ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

TRUST MONITORING FRAMEWORK FOR EFFECTIVE COOPERATION IN SATELLITE ASSISTED UAVS ENABLED VANETS

F. AL-DOLAIMY[1] , OSAMA YASEEN M. AL-RAWI[2], RABEI RAAD ALI[3], AHMED H. R. ALKHAYYAT[4], FATIMA HASHIM ABBAS[5] , ALI ALSALAMY[6]

[1] College of Medical and Health Technologies, Al-Zahraa University for Women, Karbala, Iraq
[2]Electrical and Electronic Engineering Department, College of Engineering, Gulf University, Sanad 26489, Kingdom of Bahrain
[3] Department of Computer Engineering Technology, Northern Technical University, 41000, Mosul, Iraq
[4]College of technical engineering, The Islamic University, Najaf, Iraq
[5]Medical Laboratories Techniques Department, Al-Mustaqbal University College, 51001 Hillah, Babil, Iraq
[3]College of Information Technology, Imam Ja'afar Al-Sadiq University, Al-Muthanna 66002, Iraq
E-mail: 1firasabedi@alzahraa.edu.iq, 2eng.dean@gulfuniversity.edu.bh, 3rabei @ntu.edu.iq, 4ahmedalkhayyat85@iunajaf.edu.iq, 5fatimahashim@mustaqbal-college.edu.iq, 6alsalamy877@gmail.com

ABSTRACT

Vehicular Ad hoc Network (VANETs) is high-speed networks, and it is combined with Unmanned Aerial Vehicles (UAVs) to build effective communication among vehicles. The communication modules of UAVs assisted VANETs vehicles to roadside units (RSUs), vehicles to UAVs and UAVs to UAVs. And it gets further enabled with satellite and the additional module like UAVs to satellite is included with it. Through UAVs the vehicles are monitored, and it becomes eligible to transfer highly confidential information. So, it is essential to improve the trustworthiness of the vehicles to communicate. For this purpose, Trust Monitoring Framework for Satellite Assisted UAVs Enabled VANETs (TMF-SAUAVs) is proposed in this paper. This method includes two segments such as trust evaluation and trust management. Through trust evaluation, the trust values of vehicles are calculated using direct trust, indirect trust and comprehensive trust calculation. Through trust management, the trust history of the vehicles is properly monitored to easily identify honest vehicles. This method greatly increases the efficiency of the Satellite Assisted UAVs Enabled VANETs. Using NS2 and SUMO, the simulation is run. Energy efficiency, packet delivery rate, end-to-end delay, and routing overhead are the factors considered while evaluating value. The outcomes are contrasted with earlier methods like JRT-UAVs and PDO-UAVs. The results show that, as compared to earlier efforts, the suggested TMF-SAUAVs approach achieved high efficiency and delivery rate as well as lower latency and routing overhead.

Keywords: *Vehicular Ad hoc Network, Unmanned Aerial Vehicles, Satellite Assisted, TMF-SAUAVs.*

1. INTRODUCTION

Without the aid of an infrastructure equipment, such as access point or base station, an Ad Hoc Network is a wireless network that enables simple connection setup between wireless client devices in the same physical area [1-8]. Vehicular Ad hoc Network (VANETs) is combined with Unmanned Aerial Vehicles (UAVs) to overcome the drawbacks produced by ground-level obstacles. Due to the high-speed, unpredictable mobility of cars, VANETs' first communication models are vehicle-to-vehicle and vehicle-to-infrastructure, which results in ineffective communication [9–13]. In recent days UAVs enabled VANETs are introduced at the time the communication is performed between vehicles to UAVs, vehicles to RSUs and UAVs to UAVs. UAVs are widely used in several applications which are based on the intelligent transmission system. UAVs consist of certain unique characteristics such as high ability, high mobility, high flexibility and ease to locate [14-16]. Due to this criterion, it becomes a very interesting topic for both the academia and industry sectors [17-24].

In [20], the author developed the UAV-assisted Ubiquitous Trust Evaluation (UUTE) framework. In terms of accuracy and communication expense, this framework worked more effectively. The fundamental problem with this system, though, is growing latency.

In [21], the author described a framework for UAV-assisted trustworthy code dissemination that helps choose reliable mobile vehicles for code distribution with opportunistic routing. Although this architecture provides more throughput, it has been shown to have a serious fault in that it uses more energy. Through UAVs the data collection among the vehicles becomes more effective because it can able to re-establish transmission among ground vehicles and it also serves the ground user equipment and cellular networks. UAVs are equipped with solar energy so that they can able get recharged easily and consist of omni- directional antennas to perform communication. UAVs are a device that can able to transfer such confidential information from vehicles so it is very essential to increase the trustworthiness of the vehicles. For this purpose, in this paper satellite-assisted UAVs-enabled VANETs are developed as well as a trust monitoring process is incorporated with it. The contribution of the research is described in the following:

- In order to overcome the VANETs from the ground level obstacles UAVs are introduced in it that greatly help the vehicles to perform communication through air medium so that it can get escape from the ground level obstacles.
- To improve the density and to provide overall coverage satellite-assisted UAVs-enabled VANETs are developed in this paper.
- To improve the trustworthiness of the vehicles a novel trust monitoring framework is developed in satellite-assisted UAVs enabled VANETs.
- This major process of the framework is direct trust, indirect trust and comprehensive trust calculation with trust management.
- As a result of this procedure, the network's energy efficiency and packet delivery ratio are both raised, and its delay overhead is decreased..

The remaining parts of the paper are listed as follows: The prior works that addressed the advantages and disadvantages of UAVs and VANETs are described in section 2. The network environment is displayed in section 3. The suggested TMF-SAUAVs strategy is explained in section 4. Performance analysis is carried out in section 5. Results and comparative analyses are reported in section 6. Section 7 provides a conclusion and suggestions for additional development.

2. RELATED WORKS

The authors in [22] proposed a provenance-aware distributed trust approach that aims to achieve accurate peer-to-peer (P2P) trust assessment and maximize the delivery of correctly received messages. This approach uses destination nodes and resource-constrained network environments to minimize message delay. Additionally, this work employs UAVN-pro, which takes a data-driven approach to reduce resource consumption. The results show that UAVN-pro's functionality is compatible with existing UAV network routing protocols and effectively identifies attacks.

The authors in [25] presented a collaboration trust interconnection system among UAVs to evaluate trust and choose low-cost and high-trust participants to enhance data quality. The false ratio, packet loss rate, and communication expense are all decreased by this approach. The biggest drawback of this framework is that it needs more power to keep performing.

The authors in [26] achieved an efficient and reliable network performance by proposing QoS Aware Hybrid Optimization in VANETs. The Ant colony optimization (ACO) algorithm is used for initial optimal path selection and Effective Whale Optimization (EWO) algorithm is used to find the best optimal solution to achieve effective communication in VANETs. The results shows that the performance of the proposed approach is better for effective communication for the VANETs.

The authors in [27] proposed a Risk-based Trust Evaluation Advanced Model (RTEAM) approach. The proposed model work based on Multifaceted Trust (MT) and Hop-based Trust (HT) for each required action of both reports. The results show that the risk-based trust approach outperforms a purely trust-based approach in terms of undefined cases and true positive rates.

The authors in [28] proposed a new software-defined trust based framework. The proposed framework centralized SDN controller is served as a learning agent to get the optimal communication link policy by deep learning method. The Expected Transmission Count (ETX) used as a metric to estimate the quality of the communication link in each connected vehicles' communication. Also, the author design a trust framework to avoid the bad influence of malicious and enhances the link quality.

The authors in [29] proposed a Context-Awareness Trust Management (CATM) approach for estimating the trustworthiness of received messages. The proposed approach determines the trust evaluation result of an evaluation request, remaining unaffected by the presence of conflicting

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

evidence and the trust level of entities in the network. Furthermore, the approach enables vehicles to adapt the evaluation strategy to maintain accurate estimation results in different driving situations and to verify the effectiveness of the proposed approach. The results demonstrate that this approach can effectively adjust to various driving scenarios, requiring minimal additional time.

The author in [30] presented a Low Earth Orbit (LEO) satellite- and cache-assisted unmanned aerial vehicle that enhanced throughput while also achieving ubiquitous connection and high capacity by employing model-based techniques such as cache placement optimization and UAV resource optimization. This strategy increases network speed and bandwidth while failing to reduce overhead and delay.

The author in [31] established a non-orthogonal multiple access (NOMA)-based multi-unmanned aerial vehicle (UAV) emergency network but it failed to achieve high efficiency and packet delivery ratio during communication. After analysis of the earlier work it is understood that UAVs assisted VANETs still needs some upgrade to improve the effectiveness in communication and to achieve that satellite assisted UAVs enabled VANETs are developed as so to achieve better performance trust monitoring framework is performed in this network which is detailed in the upcoming sections.

3. NETWORK ENVIRONMENTS

The types are communication which is performed in this network model is (i) vehicle to RSUs, (ii) vehicles to UAVs, (iii) UAVs to UAVs and (iv) UAVs to satellite. In order to overcome the drawbacks of the vehicle to vehicle communication and to increase the network density satellite-assisted UAVs in VANETs are introduced. The network model of satellite-assisted UAVs in VANETs is shown in Figure 1.

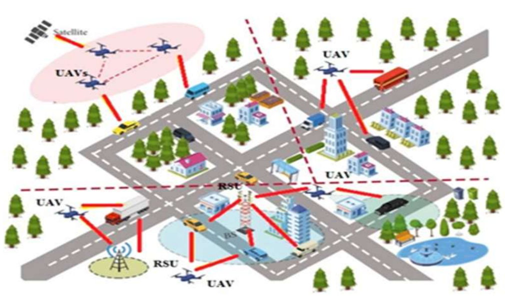

Figure 1: Network Model

3.1 Vehicle to RSUs communication

Vehicles such as RSUs that are present in its coverage area initially share information about it. RSUs are placed on roadsides, and it is static in nature. RSUs collect the data which is transmitted from the vehicles.

3.2 Vehicles to UAVs communication

At the time of communication between vehicles and RSUs there may be a presence of obstacles in the ground. At the time of transferring the data, the vehicle verifies the path whether it consists of obstacles or not. Once the obstacle is found the vehicles ignore the data transmission with the respected RSUs and transfer the data to the UAVs which is present in the coverage area so that they can get escape from the ground-level obstacles. UAVs hold access to communicate with any vehicle at any time.

3.3 UAVs to UAVs communication

Once after receiving the data from the vehicles the UAVs search for its destination. If the destination is present in it coverage area then it will transfer the data to the destination. If not then it will transfer the data to another UAV which is present in the line of sight to the destination. UAVs communication is more stable and to create cost effective network it is very essential to place the UAVs in the proper place so that using minimum number of UAVs the entire network is get covered.

3.4 UAVs to satellite communication

After collecting the data from the vehicles and the UAVs the current UAVs transfer the data to the satellite. The satellite is the controlling authority of the complete network which collects the data from all the UAVs at the final stage.

4. TMF-SAUAVS APPROACH

In this section a Trust Monitoring Framework for Satellite Assisted UAVs Enabled VANETs (TMF-SAUAVs) is developed which consists of two sections they are trust evaluation and trust management. The workflow of the proposed TMF-SAUAVs is shown in Figure 2.

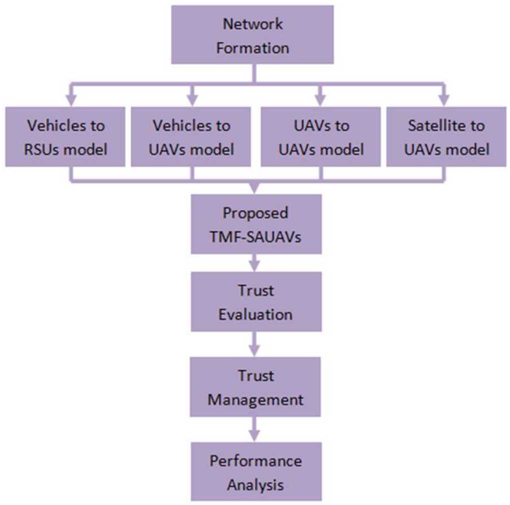

Figure 2: Workflow of the proposed TMF-SAUAVs

In this network model each vehicle can be able to communicate with the RSUs and the UAVs. So, it is essential to improve the trustworthiness of the vehicles. Here the trust estimation is performed On Board Unit (OBU) and for the data. The metrics which are considered for the trust estimation are data weight, vehicle weight, and vehicle speed and diversion rate of the vehicle. According to this metric, the trustworthiness of the vehicle is calculated, and it is mathematically expressed in equation (1).

$$TE_V = \left[1 - \frac{\Delta V_{DW}(t) + \Delta V_W(t) + \Delta V_S(t) + \Delta V_{DR}(t)}{100}\right] \quad (1)$$

Equation (1) shows the trust worthiness of each vehicle. Using those terms, the direct trust, indirect trust and comprehensive trust values of the vehicle is measured. The direct first value of the vehicle is described in equation (2).

$$DT_V = \frac{\Delta V_{DW}(t) * (\frac{\Delta V_{DF} + 1}{2} - \frac{\Delta V_S(t)}{\Delta V_{Dist}(t)})}{1 + \Delta V_{DR}(t)/\Delta V_W(t)} \quad (2)$$

In equation (2) the terms implies the possibility of data gets forwarded back to the vehicle and implies the coverage area of the vehicle with respect to time. Followed by this the indirect trust calculation is performed and it is described in equation (3).

$$IDT_V = \frac{\sum_{i=1}^{n} DT_V * \Delta V_W(t) * \Delta V_S(t)}{\sum_{i=1}^{n} DT_V} \quad (3)$$

Finally, the comprehensive trust is determined using the direct and indirect trust values, and the mathematical expression for calculating comprehensive trust is provided in equation (4).

$$CT_V = (\alpha * DT_V) + (\beta * IDT_V) \quad (4)$$

According to the equation (4) the comprehensive trust value of each vehicle is measured through this process the vehicle transmitted data reached the UAVs or RSUs without any delay and overhead.

4.1 Trust Management

The trust evaluation is performed in the vehicles before transferring and receiving the data. Trust management is performed by the RSUs and UAVs while receiving the data from the vehicles. Using equation (1) the trustworthiness of the vehicles are analyzed by the RSUs and UAVs where it will maintain the historical trust information of all the vehicles with it. During the communication with any vehicles, it will check the past history and the variation percentage of the current trust score and the past trust score. According to the long-term behaviors of the vehicle the present variation ratio is measured through that it predicts the vehicle is honest or not. In case if it lowers than certain values then the vehicle is considered as malicious, and the transmission gets neglected. This is the overall process of the trust monitoring framework in satellite assisted UAVs enabled VANETs.

5 PERFORMANCE ANALYSIS

To evaluate the performance of the proposed TMF-SAUAVs approach in this simulation real time traffic is used with realistic simulation in road networks. Real time vehicle mobility is generated using SUMO and open street map. That vehicle mobility is applied to NS2 to analysis the performance of the proposed method and it is compared with the earlier methods such as JRT-UAVs [30] and PDO-UAVs [31]. To evaluate the performance, a few parameters are measured during the process of simulation. They are energy efficiency, packet delivery rate, end-to-end delay and routing overhead. The network is constructed with 1000 vehicles, 10 RSUs and 5 UAVs. Table 1 shows the input parameters of the simulation platform.

Table 1: Simulation parameters

Software	NS2/SUMO

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Simulation Time	300 ms
Coverage Area	3000m*3000m
No of Vehicles	1000 Vehicles
No of RSUs	10 RSUs
No of UAVs	5 UAVs
No of Satellite	1 Satellite
RSUs Radius	200m
UAVs Radius	500m
Initial Energy	100 Joules
Transmission Power	0.500 Joules
Receiving Power	0.050 Joules

Figure 3 compares the energy efficiency of the proposed TMF-SAUAVs technique to previous research such as JRT-UAVs and PDO-UAVs. Improving the network's energy efficiency is critical for improving communication effectiveness.

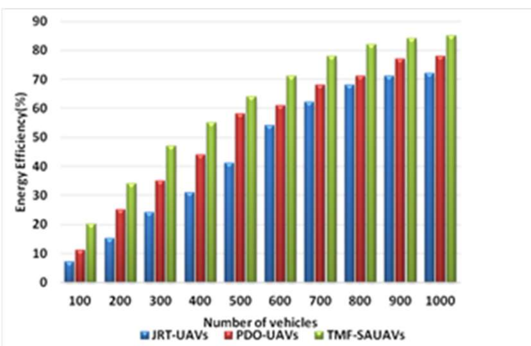

Figure 3: Energy Efficiency Calculation

The TMF-SAUAVs approach achieves an energy efficiency of 85%, while other works such as JRT-UAVs and PDO-UAVs obtain 72% and 78%, respectively. The energy efficiency of the TMF-SAUAVs approach is high when compared to previous methods, as illustrated by the output graph, due to the trust evaluation and trust management procedure.

5.1 Packet Delivery Ratio Calculation

Figure 4 compares the packet delivery ratio of the proposed TMF-SAUAVs approach to previous studies such as JRT-UAVs and PDO-UAVs. To accomplish successful communication, the network's packet delivery ratio must be improved. The TMF-SAUAVs approach achieves a packet delivery ratio of 97%, while other efforts such as JRT-UAVs and PDO-UAVs reach 88% and 91%, respectively. Because of trust monitoring frameworks, the packet delivery ratio of the TMF-SAUAVs strategy is high when compared to older methods, as seen in the output graph.

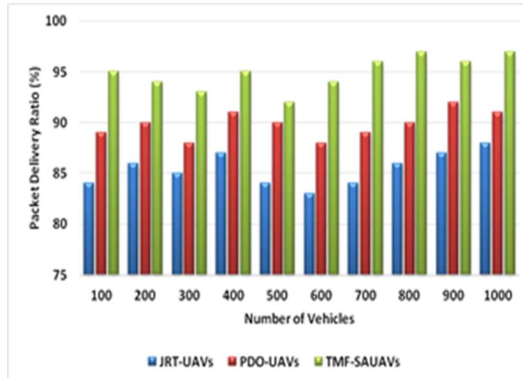

Figure 4: End to end delay calculation

5.2 End to End Delay Calculation

In Figure 5, the suggested TMF-SAUAVs approach's end-to-end delay is examined and compared to previous research such as JRT-UAVs and PDO-UAVs. The network becomes very stable if the end-to-end delay is low, and the trust monitoring framework is primarily designed to reduce the delay caused during the communications process in the network, resulting in high-speed mobility in VANETs. The TMF-SAUAVs approach produces an end-to-end delay of 85ms, whereas other works such as JRT-UAVs and PDO-UAVs cause delays of 149ms and 104ms, respectively. The TMF-SAUAVs strategy has a reduced end-to-end delay than the previous methods, as seen in the output graph.

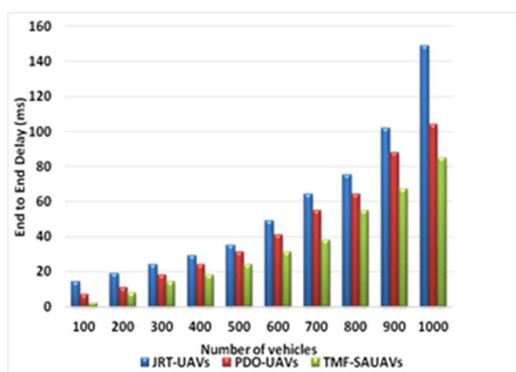

Figure 5: End-to-End Delay Calculation

5.3 Routing Overhead Calculation

Figure 6 illustrates the routing overhead of the proposed TMF-SAUAVs approach, which is compared to previous studies such as JRT-UAVs and PDO-UAVs. To achieve an effective performance of the network it is mandatory to reduce the routing overhead. Through trust monitoring process the transmission is carried out in stable manner that greatly reduced the routing overhead during communication.

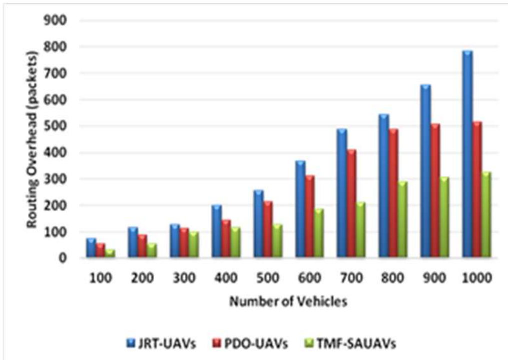

Figure 6: Routing Overhead Calculation

The routing overhead produced by the TMF-SAUAVs approach is 325 packets, whereas the delay produced by the other works like JRT-UAVs and PDO-UAVs are 784 packets and 514 packets. As illustrated in the output graph, the routing overhead of the TMF-SAUAVs approach is lower when compared with the earlier methods.

6 RESULTS AND DISCUSSION

The comparative analysis of JRT-UAVs, PDO-UAVs and the proposed TMF-SAUAVs approach are given in Table 2 where the values for the parameters such as energy efficiency, packet delivery rate, end-to-end delay and routing overhead are discussed.

Table 2: Results Analysis And Measurements

Parameters / Methods	JRT-UAVs	PDO-UAVs	TMF-SAUAVs
Energy Efficiency	72%	78%	85%
Packets Delivery Ratio	88%	91%	97%
End to End Delay	149ms	104ms	85ms
Routing Overhead	784 packets	514 packets	325 packets

Table 2 shows that the proposed TMF-SAUAVs solution outperforms previous efforts in terms of energy efficiency, packet delivery rate, end-to-end delay, and routing overhead. The proposed TMF-SAUAVs approach is 13% more energy efficient than JRT-UAVs and 7% more efficient than PDO-UAVs. In the packet delivery ratio computation, the suggested TMF-SAUAVs solution outperforms JRT-UAVs by 9% and PDO-UAVs by 6%. TMF-SAUAVs method has a 65 ms shorter end-to-end delay than JRT-UAVs and a 20 ms lower end-to-end delay than PDO-UAVs.

The TMF-SAUAVs approach has 400 packets less routing overhead than the JRT-UAVs and 200 packets less than the PDO-UAVs. The suggested TMF-SAUAVs approach outperforms previous efforts in terms of overall performance, and such findings were accomplished with the help of the trust model in satellite-assisted UAVs-enabled VANETs.

7 CONCLUSION

In this paper, a new approach is proposed to enhance the effectiveness of VANETs, called TMF-SAUAVs, transforming the network into Satellite Assisted UAVs Enabled VANETs. This innovation enables vehicles to bypass ground-level congestion and expands the network's capabilities. This approach employs direct trust, indirect trust, and comprehensive trust calculations, along with robust trust management, to elevate and oversee the trust values of vehicles. The NS2 on the Ubuntu operating system used in the simulation. Four parameters are applied to evaluat and compare against previous approaches. The parameters are energy efficiency, packet delivery rate, end-to-end delay, and routing overhead. The result shows that the proposed TMF-SAUAVs solution outperforms these earlier techniques, achieving 7% to 13% greater energy efficiency, a 6% to 9% higher packet delivery ratio, a 20ms to 60ms reduction in end-to-end delay, and a decrease of 200 to 400 packets in routing overhead. In future work, the authors should focus on optimizing bandwidth utilization and improve the proposed approach with sensors.

REFERENCES:

[1] Mostafa, S. A., Gunasekaran, S. S., Khaleefah, S. H., Ahmad, M. S., Mohammed, M. A., Hassan, M. H., & Jubair, M. A. (2022, March). Improving the Knowledge Management Processes Through a Multi-Agent Knowledge Audit Framework. In Future of Information and Communication Conference (pp. 526-539). Springer, Cham.

[2] Mchergui, A., Moulahi, T., & Zeadally, S. (2022). Survey on artificial intelligence (AI) techniques for vehicular ad-hoc networks (VANETs). Vehicular Communications, 34, 100403.

[3] Ali, R. R., Al-Dayyeni, W. S., Gunasekaran, S. S., Mostafa, S. A., Abdulkader, A. H., & Rachmawanto, E. H. (2022, March). Content-Based Feature Extraction and Extreme Learning Machine for Optimizing File Cluster

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Types Identification. In Future of Information and Communication Conference (pp. 314-325). Springer, Cham..

[4] Al-Shareeda, M. A., & Manickam, S. (2023). A Systematic Literature Review on Security of Vehicular Ad-hoc Network (VANET) based on VEINS Framework. IEEE Access.

[5] Rashid, K., Saeed, Y., Ali, A., Jamil, F., Alkanhel, R., & Muthanna, A. (2023). An Adaptive Real-Time Malicious Node Detection Framework Using Machine Learning in Vehicular Ad-Hoc Networks (VANETs). Sensors, 23(5), 2594.

[6] Mostafa, S. A., Mustapha, A., Ramli, A. A., Jubair, M. A., Hassan, M. H., & Abbas, A. H. (2020, July). Comparative analysis to the performance of three Mobile ad-hoc network routing protocols in time-critical events of search and rescue missions. In International Conference on Applied Human Factors and Ergonomics (pp. 117-123). Springer, Cham.

[7] Hassan, M. H., Jubair, M. A., Mostafa, S. A., Kamaludin, H., Mustapha, A., Fudzee, M. F. M., & Mahdin, H. (2020). A general framework of genetic multi-agent routing protocol for improving the performance of MANET environment. IAES International Journal of Artificial Intelligence, 9(2), 310.

[8] Pandey, P. K., Kansal, V., & Swaroop, A. (2022). OCSR: overlapped cluster-based scalable routing approach for vehicular ad hoc networks (VANETs). Wireless Communications and Mobile Computing, 2022.

[9] Al-Obaidi, A. S., Jubair, M. A., Aziz, I. A., Ahmad, M. R., Mostafa, S. A., Mahdin, H., ... & Hassan, M. H. (2022). Cauchy Density-Based Algorithm for VANETs Clustering in 3D Road Environments. IEEE Access, 10, 76376-76385.

[10] Abbas, A. H., Mansour, H. S., & Al-Fatlawi, A. H. (2022). Self-Adaptive Efficient Dynamic Multi-Hop Clustering (SA-EDMC) Approach for Improving VANET's Performance. International Journal of Interactive Mobile Technologies, 17(14).

[11] Abbas, A. H., Ahmed, A. J., & Rashid, S. A. (2022). A Cross-Layer Approach MAC/NET with Updated-GA (MNUG-CLA)-Based Routing Protocol for VANET Network. World Electric Vehicle Journal, 13(5), 87.

[12] Malik, R. Q., Ramli, K. N., Kareem, Z. H., Habelalmatee, M. I., Abbas, A. H., & Alamoody, A. (2020, September). An overview on V2P communication system: Architecture and application. In 2020 3rd International Conference on Engineering Technology and its Applications (IICETA) (pp. 174-178). IEEE.

[13] Habelalmateen, M. I., Abbas, A. H., Audah, L., & Alduais, N. A. M. (2020). Dynamic multiagent method to avoid duplicated information at intersections in VANETs. TELKOMNIKA (Telecommunication Computing Electronics and Control), 18(2), 613-621.

[14] Abbas, A. H., Habelalmateen, M. I., Audah, L., & Alduais, N. A. M. (2019). A novel intelligent cluster-head (ICH) to mitigate the handover problem of clustering in VANETs. International Journal of Advanced Computer Science and Applications, 10(6).

[15] Abbas, A. H., Audah, L., & Alduais, N. A. M. (2018, October). An efficient load balance algorithm for vehicular ad-hoc network. In 2018 Electrical Power, Electronics, Communications, Controls and Informatics Seminar (EECCIS) (pp. 207-212). IEEE.

[16] Z. Hajiakhondi-Meybodi, A. Mohammadi and J. Abouei, "Deep Reinforcement Learning for Trustworthy and Time-Varying Connection Scheduling in a Coupled UAV-Based Femtocaching Architecture," in IEEE Access, vol. 9, pp. 32263-32281, 2021, doi: 10.1109/ACCESS.2021.3060323.

[17] J. Zhang, H. Xu, L. Xiang and J. Yang, "On the Application of Directional Antennas in Multi-Tier Unmanned Aerial Vehicle Networks," in IEEE Access, vol. 7, pp. 132095-132110, 2019, doi: 10.1109/ACCESS.2019.2940338.

[18] Mansour, H. S., Mutar, M. H., Aziz, I. A., Mostafa, S. A., Mahdin, H., Abbas, A. H., ... & Jubair, M. A. (2022). Cross-Layer and Energy-Aware AODV Routing Protocol for Flying Ad-Hoc Networks. Sustainability, 14(15), 8980.

[19] Mostafa, S., Ramli, A., Jubair, M., Gunasekaran, S., Mustapha, A., Hassan, M. (2022). Integrating Human Survival Factor in Optimizing the Routing of Flying Ad-hoc Networks in Search and Rescue Tasks. In: Tareq Ahram (eds) Human Factors in Software and Systems Engineering. AHFE (2022) International Conference. AHFE Open Access, vol 61. AHFE International, USA.http://doi.org/10.54941/ahfe1002523

[20] M. Huang, A. Liu, N. N. Xiong and J. Wu, "A UAV-Assisted Ubiquitous Trust

Communication System in 5G and Beyond Networks," in IEEE Journal on Selected Areas in Communications, vol. 39, no. 11, pp. 3444-3458, Nov. 2021, doi: 10.1109/JSAC.2021.3088675.

[21] J. Liang, W. Liu, N. N. Xiong, A. Liu and S. Zhang, "An Intelligent and Trust UAV-Assisted Code Dissemination 5G System for Industrial Internet-of-Things," in IEEE Transactions on Industrial Informatics, vol. 18, no. 4, pp. 2877-2889, April 2022, doi: 10.1109/TII.2021.3110734.

[22] C. Ge, L. Zhou, G. P. Hancke and C. Su, "A Provenance-Aware Distributed Trust Model for Resilient Unmanned Aerial Vehicle Networks," in IEEE Internet of Things Journal, vol. 8, no. 16, pp. 12481-12489, 15 Aug.15, 2021, doi: 10.1109/JIOT.2020.3014947.

[23] D. Chen, Q. Qi, Z. Zhuang, J. Wang, J. Liao and Z. Han, "Mean Field Deep Reinforcement Learning for Fair and Efficient UAV Control," in IEEE Internet of Things Journal, vol. 8, no. 2, pp. 813-828, 15 Jan.15, 2021, doi: 10.1109/JIOT.2020.3008299.

[24] T. M. Ho, K. -K. Nguyen and M. Cheriet, "UAV Control for Wireless Service Provisioning in Critical Demand Areas: A Deep Reinforcement Learning Approach," in IEEE Transactions on Vehicular Technology, vol. 70, no. 7, pp. 7138-7152, July 2021, doi: 10.1109/TVT.2021.3088129.

[25] S. Huang, Z. Zeng, K. Ota, M. Dong, T. Wang and N. N. Xiong, "An Intelligent Collaboration Trust Interconnections System for Mobile Information Control in Ubiquitous 5G Networks," in IEEE Transactions on Network Science and Engineering, vol. 8, no. 1, pp. 347-365, 1 Jan.-March 2021, doi: 10.1109/TNSE.2020.3038454.

[26] F. Al-dolaimy, R. R. Ali, N. Nabeel, W. S. Al-Dayyeni, Abbas, F. H., Hariz, H. M., ... & M. A. Jubair, (2023). Hybrid Optimization with Enhanced QoS-based Path Selection in VANETs. International Journal of Intelligent Engineering & Systems, 16(4). doi: 10.22266/ijies2023.0831.06

[27] R. J. Atwa, P. Flocchini and A. Nayak, "RTEAM: Risk-Based Trust Evaluation Advanced Model for VANETs," in IEEE Access, vol. 9, pp. 117772-117783, 2021, doi: 10.1109/ACCESS.2021.3107467.

[28] D. Zhang, F. R. Yu, R. Yang and L. Zhu, "Software-Defined Vehicular Networks With Trust Management: A Deep Reinforcement Learning Approach," in IEEE Transactions on Intelligent Transportation Systems, vol. 23, no. 2, pp. 1400-1414, Feb. 2022, doi: 10.1109/TITS.2020.3025684.

[29] J. Guo et al., "TROVE: A Context-Awareness Trust Model for VANETs Using Reinforcement Learning," in IEEE Internet of Things Journal, vol. 7, no. 7, pp. 6647-6662, July 2020, doi: 10.1109/JIOT.2020.2975084.

[30] D.H. Tran, S. Chatzinotas and B. Ottersten, “Satellite- and Cache-Assisted UAV: A Joint Cache Placement, Resource Allocation, and Trajectory Optimization for 6G Aerial Networks”, IEEE Open Journal of Vehicular Technology, vol. 3, pp. 40 – 54, 2022, doi: 10.1109/OJVT.2022.3142170.

[31] L. Lin, W. Xu, et.al, “Prioritized Delay Optimization for NOMA-Based Multi-UAV Emergency Networks”, IEEE Transactions on Vehicular Technology, pp. 1 – 6, 2022, doi: 10.1109/TVT.2022.3184955.