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Design and Simulation of Efficient Dynamic Data Forwarding Protocol Towards Route Optimization in VANET Infrastructure

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Abstract:

Internet of Vehicles (IoV) is the recent implementation of VANET which is composed of Internet and Internet of Things (IoT). It supports the user with traffic information of the environment using vehicle network in AdHoc manner. VANET is combination of vehicles network employed for data communication as infrastructureless network especially for infotainment purposes and emergency notification of the vehicles communicating. Internet of vehicle provides the traffic information of the vehicles in terms of traffic congestion, details of vehicle collision, data communication delay, data transmission errors, and a data or packet delivery ratio. In this paper, an unmanned aerial vehicle (UAV) is employed for route optimization problem in VANET architectures for efficient data communication. In order enhance the efficiency of the packet or data routing, diverse routing protocols are employed. In this work, Optimized Link State Routing (OLSR) Protocol is employed with energy efficient strategies on multiple parameters to mitigate the routing issue and produces efficient path for efficient data communication with good network stability. Extensive simulations are conducted using NS2 simulator on multiple parameter of the network to assess the effectiveness of the proposed routing approach on varying network sizes. The performance outcomes of the proposed data routing approach using OLSR protocol attains increased efficient paths on comparing with conventional routing protocols along UAV-based protocols for data communication. Finally proposed routing protocol yields better results with respect to message throughput, message delivery ratio, latency and network overhead on comparing with existing routing protocols.

Keywords — **Internet of Vehicles, VANET, Route Optimization, Unmanned Aerial Vehicles, Artificial Intelligence.**

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I. INTRODUCTION

IoV is the recent implementation of the VANET for efficient data communication on incorporating the Internet and Internet of Things (IoT). Vehicle Adhoc Network (VANET) is a infrastructureless kind of wireless network to support the data communication among the vehicles interact on the roadside within a short distance [1]. VANET is classified into class of Mobile Adhoc NETwork (MANET) as considered as subclass of Wireless Adhoc NETworks (WANET). Mobile vehicles in VANET architecture works in two primary representation modes: Vehicle-to-vehicle (V2V) communication architecture and Vehicle to Infrastructure (V2I) communication architecture [2]. In the vehicle to vehicle architecture, the vehicles communicates the message with each vehicle in the network to communicate the data using Dedicated Short Range Communication (DSRC) protocol, while in the Vehicle 2 Infrastructure architecture model, the communication between vehicles is carried out on the roadside units [3].

Vehicular Adhoc Network has an extremely effective topology against changing the speed of the vehicle, changing the vehicle counts, and changing the direction of the vehicles [4]. VANET is to gather the traffic information of the roadside towards mitigate the issues like traffic congestion and vehicle collision on providing more reliable path which eliminate the network delay occurring by the traffic congestion [5]. Further many network issues which results in unreliable communication such as mobility issues, short range of vehicles, and infrastructure installation cost can efficiently handled using the routing protocols along other critical issues like road obstacles which makes communication difficult due to physical hindrance for vehicles to communicate efficiently[6].

Efficient data communication is carried out using several routing techniques like genetic algorithm, particle swam optimization and ant colony optimization which belongs to artificial intelligence approaches [7]. In this paper, a unmanned aerial vehicles which act as sink has been incorporated with VANET for efficient data communication with reliability and stability. Routing is carried out using optimized link state routing protocol to obtain the shortest path for data communication. Further it is optimize using multiple strategies with multiple parameter of the network to yield better performance compared to traditional optimization routing model. Finally performance of the proposed model has been compared various network parameter on varying network sizes [8].

The remaining paper is sectioned into following parts is as follows: Section 2 discusses about the conventional data routing mechanism along optimization strategies to unmanned aerial vehicle clustering architectures. Comprehensive specification of proposed architecture for stable and reliable path planning routing technique has been presented in the section 3. The network simulation results of VANET and performance assessment using different performances metric with respect to conventional were highlighted in the section 4. Finally paper has been concluded in Section 5 with providing future work.

II. RELATED WORK

In this part, Efficient Message routing approach for route planning on unmanned aerial vehicles network has been investigated in depth on basis of UAV deployment, clustering of the vehicle nodes and optimal path finding for message transmission between vehicles. All those routing techniques have been assessed on its performance by varying the network size and node direction. Further the routing model which nearly equivalent to the proposed model is described as follows

A. *U2RV: UAV-assisted reactive routing protocol for VANETs*

In this architecture, stable data routing and durability of the connectivity has been increased towards point to point communication. Proposed models manages the network issues such as frequent link failures and network partitions on network comprising during the movement of the mobile vehicles moving and frequent direction changing[9]. Proposed model will reckless response to the various topology changes to overcome the limitation of the path planning on incorporation of ad hoc mode with drones that are commonly called unmanned aerial vehicles (UAVs)it.

III. PROPOSED MODEL

In this part, VANET topology and incorporation of Unmanned Aerial Vehicle which acts as message sink for effective data transmission among moving vehicles has been constructed as efficient infrastructure. Further, numerous routing strategies has been projected to develop a architecture with optimization technique utilizing the artificial intelligence towards generating optimal path for message deliveries. Particular architecture is as follows

A. *Network Infrastructure*

Vehicles Nodes and Aerial node acting as Sinks used for data communication details of the specified infrastructure has been provided as follows

1. Node Deployment

In this work, Vehicle Adhoc Networks Composed of the set of moving vehicle is represented as M = {m1 , m2 , … , mn}. Various vehicles may be embedded with varied transmitter and receiver elements, each of which constitutes the different data collection and transmission modes. All vehicles in the network are distributed dynamically over a specified region R of UAV. The data collection and communication radius of the vehicle is represented as r and 2r, respectively [10].

2. Unmanned Aerial Vehicles

Unmanned Aerial Vehicles which acts as Sink composed of dynamic moving vehicles which is prefixed to reach vehicles and collect message from the vehicles is depicted as M = {m1, m2, …, mn}. The UAV is battery powered and its purpose to reach the each vehicle in circular passion. A circle initiates when the UAV leaves source vehicle and ends when the UAV returns to the destination vehicle. Let N0 denote the vehicle nodes at source. Tree topology will be established for message collection from source vehicle nodes and transmits to the collection point which acts as destination vehicle node[11].

B. *Message Collection Point*

Let C = {c1 , c2 , ⋯ , cm} represents the identified list of collection point of UAV to gather the message or information from the vehicle through UAV. Let π = (p0 , p1 , … , pm, p0) represents the established path which propagates through each pi□P and reaches the destination vehicle node p0. The m UAV collection points will manage the entire collected message from other vehicle and transmit the collected data to the destination vehicle through UAV. The message will be transmitted from source vehicle to UAV collection point in hop by hop propagation to decision vehicle [12].

C. *Path Selection*

In this part, Clustering of vehicles has been established for efficient data communication using UAV. Vehicle Nodes are arranged into clusters with respect to vehicle movement and quality of the vehicle link computation using KNN clustering [13]. Each Vehicle Nodes represented either to as a cluster head or a cluster member in a distributed manner on no of the vehicle nodes and frequency of nodes changing the direction. Cluster head will plan the path for data communication containing the traffic information of the environment through UAV.

Algorithm 1: Path Planning Algorithm

```
Projection of the Network
  V is number of Vehicle in the network
  C is number of clusters for path planning
Fix Path =V/C
Estimate ()
  for J =1 to V
{
    for K = 2 to x
    Incorporate the Vehicles Nodes in the Cluster groups on basis of UAV
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D. *Dynamic data forwarding strategies*

UAV acts as sink that visit all the moving vehicles on basis of frequency of direction changes. It computed on basis of optimal parameter and strategies. Instead, it calculates some moving about the critical issues on the selected points which are accessible to the other nodes and UAV. In addition, fitness function of the routing algorithm optimization determines the sequence for UAV sink to collecting that node information will increase the data communication in terms of message delivery with high stability and less latency[14].

Algorithm 2: Dynamic data forwarding algorithm

For UAV=1 to Max Node
  For each Vehicle Node
do
    Compute Fitness F(vehicle Nodes) $= \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$
    If Fitness is better than Threshold
      Transmit the Data
    end
  end
Strageies = S(s1,s2,s3);
  For each Strageies Sn in S
    Determine the optimal Path

In a multi-hop vehicle AdHoc Network transmission system, the lesser the variation in transmission distance among vehicle, the best the reliable and stable message delivery on vehicle AdHoc system.

IV. SIMULATION RESULTS

In this part, Proposed VANET architecture has been simulated with detail description of UAV assisted VANET through NS2 Simulator [15]. Extensive experiment exploits the numerous performances outcomes with its comparison with conventional techniques. The performance of the proposed approach has been illustrated with the network properties and measures of the network performance in terms of Message Throughput, Message delivery ratio, Network Overhead and latency. In this Simulation, the network set up along definition of network parameter is mentioned in the following table 1

TABLE –SIMULATION PARAMETER

Simulation Parameter	Value
Network Simulator Tool	NS2
Network Topology Size	300m *500m
Number of vehicles	50
Network Bandwidth	2Mbps
Message length	100 bytes
Simulation Time	30 minutes

The mobile sink's moving path for message delivery on reference to the cluster head has been computed for path selection. Figure 1 illustrates the simulation of the proposed network model with UAV as sink.

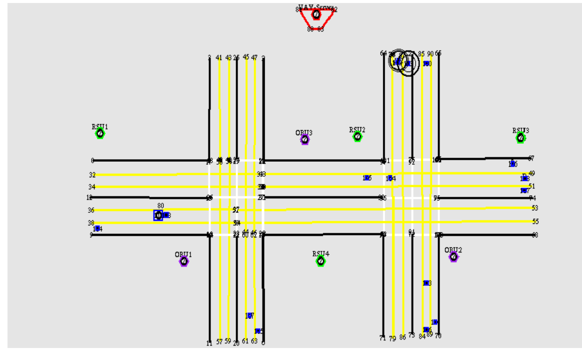
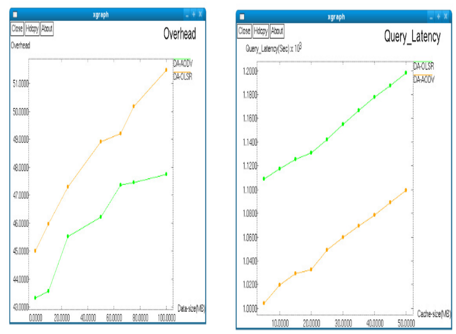


Fig1: Proposed Protocol Simulation

Each node computes the traffic information on its environment and transmits as message on data request by other vehicle. The performance of the network on varying the network size and moving node speed has been computed on basis of the latency and overhead in the figure 2 for frequency changing direction of the nodes.



(a)

(b) (

Fig 2: Performance Analysis of the protocols with respect to (a) Overhead and (b) Latency

The observations indicate that the proposed approach can identify optimal path for message delivery in less time span in case of unexpected node failure. Further increase of throughput of the model will be achieved due to incorporation of the path planning strategies as optimization to protocol. Therefore, the number of engaging vehicle node for data transmission is calculated for effective data transmission on the UAV sinks. Figure 3 represents the performance of the model against throughput and delivery rate.

(a) **(b)**

Figure 3: Performance Analysis of the protocols with respect to (a) Delivery Rate and (b) Throughput

The proposed routing techniques examine the efficiency of the vehicle and the optimal path for message delivery with shortest hop count on ensuring data reliability and stability of the proposed network.

TABLE 2 – PERFORMANCE EVALUATION OF THE PROTOCOL AGAINST VARIOUS DATA TRAFFIC IN THE NETWORK

Technique	Message Throughput in mbps	Network Overhead in mbps	Message Delivery Ratio	Routing Latency
DA-AODV-Existing	65.58	15.23	97.78	0.35
DA-OLSR-Proposed	69.26	12.59	99.85	0.26

The changing in the network size affects the routing performance of UAV assisted VANET significantly as the density of the network and the total traffic loads increases leads to high transmission delay.

CONCLUSION

Optimized Routing protocol named as multiple strategies inferred Optimized Link state Routing protocol through various consideration of the UAV assisted routing distance and time factors has been designed and implemented in this work. It employs KNN model for configuration of the node for efficient message delivery with high link quality. The multiple UAV propagation has been estimated using artificial intelligence techniques for effective path planning. The Proposed network model reduces the network overhead. Finally performance of the network has been assessed on basis of varying network size, changing the vehicle Speed and changing the vehicle direction. The Simulation outcomes demonstrate the efficiency of the proposed architecture against the conventional technique on throughput and latency.

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