IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-9, Sept. 2018 E-ISSN: 2347-2693

A Hybrid Routing Protocol Based on Route Optimization Mechanism for VANET

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Available online at: www.ijcseonline.org

Accepted: 23/Sept./2018, Published: 30/Sept./2018

***Abstract*—**In this paper, an efficient routing algorithm along with an optimization technique named as CS (Cuckoo search) is used. CS is a metaheuristic algorithm that is used to find the best route between the source node and a destination node, on the basis of healthy function. The properties of each node on the basis of energy consumption and distance basis are found out. Therefore, the node that has efficient energy, to forward the data, along with the smaller distance is selected and hence data packets are forward to that next node. In this way, the process is continuing and the data is delivered successfully to the destination node. At last, the performance parameters such as PDR (packet delivery ratio), data overhead and delay is measured.

***Keywords*—**VANET, Cuckoo search, Routing algorithm

I. INTRODUCTION

VANET is a scheme in which the moving vehicles acts as a node and interconnected with each other to form a network[1]. In VANET each vehicle within the range of 100 to 300 meters is participating to form a wireless route by making interconnections among them [2]. The car or vehicles that came out of the range break connection and the car that comes under the defined rage (110 to 300m) makes the connection [3]. In this way, a network is created. Here the VANET network is different from the MANET (Mobile area network) because the vehicles are communicating with its neighbour vehicles depending upon the road topology during their movements and hence can be able to predict the future positioning of the vehicle [4]. The architecture of VANET is mainly categorized into three domains named as the mobile-domain, infrastructure-domain and the generic –domain [5]. The mobile domain again subdivided into two types named as Vehicle domain and Mobile-device domain. The vehicle –domain consist of all types of vehicles such as a car, truck, bus, motorbike etc [6]. The mobile device domain consists of devices such as a Smartphone, computer, and personal_ navigation devices [7]. The infrastructure domain again sub-divided into two sub parts such as Roadside and Central infrastructure domain. The roadside domain includes components that are place across the road sides such as traffic light. The central infrastructure domain consists of central processing unit that collects data and manages data [8]. Moreover, the architecture of VANET varied as per the site. The communication network used in Europe is known as Car-2 Car that comprises of ad-hoc, in vehicle and infrastructure domain [9].

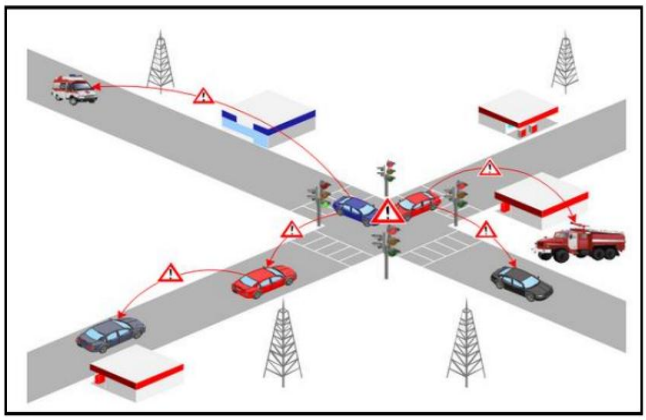

Figure 1. VANET system domain

The paper has been recognized as in the first section, a brief introduction of VANET is provided. In section II, the work performed by various authors in the field of VANET is discussed. In section-III, the flow of the research work is demonstrated along with various algorithms. Section-IV, comprises of the description of results along with the comparison with the existing techniques. Section-V, provide the overall conclusion of the proposed work followed by references.

II. RELATED WORK

In this section, Vijayakumar et al. (10, 2018) proposed an effective privacy prevention algorithm which is based on the use of signature for VANET which is used to make an essential element of IoT Internet of things) along with the progress of smart cities. Balico et al. (11, 2018) Proposed a localization approach to resolve the highly secure and accurate localization data in VANET. The future position of the vehicle has been determined along with the future time by utilizing the concept of "future time-space window".Suleiman et al. (12, 2018) presented a flexible simulation environment used in VANET. The work has been performed in MATLAB simulator tool that consists of MATLAB's statics along with machine learning algorithms. The performance of the proposed method has been evaluated by using different routing protocols such as multi-tier routing, instant routing, delay tolerant and adaptive routing. Ding et al. (13, 2018) proposed a routing protocol which considered mobility status along with MAC layer contention information. In this paper, the proposed routing algorithm has been used to determine next hop by forwarding mobility information with MAC protocol. Also, the comparison of the proposed routing protocol with different existing routing protocol has been performed. The performance has been analysed by using different vehicle speed (30 km/h and 80 km/h). The parameters such as an end to end delay, PDR and broken link have been analysed. Baker et al. (14, 2018) presented a Greed intelligent based reactive routing protocol named as AODV (Ad-hoc on demand distance), which has been used to select an appropriate route on the basis of energy consumed by nodes in VANET. The work has been examined in the city map-based VANET scenarios. Bagherlou et al. (15, 2018) presented a routing approach that is based on the clustering scheme. The cluster of vehicles has been formed on the basis of node degree and the area coverage by the vehicle. The selection of CH (cluster head) has been performed by using the neural network as a classifier. The performance in terms of route discovery process and PDR has been examined.

III. METHODOLOGY

The working of the proposed protocol is as given below:

Steps 1- Initialize n number of nodes: Initialized number of nodes such as 20, 50 and 100 nodes for three different scenarios in the area of 1000x1000 m^2.

Step 2-Route Discovery: In the route setup phase, each node acquires its metadata of the neighbourhood. This metadata is used in the route discovery to find the best next-hop node towards the destination node. The route discovery is activated whenever a source wants to transmit data to a destination in an on-demand fashion that prevents multiple interferences between source and destination. The route maintenance phase handles path failures during data transmission. In the route setup phase, source node initiates a data transmission for forwarding packets to the destination. Each node in a VANET obtains its metadata of the neighbourhood. Whenever a source node wants to transmit data to a destination, the route discovery phase is initiated to find an optimized path from the source to destination. The algorithm used for the route request is written below:

Algorithm 1: Route Requests (RREQ)

Input: RREQ Packet
Initialize Residual Eenergy=0.
For each Neighbour when received an RREQ Packet
If Neighbour is an intermediate node then
    Calculate Residual Energy
    Store in RT (Routing Tables)
    Forward RREQ packet to the Next Hop
Else if Neighbour is destination node.
    send RREP to the source node S
End of if
End of if
End of for

Step 3- HyBr based Routing: It is a hybrid protocol that combines geographic routing based on Global Positioning System (GPS) to establish routes, with topology-based routing which discovers paths using network topology data.

Step 4-Cuckoo Search based Selection:
The cuckoo search algorithm is applied to search the best route and work in an efficient way in denser and crowded area. The properties of the nodes on the basis of energy consumed by each node and on the basis of the node's position have been determined. On the basis of these properties, route is formed between source and destination. The route selection algorithm is written below:

Algorithm 2: Route Selection

Input: RREP Packet
For each selected path when received an RREP Packet
If Neighbour is an intermediate node then
    Forward RREP packet to the Next Hop
Else if Neighbour is Source node.
    Then improved HyBr based on Cuckoo Search is used to select the best path.
End of if
End of if
End of for

IV. RESULTS AND DISCUSSION

The proposed work has been performed on the NS-2 simulator tool for various network scenarios. The experiment has been conducted on three different network scenarios: in the first case, 20 nodes have been considered in the network,

in the second case, the network considered 50 nodes and in the third case, the experiment has been performed using 100 nodes. The network of 1000 ×1000 square meter has been considered. The performance of the network throughput, bundle distribution rate and End to End delay. The setup scenario is listed in the table below:

Table 1. Simulation Setup

Simulation Parameters	Values
Area	1000x1000
No. of nodes	20, 50,100
Speed	0~50m/s
Traffic	CBR
Packet Size	1000 bytes
Packet Rate	250k/s
Pause Time	500s
Simulation Time	1000s
Max Connection	40

Table 2.Packet Delivery Ratio

Routing protocols	20 nodes	50 nodes	100 nodes
AODV	0.93	0.89	0.84
HyBR	0.96	0.93	0.85
Cuckoo_HyBr	0.97	0.96	0.88

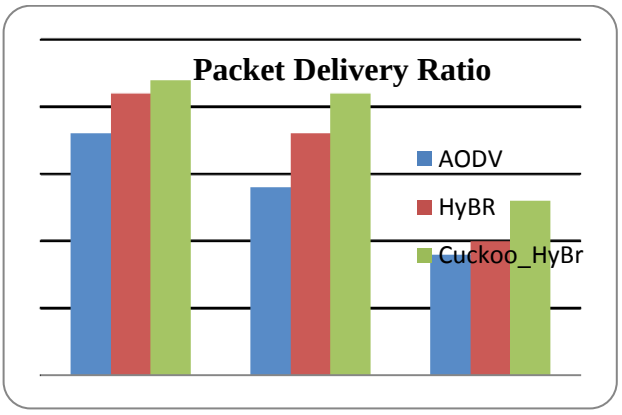

Figure 2. Performance Metrics (PDR)

The figure represents the PDR values that have been observed for three different scenarios in NS-2 simulator. The proposed technique that used cuckoo search algorithm along with hybrid technique has been compared with the routing protocol AODV and Hybrid. Here hybr is the routing protocol that works by integrating the two algorithms (geographic routing and Global Positioning System (GPS)) to establish routes. The average values of PDR measure by using the AODV routing protocol using 20, 50 and 100 nodes are 0. 93,0.89, and 0.84 respectively. It is observed that when Cuckoo with Hybrid algorithm is applied in the proposed VANET system the PDR from existing techniques AODV is improved by 4.3%, 7.87% and 4.76% for 20, 50 and 100 nodes respectively.

Table 3. Overhead

Routing protocols	20 nodes	50 nodes	100 nodes
AODV	0.44	0.59	0.68
HyBR	0.44	0.48	0.65
Cuckoo_HyBr	0.4	0.45	0.61

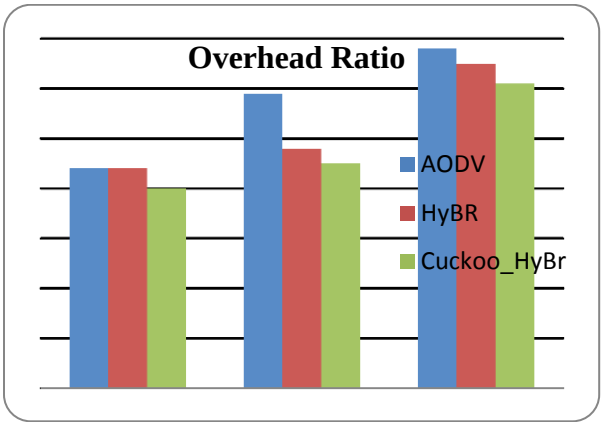

Figure 3. Performance Metrics (Overhead)

The above figure represents the graph observed for three different cases: (i) 20 number of nodes (ii) 50 number of nodes and (iii) 100 number of nodes. The blue bar represents the values of overhead observed while the AODV routing protocol is implemented. From the above figure, it is clear that as the number of nodes is increased the overhead ratio also increases. The Overhead of this proposed protocol is 7% improved if we compare with both AODV and HyBr.

Table 4. Delay

Routing protocols	20 nodes	50 nodes	100 nodes
AODV	0.36	0.4	0.46
HyBR	0.33	0.35	0.42
Cuckoo_HyBr	0.26	0.3	0.35

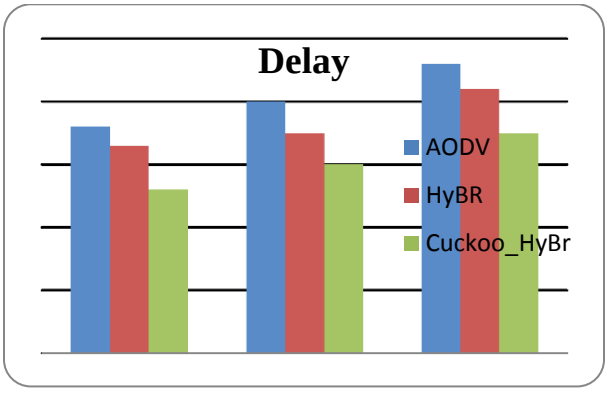

Figure 3. Performance Metrics (Delay)

The figure 3 represents the values of delay measured by three algorithms for three different scenarios are shown the graphical form. The results show that the performance of the proposed Cuckoo based HyBr is better than both AODV and HyBr. The Delay of this proposed protocol is 25% improved if we compare with AODV and 17% improved from HyBr include important findings discussed briefly. Wherever necessary, elaborate on the tables and figures without repeating their contents. Interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. However, valid coloured photographs can also be published.

V. CONCLUSION AND FUTURE SCOPE

The main aim of this work is to increase the efficiency of the VANET system. In this paper, the problem appears in VANET network while using the existing routing protocols have been overcome by using Cuckoo search with HyBr routing protocol. CS is a Bio-inspired method that is more efficient for large-scale vehicular networks due to the similarity between the manner of finding VANET routes and species behaviour to satisfy their natural needs like the discovery of food source paths for Ants or Bees. Bio-inspired bee swarm routing protocol (HyBR) improves the performance as compared to the traditional routing protocol i.e. AODV. But as the traffic increases Normalized Overhead Load of the network also increases. So to help this out a new hybrid protocol is designed that is based on Cuckoo Search optimization. The new protocol is made to work in denser and crowded areas. Cuckoo Search Optimization offers quality solutions converging quickly compared to other population-based optimization algorithms like GA. The new proposed system was simulated on the network simulator Ns2 for different network scenarios. The results calculated from the simulation outputs shows that the new system improved the performance of the existing system.

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