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Node Position Based Multi - Hop Routing For Fanets

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Abstract- In this work, we provide a stateless position-based packet routing method for a flying ad-hoc network (FANET). The goal of this project is to collect all available geographical data about the network. The node is directed to its target using its address and coordinates. Here, we introduce UAV technology to improve position-based multicarrier transmission in 3D spaces. The DRL algorithm is used by this ad hoc network while in flight. Together, DRL and LAR ensure timely arrival at the final destination. In this research, we present a decentralized intelligent routing approach using deep reinforcement learning (DRL) that takes into account the state of symmetrical nodes between two hops. The approach takes into account the location, velocity, load degree, and connection quality of nodes in the establishing process of state components, allowing for a more complete understanding of the local dynamic of the network. Using the Q values computed by the model during training of Deep Q-Networks, the nodes may do an adaptive neighbor selection. The simulation and analytical results demonstrate that the suggested technique has superior performance to various widely used methods and offers strong convergence characteristics.

Keywords-FANET; routing; UAV; reinforcement learning; Position Aware Routing Protocol

I. INTRODUCTION

To increase flight safety and meet the demands of businesses and passengers, the civil aviation sector is actively seeking for new communication technology. Flying Ad-Hoc Networks (FANETs) are an innovative solution to this problem. There is no requirement for a ground-based infrastructure when commercial airplanes are used as nodes in autonomous networks. Due to its similarities with VANETs in terms of features like trajectory constraints, FANETs may be thought of as a special case of VANETs (Vehicular hoc networks). To meet the demands of novel apps like actual weather data distribution, more efficient use of these cellular operators is required [1]. Researchers have looked at flying ad hoc networks (FAHNs) as an alternative to cellular and satellite technologies for providing Internet access in the air. Air-to-air data lines, in which packets are transmitted from aircraft to aircraft, allow domestic base stations to connect to remote or oceanic areas. The AeroSat Company has been looking at the marketability of a technology that allows a teleconference to span the Atlantic Ocean through many hops, from a ground station to an intermediate airplane, and finally to a second aircraft [2]. In 2007, piloted tests were conducted on this technique. Academics have become increasingly interested in the concept of aircraft ad hoc networks established by commercial jets in recent years. Air ad hoc networks are a scalable and price option for uses like traffic safety, dynamic route planning, and context-aware advertising since data is delivered in the form of small packets over great distances. If it must reach a node that is too far away, it may do it by communicating with a node that is close by. The signal will then be sent to the subsequent node, and so forth till it reaches its ultimate destination. In a completely mobile ad hoc network (MANET), all nodes are mobile and may connect without the need for a centralized server. So, a node has to communicate with other nodes to build networks and partake in their autonomy. One of the most impressive features of these networks is the help it provides with mobility. So, inside this network, nodes may go anywhere they like [3]. [4].

The use of mobile ad hoc networks to supplement established networks is expanding. For example, in a tactical location or following a natural catastrophe, when permanent networks may be down or take too long to react, mobile ad hoc networks may be deployed. Moreover, telephone and teleconferencing are two examples of technology that might be useful in this context [5].

Ad hoc networks that can function while in flight have been proposed more recently. using which the changeover from VANET to FANET is occurring. Aircraft are intended to function as self-aware nodes in these networks, exchanging information with both the ground as well as other aircraft in the air. Hence, these networks exhibit features that set them apart from traditional ad hoc networks, such as the ability to send signals to army radar and provide data access through in-aircraft, airframes, aircraft-to-aircraft, and aircraft-to-ship connections. It is hypothesized that the dependability and scalability of such networks might be improved by distributing air traffic across them [6]. Aircraft ad hoc networks are gaining significance in today's world of increasing air traffic, skyrocketing fuel costs, and widespread pollution.

The coverage area of a base station or satellites is an important factor to consider when organizing a network of aeroplanes that uses just that facility for communications. Without the ability to communicate with other spacecraft and ground stations, a ship would be unable to fly. FANET, on the opposite hand, increases operational coverage via craft-to-craft data connections rather than artisan data links [7]. [8]. A FANET node may continue to operate by data transmission with other vessels even if it is unable to link to the network's backbone.

Several different FANET designs have been developed to improve the system's scalability to support a growing number of connected aircraft. The FANET architecture was created to extend the range of multi-craft systems. As shown in [9], a multi-hop communication network connecting many craft may expand the operational area. The infrastructure's ability to communicate with people is impacted by the surrounding environment. Physical characteristics of the environment, such as hills, walls, or buildings, might potentially block infrastructure signals. Radio signals between ground control & aircraft are disrupted by structures like buildings, particularly in highly populated areas. FANET not only extends the operational range of multi-craft systems beyond the reach of the adversary, but also greatly improves their adaptability [10].

Decentralized and accounting for the state of symmetrical nodes in two hops, this study proposes an intelligent routing technique that utilizes deep reinforcement learning (DRL). This method establishes state components with consideration for node location, velocity, load degrees, & connection quality, therefore expanding our understanding of the network's local dynamics. While retraining of Fully Convolutional, the node may engage in an adaptive neighbor selection based on the Q values generated by the model. The simulation and analytical results demonstrate that the suggested technique has superior performance to various widely used methods and offers strong convergence characteristics.

II.LITERATURE REVIEW

Wireless sensor networks (WSNs) and Mobile ad hoc networks (MANETs) are groups of nodes that communicate wirelessly but have no central hub, predetermined structure, or administrator. These factors influence the network overhead and the packet delivery ratio. As a result, various routing protocols have been created by academics in an effort to lessen routing overhead and boost the rate of packet delivery in networks of this sort. We give a study of routing protocols that only send packets in the path of their final destination node depending on their current location. The network's routing overhead is lowered with this form of restricted flooding. GPS or other Location based services are utilised to determine the node's location [11]. Often known as "drones," micro and nano flying vehicles (MAVs & NAVs) are unmanned aircraft that may take many shapes and sizes, including miniature quadrocopters, aeroplanes, balloons, and even tiny flapping wing devices.

These are innovative mobile autonomous systems that are being studied for a wide range of mission-oriented civilian applications at the moment. 3D-mapping, rescue operations, surveillance, farmland as well as construction supervising, delivery of lightweight objects and products (for example, Amazon recently publicised their small drone delivery system), and video recording at sporting events are just some of the more popular recent uses of MAVs [12]. These unmanned aircraft are self-operating systems with a high level of situational awareness because to the abundance of sensors on board (including gyroscopes, accelerometers, laser rangefinders, global positioning systems, cameras, and integrated image processing). A dependable communication connection is necessary for all practical applications, and in certain cases whole fleets of MAVs will need to work together.

DroNet encourages theoretical studies, the development of algorithms and protocols for adaptive aerial networks, and mission-focused contributions that address issues of requirements, constraints, and regulation. Particularly welcome are articles discussing novel applications, measurements, problems, or descriptions of system characteristics and experimental findings [13]. Robotics work or applications that highlight the audience's communication issues or needs are encouraged, but the programme wants unique, unpublished work that is not under review by some other technical journal/magazine/conference. Rapid information collection, such as the whereabouts of casualties, is essential for directing search and rescue efforts in disaster zones in a safe and effective manner. Miniature robots may be rapidly sent to investigate a catastrophe scene using the notion of repelling virtual pheromones, which is based on the insect colony coordinating behaviours. Rapid area coverage is possible because to the dispersed tiny robots and their use of visual servoing [14]. For the purpose of coordinating the movements of several small robots, it is common practise to include an external observer into the control loop, like a different robot or an above camera. The group of robots may quickly disperse around the region if each one moves away from the others in close proximity.

The concept has been put into practise with the help of small scout robots, created by the University of Minnesota's Centre for Distributed Robotics and ideal for spying and investigating. Airborne network evaluation and design can't happen without mobility models as a starting point (ANs). Mobility models must accurately represent the characteristics of ANs because of their profound effect on networking efficiency. In this study, we provide a thorough review and comparison of simulation tools that have been modified or created specifically for use in evaluating ANs. We assess these mobility models by their capacity to generalise, their networking capabilities, and their accuracy in representing ANs' mobility characteristics (such as their great mobility, technical & aerodynamics constraints, and safety needs) [15].

III.PROPOSED MODEL

We introduced a stateless positioning-oriented packets routing method to transfer information from a single node to a destination node based on the total weighted probability of neighbouring nodes. In this case, the approach based on progress decides on the amount of neighbour nodes. The uniform, length, angle, and expected distance are then included into the probability weight. The estimated probability weighting of the source node was then used to choose a node at random. A network's topology is always being modified to incorporate the most up-to-date information on the path a packet must travel to reach its destination. The database of nearby nodes is called

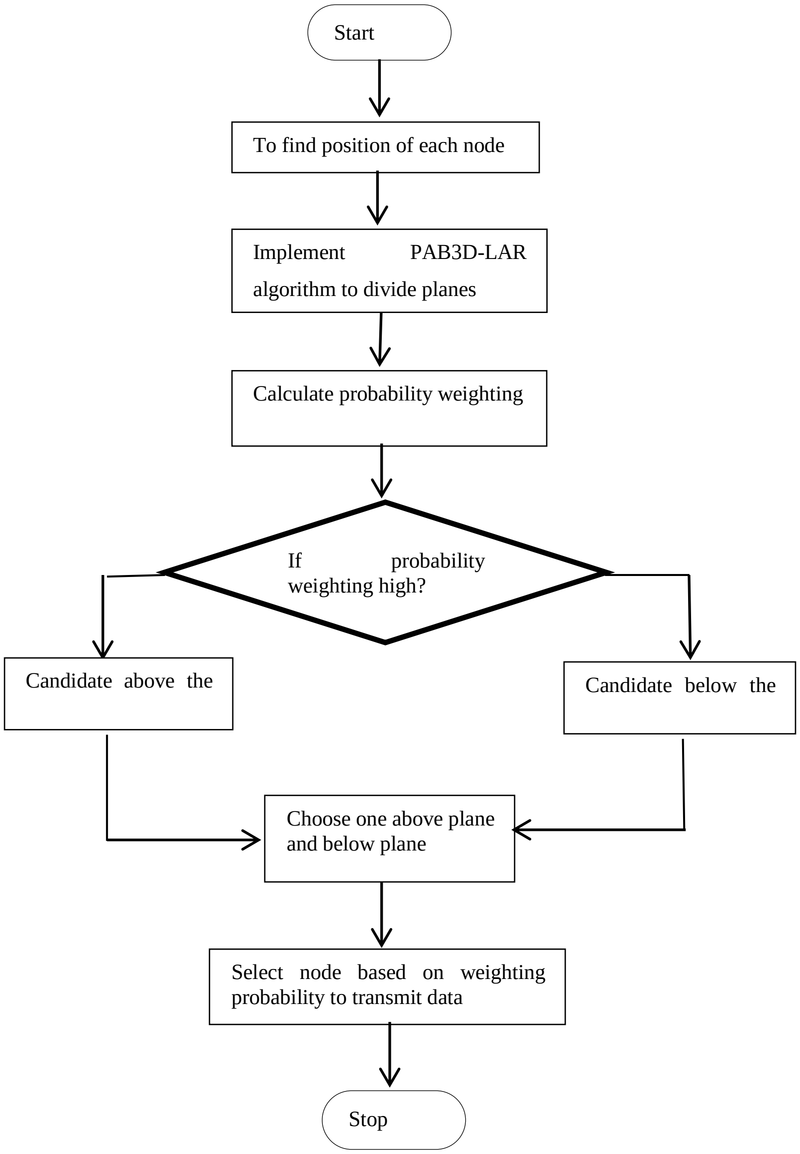

Fig.1. System Flow diagram

"neighbours." To speed up the exchange of information between nodes, DRLis used.S

Advantages

- Reduce high path dilation of LAR.
- 3D space uses two orthogonal planes.
- Increase the network performance

Network Construction

A position-based perspective is central to this concept. It supports both the 2D and 3D topological formats. Nevertheless, only 3D-topology may be used in this case. Packets from the source to the destination node might be sent through a single route or several pathways.

- **Single path strategy:**Each node must choose a single neighbour to forward the message to. It means there is only ever one duplicate of a packet floating throughout the network.
- **Multipath strategy:**Using the multipath technique, a node may relay the same message to several neighbours.

DRL Algorithm

The routing procedure finds the most direct path between two given locations. Time, amount of hops, connections utilisation, service quality, security, etc. are only few of the objectives that might guide optimal route selection. The complexity of selecting the best path in a wireless connection exponentially rises when nodes are mobile and may move across any of the three available directions (x, y and z - axes). The ant colony optimisation technique that inspired our proposed routing strategy is described below.

The "local minimum" issue may be circumvented using this method by introducing a little amount of randomness. Each node's neighbours work together in a progress-based way to bring down the progress number. A node to its left on the minimising line should be allowed to switch to a package with an equal likelihood of success. Instead of a line, a plane should be employed when using the above/below 3D technique. A flat, 2-D surface used to define 3-D space.

This procedure is used in this model, with the source node calculating the destination node's predicted zone. Minimum-sized rectangular box containing ball in one corner and anticipated zone in another corner; this is the zone established to refine the 3D flooding region. Then we assume the network is completely stationary, with no variable speeds.The success of a reinforcement learning strategy might depend significantly on how well its auxiliary components are put up. This section introduces the subspace, action space, as well as reward settings for suggested DRL-based FANETs' intelligence routing (DRL-FIR) method.

State Space

The DRL model's input state must accurately and exhaustively represent the agent's surroundings (i.e., the current UAV). In order to help the agent learn more about its surroundings, the state space in this article is composed of four routing-related properties of nodes inside two hops of the present node. This research makes use of the signal-to-interference-and-noise ratio (SINR) as a measure of channel quality $\eta_{c,i}^{I}(t)$ and $\eta_{i,j}^{II}(t)$at time t, to stand in for the signal-to-noise ratio (SNR) of the connection between current node c as well as the one-hop network I and between the one-hop site I and the two-hop node j. Nowadays, we possess:

$$\eta_{c,i}^{I}(t)=\frac{g_{c,i}(t)p_{c,i}(t)}{\sigma_i^2(t)}$$

$$\eta_{i,j}^{II}(t)=\frac{g_{i,j}(t)p_{i,j}(t)}{\sigma_j^2(t)}$$

where $g_{c,i}(t)$ and $g_{i,j}(t)$channel gain mean mean gain across both links (i.e., $c\rightarrow i$ and $i\rightarrow j$), respectively, $p_{c,i}(t)$ and $p_{i,j}(t)$represent the strength of transmission between nodes c and I whereas$\sigma_i^2(t)$ and $\sigma_j^2(t)$reflect the dispersion of Gaussian white noises at the I and jth routing nodes. In the next section of this study, the temporal identification inside the equations has been removed for simplicity. Therefore, using the Shannon formula, we may determine the channel's capacity.

$$C_{c,i}^{I}=B_{c,i}\log_2\left(1+\eta_{c,i}^{I}\right)$$

$$C_{i,j}^{II}=B_{i,j}\log_2\left(1+\eta_{i,j}^{II}\right)$$

with $B_{c,i}$ and $B_{i,j}$indicating the transfer rates of the two connections. By using the transmission power ratios as component of the state, that may be accordingly expressed as, we were able to objectively evaluate the potential of the different candidate nodes.

$$\bar{C}_{c,i}^{I}=\frac{C_{c,i}^{I}}{\sum_{n\in N_c}C_{c,n}^{I}/|\boldsymbol{N}_c|}$$

$$\bar{C}_{c,i}^{II}=\frac{|\boldsymbol{M}_c-\boldsymbol{M}_c\cap\boldsymbol{N}_c|\times\sum_{j\in(N_i-\boldsymbol{N}_i\cap N_c)}C_{i,j}^{II}}{|\boldsymbol{N}_i-\boldsymbol{N}_i\cap\boldsymbol{N}_c|\times\sum_{n,m\in(\boldsymbol{M}_c-\boldsymbol{M}_c\cap\boldsymbol{N}_c)}C_{n,m}^{II}}$$

where $N_i$indicates the set of nodes that are directly connected to a single-hop neighbour node c, in this case node I while| · | means the cardinality of set ".". While determining the percentage of nodes with two hops, we did not include those that belonged to just one hop at the same time.

Distance, a fundamental factor in nearly every location-based routing algorithms, was the second component of the state set in the suggested approach. The ability to pinpoint its location would make determining the gap between nodes a breeze. DRL-FIR used the following distance ratios:

$$\bar{D}_{c,i}^{I}=\frac{D_{c,i}^{I}}{\sum_{n\in N_c}D_{c,n/|N_c|}^{I}}$$

$$\bar{D}_{c,i}^{II}=\frac{|M_c-M_c\cap N_c|\times\sum_{j\in(N_i-N_i\cap N_c)}D_{i,j}^{II}}{|N_i-N_i\cap N_c|\times\sum_{n,m\in(M_c-M_c\cap N_c)}D_{n,m}^{II}}$$

where $D_{c,i}^{I}$ and $D_{i,j}^{II}$ distances from the current node c to the one-hop node I and from node I to the two-hop node j are shown by and, respectively.

This work also considered the loading ratio of nodes between multiple hops in the setup of the state, which could be described as considering that the economic load of nodes may considerably influence the efficiency of the routing method in terms of latency and packet loss rate.

$$\bar{L}_{c,i}^{I}=\frac{L_{c,i}^{I}}{\sum_{n\in N_c}L_{c,n}^{I}/|N_c|}$$

$$\bar{L}_{c,i}^{II}=\frac{|M_c-M_c\cap N_c|\times\sum_{j\in(N_i-N_i\cap N_c)}L_{i,j}^{II}}{|N_i-N_i\cap N_c|\times\sum_{n,m\in(M_c-M_c\cap N_c)}L_{n,m}^{II}}$$

where $L_{c,i}^{I}$ and $L_{i,j}^{II}$indicate the MAC layer queue length for nodes I and j.

We also point out that nodes' mobility characteristics should be taken into account since they may significantly impact the longevity of connections, which in turn affects the dependability of routing. Duration of connection between I and j nodes (i.e., $T_{i,j}$) can be determined by applying the following equation:

$$\left(x_i+v_{xi}T_{i,j}-x_j-v_{yi}T_{i,j}\right)^2+\left(y_i+v_{yi}T_{i,j}-y_j-v_{yj}T_{i,j}\right)^2=R^2$$

where (x_a,y_a) and (v_{xa},v_{ya})represent node a's coordinates and its velocity vector. Next, in the suggested method's final state, the linked lifetime ratios were established, which may be written as

$$\bar{T}_{c,i}^{I}=\frac{T_{c,i}^{I}}{\sum_{n\in N_c}T_{c,n}^{I}/|N_c|}$$

$$\bar{T}_{c,i}^{II}=\frac{|\boldsymbol{M}_c-\boldsymbol{M}_c\cap N_c|\times\sum_{j\in(N_i-N_i\cap N_c)}T_{i,j}^{II}}{|\boldsymbol{N}_i-N_i\cap N_c|\times\sum_{n,m\in(M_c-M_c\cap N_c)}T_{n,m}^{II}}$$

with $T_{c,i}^{I}$ and $T_{i,j}^{II}$, each signifying how long a connection will be active$c\rightarrow i$ and $i\rightarrow j$.

The current DRL-FIR technique status is expressed as a matrix, which$S = [S^I, S^{II}]$ with $S^I = \left[\bar{C}^I_{c,i'} \bar{D}^I_{c,i'}, \bar{L}^I_{c,i} \bar{T}^I_{c,i}\right]^T_{i \in N_c}$ and $S^{II} = \left[\bar{C}^{II}_{c,i'} \bar{D}^{II}_{c,i'} \bar{L}^{II}_{c,i'}, \bar{T}^{II}_{c,i}\right]^T_{i \in N_c}$.

Action Space

A choosing of activities in the action space, intuitively speaking, maps to the selection of the next hop router. DRL-FIR is an offline learning mode, in contrast to Q-learning, which constantly adjusts the Q value of every surrounding node. So, prior knowledge of the number of nodes inside the state space that can be reached with a single hop may be used to determine the size of a action space. Using mathematics, we get$a \in \{\text{node}_{c1}$, node $_{c2}, \cdots$, node $_{c|N_c|}\}$, where node e_{c*}indicates that node * is the following hop in the routing process after node c.

Reward

With careful consideration of candidate nodes, the suggested technique sought to ensure the dependability, stability, & integrity of data transmission. According to this objective, the agent should maximise its reward if the next node it visits is the final destination.

$$F_j = \begin{cases} 1, & \text{Node } j \text{ is the destination node} \\ 0, & \text{Node } j \text{ is not the destination node} \end{cases}$$

We also point out that ordinary relay nodes must be encouraged as a means of guiding the routing process towards convergence. As a result, the incentives system was designed with the aforementioned four considerations in mind. In particular, designateC_j and T_j, accordingly as the current node's channel capacity as well as the chosen next node j's link lifespan, andD_j and $L_j$as j times the length of the MAC queue and the distances to the destination. The suggested method's incentive structure is as follows:

$$r = -\left(\mu_1 e^{-\frac{c_j}{c_{\max}}} + \mu_2 \frac{D_j}{D_{\max}} + \mu_3 \frac{L_j}{L_{\max}} + \mu_4 e^{-\frac{T_j}{T_{\max}}}\right) F_j,$$

where $C_{\max}, T_{\max}, D_{\max}$, and $L_{\max}$, between the nearest one-hop nodes, and the maximal channel capacity, connection lifespan, destination distance, and MAC queue length;μ_* is the weight factor, and we have $\mu_1 + \mu_2 + \mu_3 + \mu_4 = 1$.

In this passage, we use a DRL-based hybrid approach. DRL uses a same partitions as LAR, but avoids the latter's excessive route dilatation. DRL selects a single applicant from pool of neighbourhood prospects, whereas DRL splits the packet between each of the prospects who happen to share the same square.

IV. EXPERIMENTAL RESULTS

In this part, we will discuss and compare the simulated results for our suggested routing algorithm - DRL. Pattern Of Interaction - 2 was used for simulation and testing of the DRL routing algorithm (NS2). In the FANET, 45 UAV nodes were dispersed at will throughout a simulated 1,000 by 1,000 metre area. The maximum distance a node could transmit via its broadcast channel was 120 metres, and its packet size was capped at 512 bytes. In addition to randomly generating the frequency, SINR, buffer size, and movement speed, the generated data followed a normal distribution.

The simulation was set up such that a node's route of reflection would continue after it left the zone, as well as the source and destination nodes would be selected at random. A network area of 1000" "mx1000m contains drones. Drones are randomly dispersed, although the workstation is placed at the system's geographic centre. The drone's random route is calculated using the Random WayPoint (RWP) mobility concept. We found that the DRL technique, from which our proposed routing protocol is developed, was the most similar of the five alternatives we considered. In this section, we will discuss the evaluation criteria and simulation results of the research. With the following factors in mind, we studied the behavior and impacts.

Table 1. Simulation parameters.

Potentially contain	Value
Imitationpart	1000m × 1000m
Bulgebroadcas variety R	120m
Bulge amount	45
Obtainable bandwidth B	1Mb ~ 5Mb
Pack size	512Byte
SINR η	10dB ~ 40dB
MAC line length L	1Kb ~ 10Kb
Poignanthaste$L$	3m/s ~ 10m/s
Deterioration rate of $\varepsilon, \varepsilon_{decay}$	0.995
The negligible value of $\varepsilon, \varepsilon_{min}$	0.001
Experience-replay recollection capacity	200
Target net update frequency F_t	500
Experience-replay minibatch size	32
Exercise/test set size	2000/500

The term "packet loss rate" refers to the frequency with which packets of data are lost. Loss of packets in a typical network significantly affects both quality of service and responsiveness. As the packet loss rate & network latency both rise, the overall network throughput suffers. Figure 4 displays the overall impact of packet losses experienced throughout the experiment. We discover that DRL significantly lowers the amount of lost packets compared to DSR and TORA. Figure 5 shows more proof that our proposed routing method effectively lowers packet loss.

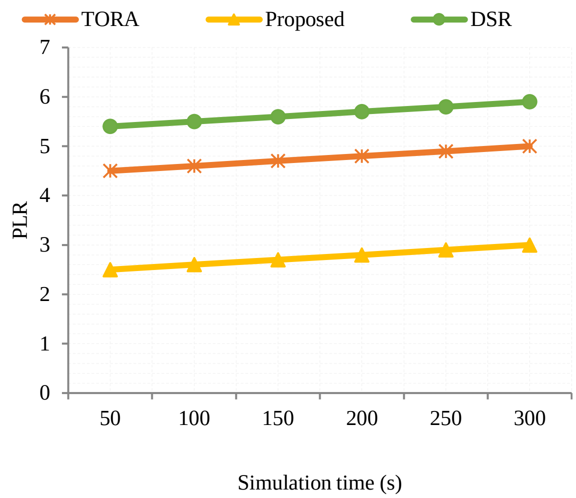

FIGURE 6. Comparison of PLR

Network throughput is the rate at which data may flow across a network, measured in terms of the overall amount of correctly received packets (often in terms of the packet size). In order to determine throughput, only packets that have arrived at their destination successfully are considered. You can figure it out by Eq. 4

$$\text{Throughput} = \frac{\Sigma \text{ received packets size}}{\text{time}}$$

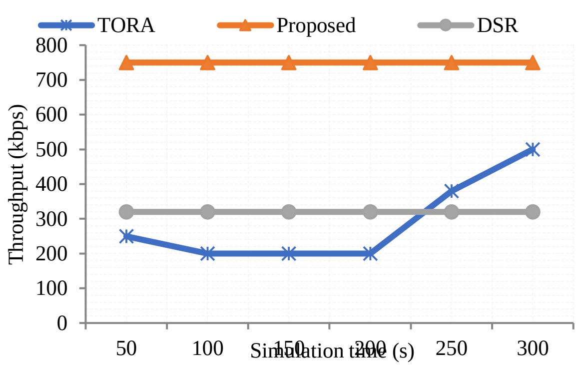

Fig.5.Comparative analysis on throughput

TABLE 2. Superiority of DRL in throughput over other protocols.

Throughput	DRL	DSR	TORA
DRL	+58.81	+26.14	+23.08

TABLE 3. Packet loss ratio for DRL, DSR, and TORA protocols

Routing Protocols	Packet loss Ratio (%)
DSR	7.2
TORA	5.45
DRL	3.4

Throughput is one indicator of the efficiency and scalability of a routing protocol. We discovered that DRL routing approaches greatly outperformed other routing protocols in terms of network performance. We examine the similarities and differences between the DRL, DSR, and TORA routing protocols. The proportion of data packets that were successfully received by their destination node is measured by the packet received ratio. Calculate it using Eq. 5. Table 3 displays the results of the DRL routing protocol. This table shows that DRL has the highest packet reception ratio of any protocol tested.

$$\text{Packet Received Ratio} = \frac{\text{No. of packets received}}{\text{Total sent packets}}$$

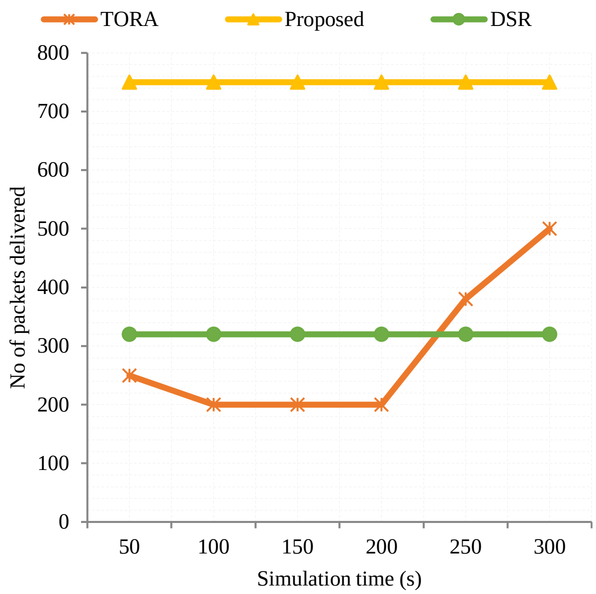

Fig.4.Comparative analysis on packets delivered

Table 4. Packet received ratio for DRL, DSR, and TORA protocols

Routing Protocols	Packet Received Ratio (%)
DSR	76.06
TORA	85.45
DRL	95.45

The average end-to-end delay measures how long it takes for a set of packets to travel from their source to their final destination. It is estimated by subtracting that time the packet was sent from the time it arrived at its destination. With NS2, each traffic flow is assigned a different identity that may be used to follow a packet all the way from the time it is sent until it is either discarded or received. The average round-trip latency is shown in Figure 7 and is computed using Eq. 6.

$$D_{avg} = Tr_{avg} - Ts_{avg}$$

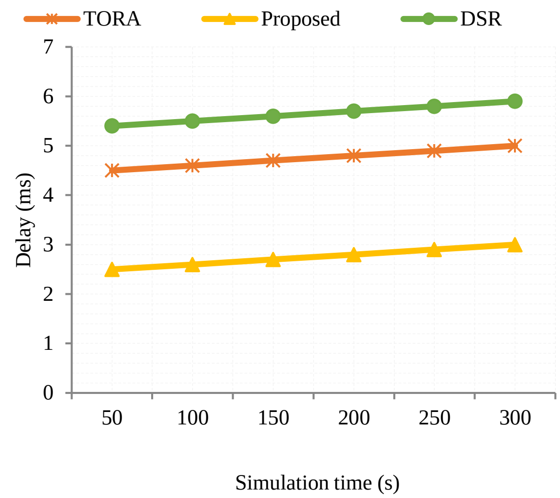

FIGURE 7. Average end-to-end delay of packet transmission.

TABLE 4. Delay Analysis

	DRL	DSR	TORA
Delay	8.72	6.25	13.45

where,
D_{avg} is normal delay,
Tr_{avg} average packet reception time,
Ts_{avg} How Often On Average Are Packets Sent.

The packet drop rate is a crucial indicator of a routing protocol's effectiveness, and DRL has shown a strong propensity to lower it. Throughput and QoS may be increased by decreasing the number of packet drops that occur per second. Throughput in networks is also significantly impacted. An increase in network throughput is an indicator of future network scalability. The ratio of packets received, another indicator of QoE, has also increased (QoE). The bit-per-joule ratio is a critical factor in determining the durability of a network. It evaluates the amount of power needed to achieve a certain throughput.

DRL's highest rating demonstrates its ability to considerably extend the lifespan of a network. Finally, it demonstrates a quantifiable improvement in latency from beginning to finish. Although suitable scheduling algorithms are crucial for FANETs, the suggested technique in this study is well suited to FANETs with topology dynamic features since it takes into account different states of nodes within a small area.

In addition, the strategy is practically viable since it is not necessary to receive the information from every node inside the two hops. Nevertheless, although the suggested method's computation uses relatively few resources, making it perfectly cheap for UAV nodes, its primary drawback compared to other used comparison techniques is its suggested high, as it requires obtaining more information and carrying out the relevant preprocessing. It's worth noting that centralized routing algorithms may have certain benefits over distributed algorithms thanks to their global planning process, even if they can't tackle the dynamic issue of FANETs very effectively.

Hence, researchers might look into the possibility that a routing algorithm that combines central & distributed modes would have higher performance. At the same time, the proliferation of wireless networks for communication will lead to an explosion in both the volume and variety of communications. By taking into account the varying performance needs of different message kinds, the resulting routing algorithm is predicted to be more adaptable and efficient in its service delivery to end users.

V.CONCLUSION

In this work, we implement a 3D-network FANET using a stateless position-based packet routing method (Flying Ad-hoc Network). With the aforementioned technique, its effectiveness lies on dense networks rather than sparse ones. To get around this issue, we will combine all of the algorithms into a new one, DRL, and randomly alter its input parameters. It quickly lengthens paths and speeds up packet delivery. When used in 3D settings, its primary emphasis on planarization contributes to overall network performance improvement.To achieve more the realistic UAV-to-UAV communication method we want to implement in the future, we must consider an antenna array patterns representing a toroid shape instead of a sphere. Studying a focused position modification method, in which nodes autonomously alter their location to increase the likelihood of packet delivery, might be another fascinating line of inquiry.

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