated route from  $V_S$  to  $V_D$

- 1) Start Routing
- 2) Vehicles (V) start broadcasting of RREQ messages to neighbour vehicles
- 3) Defined a message for RREQ=[  $V_S$ , Hop Count,  $V_D$ ], At initially Hop Count = 0
- 4) Broadcast RREQ to Neighbours Vehicles and record Hop Count
- 5) Neighbour UAVs Receive RREQ and check requirements
- 6) If [ $V_S$ , Hop Count,  $V_D$ ] == Neighbour Vehicles [ $V_S$ , Hop Count,  $V_D$ ]
- 7) Route = Neighbour V is a  $V_D$
- 8) Each Vehicles Send RREP to  $V_S$
- 9) Hop Count = 1
- 10) Else
- 11) Route = Neighbour Vehicles
- 12) Send RREP to  $V_S$
- 13) Hop Count = +1
- 14) End
- 15) Update and repeat step 3 to 13 until  $V_D$  not founded
- 16) Possible Route,  $R = R_1, R_2, R_3, \dots, R_N$
- 17) For r in range of R
- 18) Current Route,  $R = R(r)$
- 19) Calculate to distance (D) from  $V_S$  to  $V_D$
- 20) If D is minimum then
- 21) Final route,  $FR = R(r)$
- 22) Else
- 23) Check next route condition
- 24) End
- 25) End
- 26) To optimized the FR, Cuckoo Search Algorithm (CSA) is used
- 27) Set up basic parameters of CSA: Population of Egg (E) – Number of Vehicles

Final Route (FR) – Route from  $V_S$  to  $V_D$   
Fitness Function:  $F(f) = \begin{cases} 1; & \text{if } V_P < \text{Threshold}_P \\ 0; & \text{Otherwise} \end{cases}$

In the fitness function,  $V_P$  : is properties of current vehicle which are in FR and  $\text{Threshold}_P$  is the threshold properties of all communicating vehicles which is define on the basis of energy and distance

- 28) Calculate Length of Route in terms of R Length
- 29) Set, Optimized Route,  $OR = []$
- 30)  $V_S$  is first vehicle of Optimized Route,  $OR(1) = V_S$
- 31) For i in rang of R Length
- 32)  $C_{Egg} = FR(i) = V_P //$  Current Egg from E
- 33)  $T_{Egg} = \text{Threshold}_P //$  Current Egg
- 34)  $F(f) = \text{Fit Fun}(C_{Egg}, T_{Egg})$
- 35)  $Vehicles_{Prop} = \text{CSA}(F(f), FR(i))$
- 36) End
- 37) Index = Find index of  $Vehicles_{Prop}$  in FR

- 38) If index of route is normal then
- 39)  $OR(i) = FR(\text{index})$
- 40) Else
- 41) Mark as faulty route
- 42) End
- 43) Call and set the SVM using OR properties as training data (T), number of V as group (G) and Kernel function (RBF)
- 44) Set,  $VANET\_Structure = \text{SVMTRAIN}(T, \text{Group}, \text{RBF})$
- 45) Current Vehicle,  $V_C =$  Properties of current vehicle in VANET
- 46) Vehicle Characteristics =  $\text{SVMCLASSIFY}(VANET\_Structure, V_C)$
- 47) If Vehicle Characteristics is valid then
- 48)  $OR = \text{Validated}$
- 49) Else
- 50)  $OR = \text{Need Correction}$
- 51) End
- 52) Returns: OR as an optimized and validated route from  $V_S$  to  $V_D$
- 53) End

#### IV. RESULT AND DISCUSSION

MATLAB simulator is used to design a hybrid CS with SVM based VANET. The performance of the network is measured on the basis of PDR and end to end delay.

Data Packet Sending Rate (s)	End-to-End Delay (s) (AODV)	PDR (%) (AODV)	End-to-End Delay (s) Existing (RTAR)	PDR (%) Existing (RTAR)
0.1	0.075	98.5	0.083	97.2
0.2	0.061	98.6	0.064	97.2
0.3	0.038	98.8	0.049	97.3
0.4	0.030	98.9	0.032	97.4
0.5	0.019	99.1	0.02	98.6
0.6	0.025	99.3	0.028	98.7
0.7	0.022	99.2	0.026	98.5
0.8	0.021	99.7	0.024	97.8
0.9	0.012	98.8	0.01	97.2
1.0	0.007	98.9	0.008	97.5

Table 1: Computed parameters with average vehicular density scenario

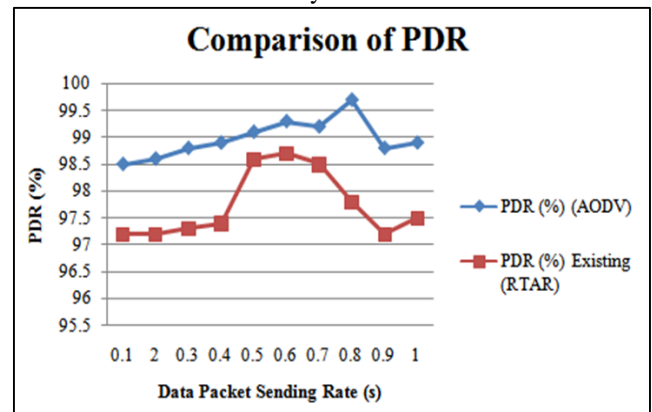


Fig. 3: Comparison of PDR

The comparison of PDR with respect to data packet sending rate has been depicted in Figure 3. The red and the

blue color lines represent the PDR obtained after the transmission of information between vehicles. From the figure it is clear that the proposed algorithm attain higher PDR compared to existing algorithm. This is due to the appropriate selection of route by designing a novel fitness function for CS along with the selection of route using SVM. The average percentage of PDR obtained for proposed VANET structure and for existing VANET are 98.98 and 97.74 respectively. Thus, it is clearly scene that the PDR for the proposed work has been increased by 1.27%.

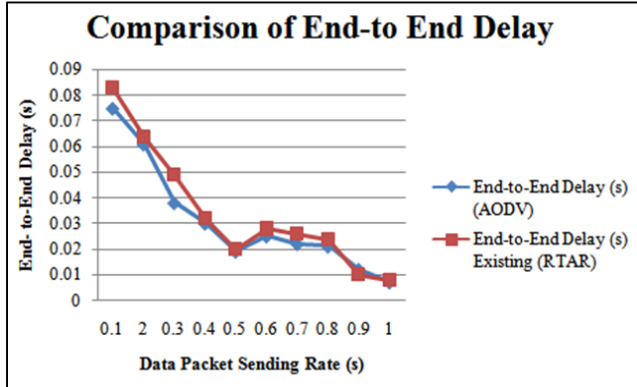


Fig. 4: Comparison of End- to- End Delay

The comparison of end-to-end delay of the proposed work using AODV as a routing protocol with existing work in which the researchers have used RTAR as a routing protocol has been presented in Figure 4. From the graph it is clearly scene that with the increase in the data packet sending rate, the delay for data transmission has been reduced and become minimum when data packet sending rate is 1s. The average of end to end delay observed for proposed and existing work is 0.031 s and 0.034s respectively. Therefore, there is a reduction of 8.82 % while using AODV with CS and SVM approach. The delay rate decreased due to the proper selection of route between the transmitting vehicle and the receiving vehicle.

## V. CONCLUSION

In the proposed research work, we are increasing the performance of the vehicular network by optimizing the route by using the CS as an optimization algorithm. AODV routing protocol has been used to find the path from source to destination. But in case of packet drop or due to the failure of route due to any reason, the route has been optimized by using the healthy function of CS algorithm.

Also, to provide a secure network, we have used SVM algorithm. This algorithm helps to store the properties of each and every nodes present in the network into the database. Whenever, a new node with different property is finds in the network, it is defined as malicious node. This is possible by comparing the properties of every node that are responsible for the communication. In this way the malicious node is determine and the vehicular network is protected. The performance of the proposed work is measured in terms of packet delivery ratio (PDR), and throughput. The average value of PDR and end-to-end delay have been measured and compared with the existing approach. From the comparison it has been determined that the PDR has been increased by 1.27% and the end to end delay has been reduced by 8.82 %.

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