Routing flying Ad Hoc network using salp swarm algorithm

Alaa Ibrahim Mahmood[1], Omar Ibrahim Alsaif[2], Ibrahim Ahmed Saleh[3]
[1]Department of computer Science, Directorate of Education in Nineveh, Mosul, Iraq
[2]Department of Computers system, Mosul Technical Institute, Northern Technical Universit, Mosul, Iraq
[3]Department of Software, College of Computer and Mathematics, Mosul University, Mosul, Iraq

Article Info

Article history:

Received Jan 19, 2022
Revised Jul 3, 2022
Accepted Jul 26, 2022

Keywords:

FANET
Routing
Salp swarm optimization
Self-organizing network
Unmanned aerial vehicles

ABSTRACT

An Ad-hoc network is collection of mobile nodes without the necessity of existing any centralized access points. In this paper introduce novel protocol that used to improveAdHoc protocol with salp swarm algorithm to routed flying Ad Hoc Network (FANET) by method of simulation. FANET predicated unmanned aerial vehicles (UAV), it designed wireless network has nodes withwith high mobility, actively changing topology and movement in 3D space. The main problem for FANET manner of routing packets among managed nodes. The new protocol based on salp swarm algorithm called "SalpAdHoc" protocol to solve routing problem and less the conjunction, thesimulation results of an experimental study confirming the feasibility of using salp swarm algorithms for routing in FANET are presented.

Corresponding Author:

Alaa Ibrahim Mahmood
Department of computer Science, Directorate of Education in Nineveh
Mosul, Iraq
Email: alaaibmah2@gmail.com

1. INTRODUCTION

Flying Ad Hoc network (FANET) is a group of unmanned air vehicle (UAVs) communicating by analogy with mobile Ad Hoc network (MANET) and automobile peer-to-peer networks vehicular Ad Hoc network (VANET), represents private type of self-organizing network based on UAVs. These networks provide a vast range of commercial and civil usages. The organization of this type of communication is vital not only to implement tasks to ensure monitoring and observation but also effective coordination the movement of vehicles, improving safety (for example, as a means of preventing collisions) [1].

A classic ad hoc network type of a dynamic mobile network without aninfrastructure. It automatically generated as a result of the connections between mobile nodes. The set of mobile nodes are collected in certain area randomly by the fact that no central control node. Each node of an ad-hoc network can function as a router, organizing and supporting the routing process both to other nodes on the same network, and to devices that are transmitters or receivers [2].

The features of ad-hoc networks include changing topologies; limited energy resources, change their location and changed signal propagation conditions. Moreover, bandwidth and visibility range varied from the radio signal. The purposes for ad-hoc networks can be very diverse. It is known that ad-hoc networks can be used in transport systems, and unmanned aerial vehicles (UAVs), often in those situations when you need to deploy a network for some time to transfer data. Currently, there are a large number of simulation systems for the design and analysis of computer networks. These modeling systems can be divided intospecialized for example (COMNET [3], OMNet, OPNET, and NS-2 [4]) and general purpose modelingsystems (ANYLOGIC [4]). The present in the article the instrumental tools of computer-aided design and simulation modeling of TriadNS [5]. One of the features ofNS-2 is a way to present a simulation model in three layers:

- Layer of structures (computing nodes and computer network lines).
- Layer of routines (describes the behavior of computing nodes).
- Message layer (description of messages and data of a complex structure, it is assumedcomputing nodes exchange messages) [6].

In this paper used salp swarm optimization (SSA) based on the behavior for find foods, SSA is based on the self-organization that allows achieving the common goals thanks to low-level interaction. The SAA makes use of two-level strategy "exploration and exploitation" in first level exploration focuses on discovery best solution by seeking a search space suitablely, while exploitation focuses on exploit data in local area.

The paper considers algorithms based on Salp swarm optimization, which implemented routingproblem is solving in self-organizing wireless networks MANET or VANET. Experimental studies were conducted to determine the possibility of using the salp swarm optimization in the FANET [7].

The reset of paper, section 2 is illustratesalp swarms algorithm, section 3 is concerted for self-organizing unmanned, section 4 routing methods algorithms, section 5 routing in a self-organizing network based on salp swarm optimization, while section 6 is simulation the protocol, finally section 7 is conclusion.

2. SALP SWARM ALGORITHM (SSA)

SSA is developed in 2017, it simulatethe behavior of salp swarms and theminteraction socially [6]. They are living in deep of oceans and seas. They moving in regulated swarm called “salpchains” water forces to detect their food, it has leader which has optimalruling for leadership a swarm in proparate environment, stayed for long time at heading ofchain. However, but different other swarms, the leader no longer directly affects the movement of the whole group, but affects directly to move of second salpnext to him, the second salp directly affects the third salp, and so on, as shown in Figure 1.

Figure 1. Salp chain

To represent salp chain mathematically that divided into two sets: “leader” is headsalp and others arecalles “followers”. It has been done to reinforce their movement in searching forfood. The SSA algorithm has following properties:

- The position of salps is defined search space *d*-dimensional, where *d*is number of variablesof a given problem.
- The source of food$F$ is swarm's target. F = [F_1, F_2, . . . ,F_D]^T. The upper and lower boundsofsearch space are ub= [ub_1, ub_2, . . . ,ub_D] and lb= [lb_1, lb_2, . . . , lb_D]. Then initialize the position of salpx_{ij}in a random manner, i= 1, 2,….. , N, j = 1, 2, . . . ,D.

$$x_j^i = rand(N,D) * (ub(j) + lb(j)) \quad (1)$$

- In equation 2illustrate updated the position of leader,

$$x_j^1 = \{F_j + c_1\left(\left(Ub_j - lb_j\right)c_2 + lb_j\right) c_3 \geq 0 \; F_j - c_1\left(\left(Ub_j - lb_j\right)c_2 + lb_j\right) c_3 < 0 \quad (2)$$

Where x^1_j is the position of leader in j-th dimension, Ub_jisupperboundaryand$lb_j$is the lower boundary; *Fj*denotedto food source position [6].

- The coefficient $c_1$is balances between the exploration and exploitation.

- Exploration focuses to find better solution from search space of exploring suitably, while exploitation focuses onexploiting datafrom local area. c1 is decreased over iterations.
- c_2 and c_3 are important parameters random numbers produced within the interval [0,1].
- c_3 is indicating whether next position of current leader salp should to be toward +∞ or - ∞.
- The followers update their position according to Newton's law of motion using (3).

$$c_1 = 2\, exp\, exp\ -(\frac{4l}{L})^2 \tag{3}$$

The varables numbers c_2 and c_3 are randomly generated within interval [0, 1]. C_1 is accountablefor indicating whether next position of current leader shouldbe toward +∞ or - ∞. The followers update their position according to Newton's law of motion using (4).

$$x_j^i = \frac{1}{2}at^2 + v_0 t \tag{4}$$

Where i≥2 represent position of the i-th follows in the j-th dimension, t is the time v0 is the initial speed, and $a = \frac{v_{finial}}{v_0}$ where v= $(x\text{-}x_0)/t$
Since the time is considered as iterations and $v_0 = 0$, equation 5 can be reformulated as in (5) [6].

$$x_j^i = \frac{1}{2}\left(x_j^i + x_j^{i-1}\right) \tag{5}$$

Therefore, updating of follower position illustrate in (6).

$$x_j^i = x_j^i + R = \frac{1}{2}\left(x_j^i + x_j^{i-1}\right) \tag{6}$$

The pseudo code of SSA are shown in Figure 2:

```
begin
    Set algorithm parameters: The population size is N, the dimension of the problem is
D, the maximum number of iterations is Max_Iteration.
    Randomly initialize the population according to Equation (1). The fitness value of
each salp individual is calculated, and the optimal individual is selected as the food
source location.
  while (t < = Max_Iteration) do
    for i = 1 to N do
      if (i < = N/2) do
        Update the position of leader according to Equation (2).
      else
        Update the position of follower according to Equation (6).
      end if
    end for
    Calculate the fitness value of individual population and the food source location is
    updated.
    l = l + 1.
  end while
end
```

Figure 2. Pseudo code of SSA

3. SELF-ORGANIZING UNMANNED AERIAL VEHICLES

Recently, FANET networks have become very popular instead of VANET (peer-to-peer self-organizing), the main nodes of which are unmanned aerial vehicles (UAVs). In this type of networks used UAVs as a foundation for organization of network infrastructure is an attractive approach in terms of increasing telecommunications capabilities of network. The network based on the UAV is characterized by versatility, flexibility and low operating costs [7]. Such a network can be applied in the most diverse branches shown in Figure 3.

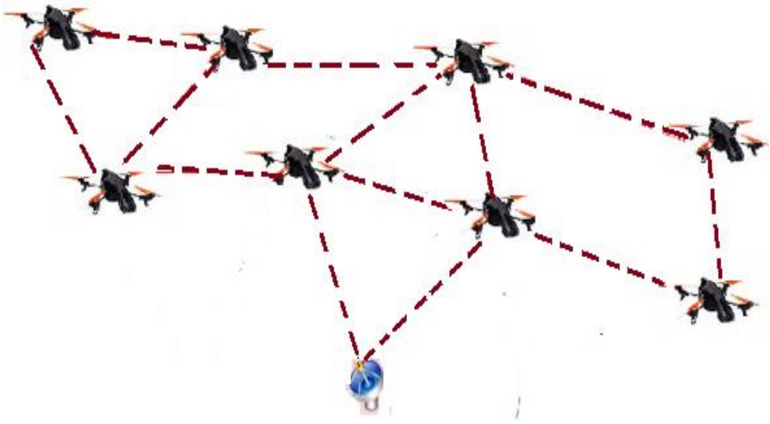

Figure 3. An example of using the FANET network for traffic monitoring

4. ROUTING METHODS ALGORITHMS IN FANET

The technologies for organizing self-organizing FANET networks are currently under development; new methods for routing algorithms are emerging [8]. The choice of routing protocol is determined by the requirements: number of nodes, their mobility, support for quality of service (QoS), and types of transmitted traffic. The basis algorithm for any routing protocol is founddistancenodes.

At the same time, routing methods must meet the following requirements [9]:

- Take into account the features of FANET that ensure fast convergence and creating a route without absence of looping routes.
- Ensure reliable delivery of packages for support multiple routes of information delivery to destination.
- FANET must have mechanisms to detect inaccessible routes and their removal/restoration to ensure the construction of routes in accordance with the requirements (QoS and jitter).
- Ensure minimal network load with service information.
- Have security mechanisms for routing and transferring data.
- Ensure minimization of energy consumption of network nodes [10].

5. ROUTING IN A SELF-ORGANIZING NETWORK BASED ON SALP SWARM OPTIMIZATION

Salp algorithms developed for telecommunication networks differ from most traditional algorithms. It has features that enable to solve routing problems in wireless self-organizing networks:

- Salps organize an effective and highly organized system.
- Demonstrate adaptability to changing environmental conditions;
- Possess fault tolerance and able to quickly restore their numbers after the loss of individuals. There is highpopulationscalability in thisalgorithm. ConsiderSalp Ad Hoc salp algorithm (see Figure 4) is routing process in a self-organizing network [11]. The first stagen “intelligence” consists of direct and reverse intelligence. Direct intelligence officers search for a destination siteon the network. When is detect a node of destination, the followers’ reverse returns to the source node. The followers contain following information: the followers identification (ID), the ID ofthe source node, the minimum residual energy (initial value equal to infinity) and number of hops (initialvalue equal zero). Leader is sent to all followers of source node. Eachintermediatenodeincrements the hop counts by one [12].
- The energy efficiency of the transmitted data depends on the value of this counter. When a destination node is detected, reverse returns to source node. On intermediate nodes, the algorithm monitors changes in characteristics. Intelligence officers and, guided by the information received, decides on the effectiveness of the route [13].

In this way, there are established multiple channels between source and destination node. After completion of exploration and establishment of the route, they determined require search through explosion, and then comes the stage of exploiting resources. Salp transmits data by analogy with lower bounds of the search space. The data is transferred from source node to destination, all decisions are initiated by the source node. In order to return, and salps must continuous to exploration accordance with the ID-routes. During the return, the quality of routes is limited, while energy-inactive are removed from routingtables [14].

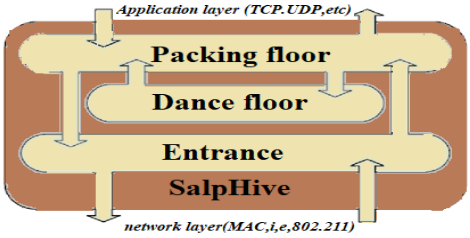

Figure 4. SalpAdHoc protocol architecture

6. SCENARIO FOR SIMULATION

Comparison of routing protocols in self-organizing networks FANET is difficult due to the influence of a large number of factors that are random in nature and for this reason poorly amenable to rigorous mathematical analysis [15]. To study the work of Ad Hoc network applied simulation tools. The emergence of simulation software has made it possible to carry out the necessary research and experiments, including improving existing and developing new routing protocols without actually deploying the network [16], [17]. For carrying out simulation modeling, a wide range of software is offered. The most well-known and popular are the following simulation tools "NS-3, OPNET/Riverbed SteelCentral, OMNET".

In this paper, the salpAdHoc routing protocol was studied byNS-2 (network simulator) with install salpAdHoc protocol installed. The comparison was carried out with the protocols implemented in the simulator: AODV, DSDV, and DSR [18], [19].

In the simulated network, are defined in the following restrictions:

- Version of the network simulator - NS-2.34.
- Visualize the movement of the UAV using the utility NetAnim.
- The study of routing protocols was made for groups consisting of 10, 20, 30, 40, 50 UAVs.
- The parameterswhichused forsimulationwerechosenbased on the analysis of various publications like [20], [21].

As a result, it was concluded that all researchers use approximately the same parameters in Table 1, which vary depending on the objectives of the study. The simulation experiment scenario consists of nodes simulating the behavior of UAVs moving randomly in accordance with the mobility model based on random route points random waypoint mobility (RWM) in the area of 1800x1800 m2 (Figure 5) each node moves to selected position randomly with a randomly chosen speed between a predefined minimum and maximum speed [22], [23]. At the application level, a generator with a fixed packet delivery rate isused as a source of useful traffic. Simulation of traffic transmission at the transport level is performed using UDP datagrams at a speed of 512 Kbps [24], [25].

Apart from scenarios in which the number of nodes in the network and the speed of movement changed, the rest of conditions were same [26], [27]. The following metrics are used to evaluate the performance of routing protocols [28]:

- End-to-End delay: sum of delays from moment first transmitted byte untel the last byte reached to recivers. It comprises transmission delay, propagation delay, and process queue delay.
- Throughput: features maximum possible rate ofsuccessfulsubmission ofpackets over aconection channel.
- Routing Overhead: include the router's operations such as choose routes of packets and designing routing table [29]-[32].

Table 1. Parameters of simulation

Parameter	Value
Area Size	1800 * 1800 square mater
Model of Mobility	Model of walk randomly
Number of UAV	10, 20, 30, 40, 50
Iteration period	25 sec
Speed of Knot	20-100 m / s
Traffic generator	CBR
Level of MAC	802.11 in Ad Hoc
Signal publishing Model	Friis
Type of Antenna	Omni
CoverageAntenna Area	250 m
Level of Transport	UDP
Package size	512 KB

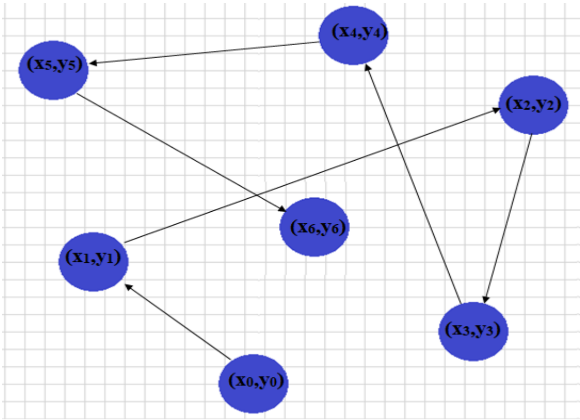

Figure 5. Mobility model based on random route points

7. SIMULATION RESULTS

In this paper suggested that an increase in the number of nodes, the salpAdHoc protocol will demonstrate better performance than Ad-hoc on-demand distance vector (AODV), dynamic source routing (DSR) protocols and destination-sequenced distance-vector routing (DSDV). It was expected increased routing overhead and end-to-end delay, whereas throughput would remain without significant changes. For experiment applied in this paper, used a varying number of nodes in range of values from 20 to100 .the expression result shown in Tables 2 and 3.

As shown in Table 2 that with an increase in the number of nodes, the throughput of the SalpAdHoc, DSR, AODV protocols increases, while DSDV throughput decreases in proportion to the increase in the number of nodes and also shown the SalpAdHoc is protocol in number 50 best from DSR protocol. Also see ratio of traffic shows that with an increase in the number of nodes there is an increase in “routing overhead” for all protocols consideration. At the same time, DSDV and DSR displybest performance, and salpAdHoc is on average superior to AODV.

According to Table 2 and Table 3 shows the behavior of algorithms relative to end-to-end delay for number of nodes. SalpAdHoc is slightly inferior with AODV and DSR protocols. DSDV has best performance since is a proactive/tabular protocol and routes to all nodes are stored in its routing table. Algorithms exhibit different behaviors in this regard; DSDV is marked by volatile behavior. SalpAdHoc is most adaptive algorithm in relation to topology changes; in public, change in speed has a negligible effect on its throughput. With increasing speed, the salpAdHoc and AODV algorithms quickly adapt inchanges and have better throughput performance.

From Table 3 that DSDV and DSR do not have a large load in terms of the routing overhead with increasing node mobility, simultaneously, salp AdHoc is increased stress. AODV has exactly the opposite behavior tosalpAdHoc due to the fact that AODV uses the routing table to save multiple paths to destination, and alternative paths can be found without having to start the route discovery process. SalpAdHoc has large costs compared to protocols due to the need to find a new route to the destination node, which, in turn, gives an advantage over other protocols in terms of bandwidth.

Based on the results obtained during the experimental study, we can draw the following conclusion, the salpAdHoc algorithm provides a higher throughput compared to DSDV and DSR, but is inferior to them in delay. On average, salpAdHoc performance is similar with considered protocols DSDV, DSR and AODV. SalpAdHoc can be used to route packets on a FANET network.

Table 2. Compare ratio of bandwidth to speed of nodes movement

	Band width				Service traffic				End –to-end delay			
nodes	Salp Ad Hoc	AODV	DSDV	DSR	Salp Ad Hoc	AODV	DSDV	DSR	Salp Ad Hoc	AODV	DSDV	DSR
20	16	16	16	16	50	10	10	8	0	0	0.016	0
40	52	38	54	56	130	100	15	15	0.012	0.008	0.014	0.013
60	76	34	80	82	138	150	30	30	0.035	0.02	0.01	0.035
80	78	20	82	100	190	225	45	50	0.048	0.018	0.006	0.049
100	79	0	100	62	195	290	50	60	0.052	0.042	0	0.054

Table 3. Compare ratio of end-to-end delay to speed of nodes movement

	The ratio of BW speed				the speed of movement of nodes				End-to-end delay of end-to-end delay to the speed of movement of nodes			
Nodes mobility speed	Salp Ad Hoc	AODV	DSDV	DSR	Salp Ad Hoc	AODV	DSDV	DSR	Salp Ad Hoc	AODV	DSDV	DSR
20	44	58	18	44	10	10	10	10	0.3	0.2	0	0.2
40	50	60	30	82	52	54	38	60	0.5	0.3	0	0.4
60	72	57	12	30	74	81	26	85	0.8	0.4	0	0
80	20	20	20	20	79	86	20	100	0	0	0	0
100	68	71	2	2	78	100	0	64	1.5	1.2	0.1	0

8. CONCLUSION

To date, there is no routing algorithm that meets all the requirements for FANET, and provides high rates of network efficiency in various conditions. Using the salpAdHoc protocol as an example, an experimental analysis was conducted, the results of which confirm the feasibility of using salpswarm optimization for routing in FANET compared to other algorithms. The direction for further research is to study the behavior of the salpAdHoc algorithm when used in various scenarios. When conducting experimental studies, it is planned to emulate not only different types of traffic (voice/video), but also to change the size of the data packets being sent. In addition, it is advisable to conduct research related to the development of a unified methodology for testing routing protocols in FANET.

REFERENCES

[1] K. Kumari, S. Maakar, and B. Sah, "A brief survey of mobility model for FANET," in *Proceedings of National Conference on Innovative Trends in Computer Science Engineering (ITCSE-2015)*, 2015, no. April, pp. 106–108.

[2] S. Mirjalili, A. H. Gandomi, S. Z. Mirjalili, S. Saremi, H. Faris, and S. M. Mirjalili, "Salp swarm algorithm: A bio-inspired optimizer for engineering design problems," *Advances in Engineering Software*, vol. 114, pp. 163–191, Dec. 2017, doi: 10.1016/j.advengsoft.2017.07.002.

[3] N. Akhtar, S. C. Ergen, and O. Ozkasap, "Vehicle mobility and communication channel models for realistic and efficient highway VANET simulation," *IEEE Transactions on Vehicular Technology*, vol. 64, no. 1, pp. 248–262, Jan. 2015, doi: 10.1109/TVT.2014.2319107.

[4] M. H. Tareque, M. S. Hossain, and M. Atiquzzaman, "On the routing in flying ad hoc networks," in *Proceedings of the 2015 Federated Conference on Computer Science and Information Systems, FedCSIS 2015*, Oct. 2015, pp. 1–9, doi: 10.15439/2015F002.

[5] A. H. Maray, O. I. Alsaif, and K. H. Tanoon, "Design and implementation of low-cost medical auditory system of distortion otoacoustic using microcontroller," *Journal of Engineering Science and Technology*, vol. 17, no. 2, pp. 1068–1077, 2022.

[6] N. Sevryugina and P. Kapyrin, "Triad model: simulation - functional tensometry - information database in the assessment of the reliability of technological machines," *E3S Web of Conferences*, vol. 263, 2021, doi: 10.1051/e3sconf/202126304063.

[7] Y. Fan, J. Shao, G. Sun, and X. Shao, "A Modified salp swarm algorithm based on the perturbation weight for global optimization problems," *Complexity*, vol. 2020, pp. 1–17, Nov. 2020, doi: 10.1155/2020/6371085.

[8] M. A. Yahya *et al.*, "Noise cancellation for HIPERLAN/2 with open loop transmit diversity technique," *Inventions*, vol. 4, no. 3, p. 46, Aug. 2019, doi: 10.3390/inventions4030046.

[9] S. Wei *et al.*, "Simulation study of unmanned aerial vehicle communication networks addressing bandwidth disruptions," in *Proceedings of SPIE - The International Society for Optical Engineering*, Jun. 2014, p. 90850O, doi: 10.1117/12.2050765.

[10] L. Gupta, R. Jain, and G. Vaszkun, "Survey of important issues in UAV communication networks," *IEEE Communications Surveys and Tutorials*, vol. 18, no. 2, pp. 1123–1152, 2016, doi: 10.1109/COMST.2015.2495297.

[11] I. A. Saleh, O. I. Alsaif, and M. A. Yahya, "Optimal distributed decision in wireless sensor network using gray wolf optimization," *IAES International Journal of Artificial Intelligence (IJ-AI)*, vol. 9, no. 4, p. 646, Dec. 2020, doi: 10.11591/ijai.v9.i4.pp646-654.

[12] İ. Bekmezci, O. K. Sahingoz, and Ş. Temel, "Flying Ad-Hoc Networks (FANETs): A survey," *Ad Hoc Networks*, vol. 11, no. 3, pp. 1254–1270, May 2013, doi: 10.1016/j.adhoc.2012.12.004.

[13] O. K. Sahingoz, "Networking models in flying Ad-Hoc networks (FANETs): concepts and challenges," *Journal of Intelligent & Robotic Systems*, vol. 74, no. 1–2, pp. 513–527, Apr. 2014, doi: 10.1007/s10846-013-9959-7.

[14] J. D. Mallapur, S. S. Manvi, and D. H. Rao, "Fuzzy based approach for packet dropping n wireless networks," *International Journal of Advanced Networking and Applications*, vol. 1, no. 5, pp. 301–306, 2010.

[15] G. M. Dias Santana, R. S. de Cristo, and K. R. L. J. C. Branco, "Integrating cognitive radio with unmanned aerial vehicles: an overview," *Sensors*, vol. 21, no. 3, p. 830, Jan. 2021, doi: 10.3390/s21030830.

[16] S. Temel and I. Bekmezci, "On the performance of flying Ad Hoc networks (FANETs) utilizing near space high altitude platforms (HAPs)," in *RAST 2013 - Proceedings of 6th International Conference on Recent Advances in Space Technologies*, Jun. 2013, pp. 461–465, doi: 10.1109/RAST.2013.6581252.

[17] M. Bani and N. Alhuda, "Flying Ad-Hoc Networks: routing protocols, mobility models, issues," *International Journal of Advanced Computer Science and Applications*, vol. 7, no. 6, pp. 162–168, 2016, doi: 10.14569/IJACSA.2016.070621.

[18] I. A. Saleh, W. A. Alawsi, O. I. Alsaif, and K. Alsaif, "A prediction of grain yield based on hybrid intelligent algorithm," *Journal of Physics: Conference Series*, vol. 1591, no. 1, p. 012027, Jul. 2020, doi: 10.1088/1742-6596/1591/1/012027.

[19] A. Tarabasz, "The impact of the internet of things on new approach in network management," *International Journal of Contemporary Management*, vol. 15, no. 2, pp. 151–170, 2016, doi: 10.4467/24498939IJCM.16.011.5555.

[20] A. Ahmed, O. Ogunbiyi, and T. Aduragba, “Optimal data collection from a network using probability collectives (Swarm Based),” *International Journal of Research in Engineering and Science*, vol. 3, no. 4, pp. 49–58, 2015.
[21] S. Q. Alhashmi, K. H. Thanoon, and O. I. Alsaif, “A proposed face recognition based on hybrid algorithm for features extraction,” in *2020 6th International Engineering Conference “Sustainable Technology and Development" (IEC)*, Feb. 2020, pp. 232–236, doi: 10.1109/IEC49899.2020.9122911.
[22] S. Qazi, A. Alvi, A. M. Qureshi, B. A. Khawaja, and M. Mustaqim, “An architecture for real time monitoring aerial Adhoc network,” in *2015 13th International Conference on Frontiers of Information Technology (FIT)*, Dec. 2015, pp. 154–159, doi: 10.1109/FIT.2015.36.
[23] C. Bettstetter, G. Resta, and P. Santi, “The node distribution of the random waypoint mobility model for wireless ad hoc networks,” *IEEE Transactions on Mobile Computing*, vol. 2, no. 3, pp. 257–269, Jul. 2003, doi: 10.1109/TMC.2003.1233531.
[24] O. Alsaif, I. Saleh, and D. Ali, “Evaluating the performance of nodes mobility for zigbee wireless sensor network,” in *ICCISTA 2019 - IEEE International Conference on Computing and Information Science and Technology and their Applications 2019*, Mar. 2019, pp. 1–5, doi: 10.1109/ICCISTA.2019.8830652.
[25] O. Bouachir, A. Abrassart, F. Garcia, and N. Larrieu, “A mobility model for UAV ad hoc network,” in *2014 International Conference on Unmanned Aircraft Systems, ICUAS 2014 - Conference Proceedings*, May 2014, pp. 383–388, doi: 10.1109/ICUAS.2014.6842277.
[26] E. A. Abdullah, I. Ahmed Saleh, and O. I. Al Saif, “Performance evaluation of parallel particle swarm optimization for multicore environment,” in *2018 International Conference on Advanced Science and Engineering (ICOASE)*, Oct. 2018, pp. 81–86, doi: 10.1109/ICOASE.2018.8548816.
[27] Y. Bai, Y. Mai, and N. Wang, “Performance comparison and evaluation of the proactive and reactive routing protocols for MANETs,” in *Wireless Telecommunications Symposium*, Apr. 2017, pp. 1–5, doi: 10.1109/WTS.2017.7943538.
[28] J. Gao, Y. Shen, X. Jiang, O. Takahashi, and N. Shiratori, “End-to-end delay modeling for mobile Ad Hoc networks: a quasi-birth-and-death approach,” *arXiv preprint arXiv:1312.7201*, Dec. 2013, [Online]. Available: http://arxiv.org/abs/1312.7201.
[29] Z. Luo, Y. Cui, X. Wang, and H. Luo, “On the throughput and delay in Ad Hoc networks with human mobility,” *IEEE Transactions on Communications*, vol. 63, no. 6, pp. 2273–2287, Jun. 2015, doi: 10.1109/TCOMM.2015.2427167.
[30] V. Mehta and N. Gupta, “Performance analysis of QoS parameters for WiMAX network,” *International Journal of Science and Research (IJSR)*, vol. 5, no. 6, pp. 512–521, Jun. 2016, doi: 10.21275/v5i6.NOV164379.
[31] A. I. M. Ali, “E-Governance System Challenges and Cloud Computing Benefits in E- Governance,” *Technium*, vol. 3, no. 11, pp. 19–31, 2021.
[32] A. I. Mahmood and A. Saleh, “Apply improve monkey algorithm (IMA) for software testing process,” *International Journal of Software & Hardware Research in Engineering (IJSHRE)*, vol. 9, no. 9, pp. 142–150, 2021.

BIOGRAPHIES OF AUTHORS

Alaa Ibrahim Mahmood was born in Mosul-Iraq. She holds a M.Sc degree in information Technology from university Utara Malaysia (UUM), B.Sc degree in computer science from college computer science and mathematic, University of Mosul, Iraq. She is a lecturer in secondary school (AL-Zuhur) in Mosul, Iraq. He can be contacted at email: alaaibmah2@gmail.com.

Omar Ibrahim Alsaif he received his B.Sc. in electrical engineering from University of Mosul, Mosul, Iraq, in 1992. He received his M.Sc. and Ph. D degrees in electrical and microelectronic engineering from Mosul University, in 2005 and 2018 respectively. He is currently a lecturer in the Mosul Technical Institute/Northern Technical University in Mosul, Iraq. His research interests in clude microelectronic solid-state systems and renewable energy. He can be contacted at email: omar.alsaif@ntu.edu.iq.

Ibrahim Ahmed Saleh was born in Mosul-Iraq in 1963. He received his MSc. degree (in signal and image processing) from the University of Mosul, Iraq in 2003 and in 2013 he received his PhD inartificial techniques and computer networking from Mosul University. He became professor in 2021. From 1997 to 2005, he worked at computer center in Mosul University/Iraq. Currently he is lecturer at the Dept. of Software Engineering, College of Computer Sciences and Math, and University of Mosul, Iraq. He can be contacted at email: i.hadedi@uomosul.edu.iq.