Performance evaluation of software defined networking into vanets system

Younus Hasan Taher[1], Israa Alsaadi[2], Mohammed Ayad Saad[1,3], Adnan Hussein Ali[4], Mohammed Essa[5], Ahmed Hashim Rashid[1]
[1]Department of Electrical, Electronics and Systems Engineering, Universiti Kebangsaan Malaysia, Bangi, Malaysia
[2]Department of Computer Science, College of Science for Women, University of Baghdad, Baghdad, Iraq
[3]Department of Medical Instrumentations Technique Engineering, Al-Kitab University, Kirkuk, Iraq
[4]Middle Technical University, Institute of Technology, Baghdad, Iraq
[5]Department of Medical Instrumentations Technique Engineering, Jannat Iraq College, Ramadi, Iraq

Article Info

Article history:

Received Aug 30, 2022
Revised Apr 4, 2024
Accepted May 17, 2024

Keywords:

Ad hoc on demand distance vector
Delivery delay time
Packet delivery ratio
Software defined network
Vehicular ad hoc network

ABSTRACT

Vehicular ad hoc networks (VANETs) is an important topic nowadays. A lot of research deal and attracts consideration owing to potential for increasing traffic and travel efficiency, improving road safety for vehicles, providing convenience and comfort to both drivers and passengers. The need for a packet delivery ratio (PDR) and low delivery delay time in communication are the key elements in modern life especially when traveling in vehicles. To satisfy these demands; researchs in VANET systems aims to develop some new technologies. One of these technologies is using software-defined-network (SDN) to enhance communication between vehicles on the road. Because of this, project evaluates using SDN protocol with two most viable VANET protocols which are ad hoc on demand distance vector (AODV) and optimized link state routing (OLSR) in LTE communication. Two performance metrics are used to evaluate the performances, the PDR and the delivery delay time. The simulation is performed in the varying density network and varying speed vehicles. The simulation results show that SDN displays better performance than AODV and OLSR in both PDR and delivery delay time. SDN uses global views of SDN controller to determine the shortest route with the highest vehicle density. Additionally, it solves the local maximum issue and adds dense connectivity.

Corresponding Author:

Mohammed Ayad Saad
Department of Electrical, Electronics and Systems Engineering, Universiti Kebangsaan Malaysia
Bangi, Malaysia
Email: mohmmad9alani@gmail.com

1. INTRODUCTION

Nowadays, research on vehicular ad hoc networks (VANETs) is crucial. Vehicle communication researchers are interested in a variety of forms of study on this subject since it has the potential to increase vehicle road safety [1], [2] enhance traffic and travel efficiency, and provide convenience and comfort for passengers and drivers intelligent transport services (ITS) is an example of an intelligent transportation system [3]. ITS is the parent of several areas of transportation communication due to the expected growth in mobile devices and mobile traffic, these areas are the vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications VANETs can be used to provide a wide range of services [4], both safety-related and unrelated uses. Examples include services for managing traffic for vehicles, surveillance, and cloud-based mobile vehicular services [5], [6].

As previously said, VANETs are significant because to their realism and capacity to accommodate new services and protocols. Due to its significance, the VANETs system has several difficulties while creating its applications, such as imbalanced flow traffic among multiple-path topology [7], and ineffective network use additionally, open, and adaptable automotive designs are essential for improving the transportation system, as well as for improving the environment's productivity [8], [9]. The control of users, apps, and network resources. The primary subject to address some of these issues is software-defined networking (SDN), therefore researchers take it into account [10], [11]. Using OpenFlow, the most popular SDN protocol, SDN provides a potent method with a methodical means to regulate the network [12], [13]. Figure 1 depicts several VANETs use cases where SDN may be utilised as a flexible controller to meet the needs of these cases [14], [15].

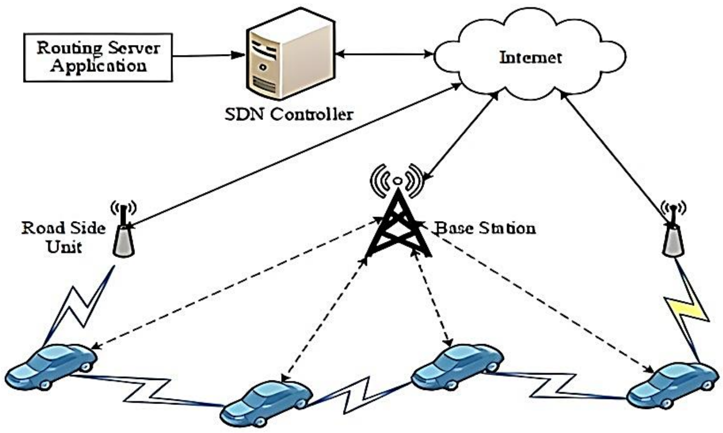

Figure 1. Software-defined VANET routing framework

In this paper, applying SDN into VANETs is the main core of this thesis with a study of suitable architecture, operations, and focus on the benefits of SDN in intelligent transportation [16], [17]. The emerging of SDN into VANETs is suitable in this study because of its highly adaptive, flexible, programmable, and scalable environments under study. This paper is organized as follows. Section 1 introduces the VANET along with recent studies [18], [19]. Section 2 related work, section 3 presents the proposed method. Section 4 presents the simulation parameters. Section 5 discusses the simulation results. Concluding remarks are described in section 6.

2. RELATED WORKS

Simulate the performance of a prediction control scheme called Offloading based on SDN for the offloading of the V2I as a type of VANETs system. The simulation results show that the performance of the system proposed for the cellular networks load and traffic is reduced, and the networking quality increased using IEEE 802.11p network of the roadside unit (RSU). It evaluates the performance of the VANETs system using 5G and SDN to evaluate the performance tradeoff between network, mobility, performance, and security features. The results show that the integration between these types of networks can make the system more secure with very high reliable operation. By simulating the efficient service channel allocation method to reduce interferences between services supplied on neighbouring channels [20], the performance of the channel allocation scheme in the SDN-VANETs system was assessed in Radha. By illustrating how VANET may be simulated on SDN with the availability of WiFi network to assess latency, throughput, and packet loss between cars, all the necessary performance metrics for the VANETs system are simulated [21]. Improves heterogeneous network (HetNet) management over IEEE 802.11p to minimise signalling overhead and improve the overall communication quality of the HetNet under the control of SDN by simulating the performance of SDN into VANETs system with addition to 5G integration [22]. By evaluating the effectiveness of using SDN in high-performance vehicular networks using the concept of SDVN, which was described as SDN-based vehicular network architecture [23], and evaluating the effectiveness of SDN into VANETs system using road architecture with an interactive environment, the mitigation of the overhead of the SDN-VANETs system is also presented. Results indicate that performance advantages are higher when compared to conventional VANET systems [24]. To find out how the design of the VANET network can effectively support the performance of SDN networking, a variety of propagation and scenario types for traffic and changing environments are simulated. There are now many different types of services and applications planned for the automotive setting. The SDN network exhibits improved performance metrics in the same environment when compared to the current methods used in VANETs systems, and it leverages SDN architecture in VANETs to control the geographic position of RSUs [25]. This provides a much better performance statistic for choosing an appropriate placement for RSUs. This article uses 802.11p to calculate the packet delivery ratio (PDR) based on movement velocity and the number of nodes to assess the efficacy of integrated SDN-VANETs in data forwarding in a multipath environment.

3. METHOD

The usage of SDN in VANETs is the main topic of this study. The SDN-VANET application's architecture, operations, and advantages are specifically simulated in this project. As previously indicated, this combination works well in contexts for highly adaptable, flexible, programmable, and scalable VANETs. The case being studied is how to route the VANET system effectively utilising SDN for data forwarding in multipath situations concerning performance parameters like throughput, end-to-end latency, and PDR. The overall methodology of the system consists of applying SDN to the VANET system by using the components as follows: i) SDN controller, this is the main component that should illustrate in the scenario proposed to control the network routing between vehicles of the entire system; ii) SDN wireless node, it is considered the vehicle under study in which they have performed various activities after receiving the command message from the SDN controller; and iii) SDN RSU, this is the element that is used for IEEE 802.11p protocol which is used in this study. RSUs are deployed in a suitable location along with road segments. The simulation starts by applying the SDN protocol to the general VANET system which consists of 40 to 200 IEEE 802.11p nodes along the area, and the vehicles travel the simulation area at low speed varies from 5 m/s to 30 m/s which this proposed scenario performed in a low-speed high-density area like a crossroad.

The flow chart of the simulation is as shown in Figure 2. The simulation starts with initializing and building the network topology using Quale. Along with the simulation, the performance metrics were simulated for the changing in moving velocity and for changing the number of nodes. The performance metrics results for SDN routing will be compared with other traditional ad hoc routing protocols as mentioned.

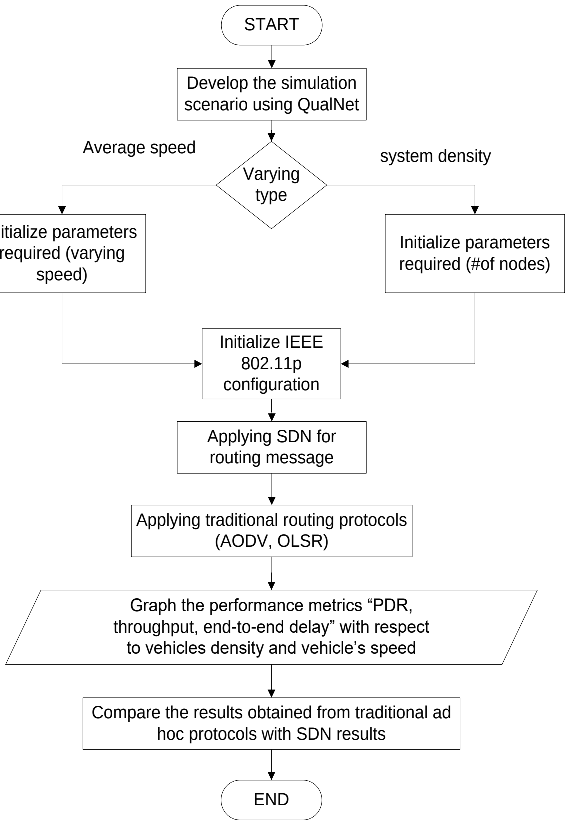

Figure 2. The flowchart of the method

4. SIMULATION SCENARIOS AND PARAMETERS

Figure 3 demonstrates the interaction between the parts of our software-defined VANET. The simulation parameters for the suggested scenario are shown in Table 1. The simulation of SDN-VANETs performance for the performance metrics listed above under the variation of vehicle speed and numbers of RSU in the simulation area for the low-speed high-density area with comparison to the results with some traditional Ad hoc routing protocols are simulated in this performance evaluation study. To create the road network, the simulation is run over a QualNet as previously explained. To meet the needs of short-range communication, this road network is a grid-type system with an area of 1,000×1,000 m^2. Each road section is 200 m long. Along the whole simulation region, there are anything from 40 to 200 nodes. Each SDN wireless node includes short-range IEEE 802.11p wireless ports.

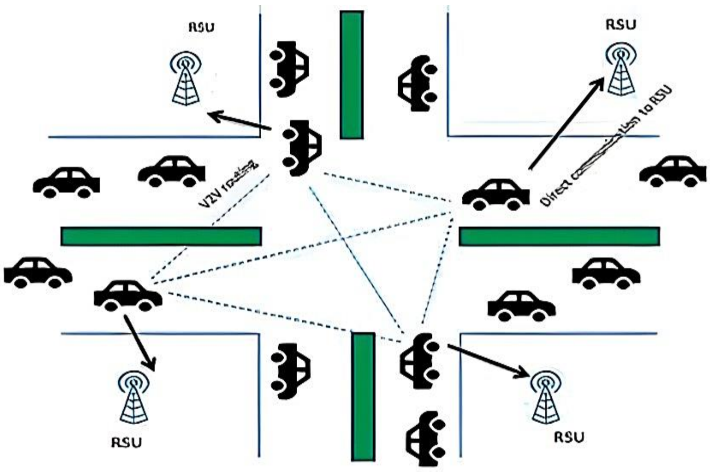

Figure 3. The proposed scenario for SDN-VANET communications

Table 1. Simulation parameters and values

Parameter	Value
Simulation area	1000×1000 m^2
Road section	200 m
Node number	40–200 nodes
The place for SDN controller	The simulation area's core has been equipped with LTE connectivity
Wireless interfaces	short-range: 802.11 with the Friis propagation loss model
Packet rate	4 packets/s
Size of the package	1024 byte
Time between messages	500 ms
Moving velocity	5–30 m/s

The transmission range is constrained by the Friis propagation loss model as a result of the shift in the vehicles' sluggish motion. The 1024-byte packet size is generated at a rate of 4 packets per second. The period between beacon messages is 500 ms. Vehicles are travelling at speeds ranging from 5 to 30 m/s for short-range communication. In Table 1, the simulation parameters are shown.

5. RESULTS AND DISCUSSION

This section outlines and discusses the main finding of the work, the simulation results obtained from the simulation of the project with the simulation parameters mentioned. The results show the performance evaluation of the PDR, delivery delay time (end-to-end delay), and throughput under changing the speed of vehicles in the road and the change of node density as mentioned in Table 1. for different types of routing protocols compared to the proposed SDN routing protocol.

5.1. Packet delivery ratio results

As shown in Table 1, the PDR findings are based on the simulation of a grid-style network with segments of road of 200 metres each, a simulated region with a node density ranging from 40 to 200, and an LTE connection with a constant speed of 20 metres per second. The simulation area's centre is where the

SDN controller LTE access is situated, within wireless range of every SDN wireless node. The simulation is also run with 120 constant nodes moving at a constant speed between 5 and 30 m/s. To assess the viability of an SDN in VANET networks, Figure 4 compares the SDN routing protocol to various conventional routing protocols, such as optimized link state routing (OLSR) and ad hoc on demand distance vector (AODV).

Figure 4 shows that the PDR decreases as moving velocity increases. Vehicles move at fast speeds, which causes network topology to change quickly, increasing the packet loss ratio. Due to the drawbacks of AODV's flooding mechanism and OLSR's greedy forwarding method, it exhibits relatively poor PDR when utilising AODV and OLSR. The flooding approach used by AODV consumes a significant amount of system capacity, leaving less bandwidth available for data transmission and lowering the delivery ratio. Additionally, the OLSR's greedy technique switches to perimeter mode when the local optimum is trapped, increasing transmission latency. Results from the SDN routing protocol demonstrate that it provides the best PDR compared to all other protocols utilised in this simulation. While the OLSR and AODV only provide 75% and 74% of packets at the same.

These findings demonstrate that the SDN routing protocol works better than the other established routing methods. As a result, the SDN system reacts to topology change significantly more quickly. Specifically, as soon as the SDN wireless nodes update the SDN controller with neighbour information, the SDN controller instantly recognises that the topology has changed and sends out the appropriate control messages. The SDN controller's accumulated knowledge is the cause of everything. Figure 5 shows the result of the PDR when changing the number of nodes in the road from 40 to 200. The simulation result shows that changing the routing protocol will lead to changes in PDR. When using the SDN protocol, the PDR reaches 90% delivering at 200 nodes on the road while the OLSR reaches 80% at the same number of nodes and 70% for the AODV. According to these findings, the network density significantly affects the PDR. Since a sparse network cannot provide the necessary connection, PDR rises in crowded network circumstances. The SDN offers a comprehensive picture of traffic data to help routing strategies choose the quickest route with the highest vehicle density.

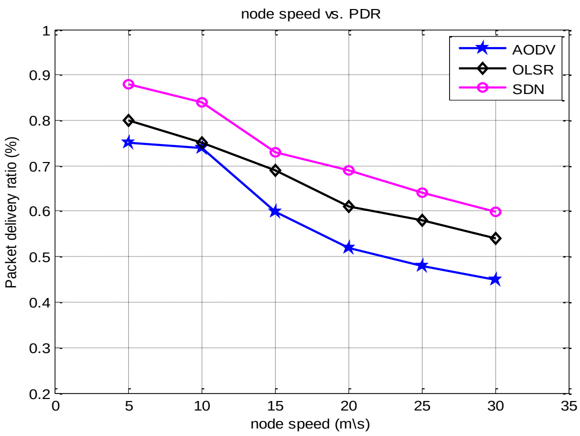

Figure 4. PDR concerning node speed

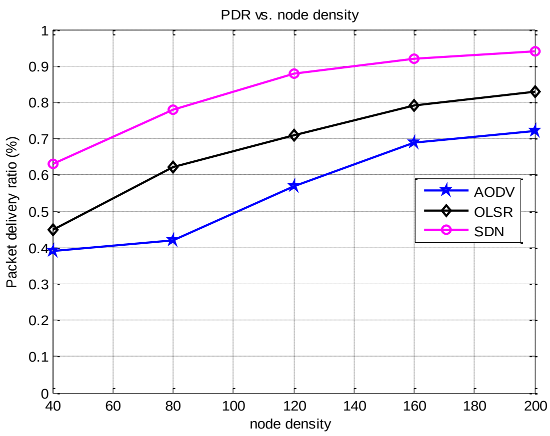

Figure 5. PDR with respect to changing number of nodes

5.2. Delivery delay time results

To compare the use of SDN as a routing protocol in this simulation study, this section studies the use of different routing protocols against the use of SDN concerning delivery delay time under changing the node density in the simulation area from 50 to 200 and under changing the speed from 5 to 30 m/s. All simulation parameters are as listed in Table 1. With a packet generation rate of 4 packets/s and packet size of 1,024 byte. The period between beacon messages is 500 ms. At intervals of one second, SDN wireless nodes will update neighbour data for the SDN controller.

Because the rise in movement velocity causes frequent topology changes in the network, Figure 6 illustrates how the delivery delay time increases as moving speed increases. Instability in the connections connecting the cars causes an apparent increase in packet retransmission. The SDN protocol has a delivery delay time of 0.6 seconds, as illustrated in Figure 6, as opposed to 1.6 seconds for the OLSR and 2.4 seconds for the AODV. The notion that the improvement of SDN's PDR is reflected in the shorter SDN delivery time can be drawn from this finding. Figure 7 illustrates how the delivery delay time lowers as the road density grows. This is because a high vehicle density may provide adequate connection, making the links between nodes more robust, which will shorten retransmission times and transmission delay. SDN has a substantially reduced delivery delay time than AODV and OLSR because it uses the SDN controller's global perspective to solve the local maximum issue and supply dense connection. In terms of PDR and delivery delay time, the SDN performs better than AODV and OLSR overall. SDN uses the global view of the SDN controller to determine the shortest route with the highest vehicle density. The local maximum issue is also resolved, and a dense connection is introduced.

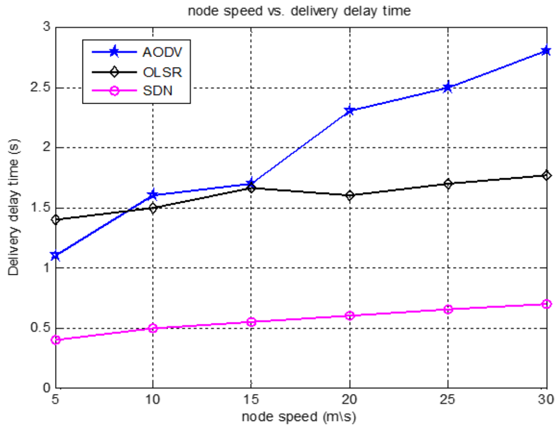

Figure 6. Delivery delay time with respect to node speed

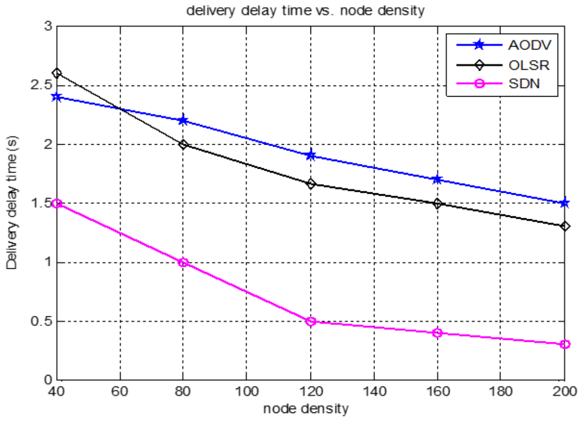

Figure 7. Delivery delay time concerning changing the number of nodes

5.3. Throughput results

To continue to compare the response of the SDN-VANET with other traditional ad hoc routing protocols, the throughput of the system as a very useful and important performance metric is simulated in this section with the same parameters used in the previous simulations mentioned in Table 1. Figure 8 shows the result of the AODV and OLSR routing protocols concerning node speed compared with the SDN routing proposed. The results also show that SDN routing gives better throughput than other protocols. It reaches 115 kbps at 10 m/s while the OLSR reaches 108 kbps at the same speed. The OLSR protocol still has the middle performance between the two others. From Figure 8, the throughput of the system decreases as the speed increase. This is because that the delivery ratio also decreases for the increasing speed as mentioned in Figure 4. Figure 9 shows the opposite response of the throughput and it is also acceptable to that obtained from Figure 6 because the delivery ratio increase with the increase in node density so the throughput of the system increase with the increasing number of nodes.

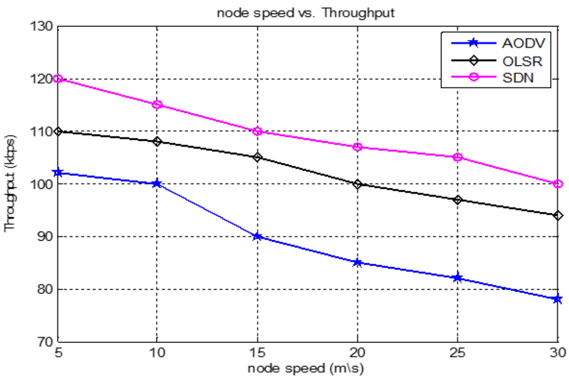

Figure 8. Relationship between throughput and node speed

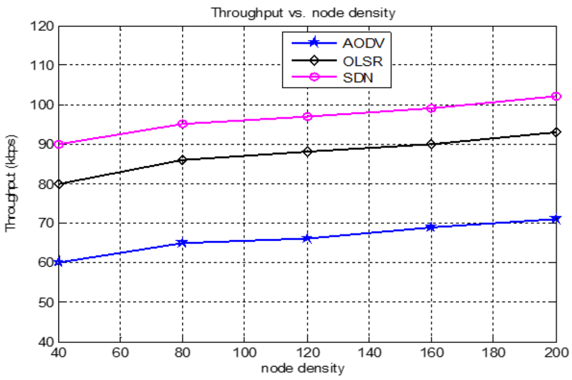

Figure 9. Throughput with respect to changing number of nodes

6. CONCLUSION

The purpose of this paper is to provide a thorough overview and a practical simulation for the use of SDN as a routing protocol in VANET networks in order to assess the impact of using SDN routing in comparison to other traditional routing protocols used in MANETs/VaNETs. To do this, we simulate the PDR and delivery delay time for each routing protocol while varying the node density in the simulation area and the node speed at 1,000×1,000 m^2, with each road segment being 200 m. The outcomes of the simulation demonstrate that altering the routing protocol would affect PDR. When employing the SDN protocol, the PDR achieves 90% delivery at 200 nodes in the road, compared to 80% for the OLSR and 70% for the AODV for the same number of nodes. Additionally, the SDN protocol has a delivery delay time of 0.6 seconds as opposed to 1.6 seconds for OLSR and 2.4 seconds for AODV. This finding supports the idea that SDN's improved PDR results from its shorter delivery time. The SDN controller's accumulated knowledge is, in general, the cause of all of this.

REFERENCES

[1] S. A. M. Al-Juboori, F. Hazzaa, Z. S. Jabbar, S. Salih, and H. M. Gheni, “Man-in-the-middle and denial of service attacks detection using machine learning algorithms,” *Bulletin of Electrical Engineering and Informatics*, vol. 12, no. 1, pp. 418–426, 2023, doi: 10.11591/eei.v12i1.4555.

[2] N. Mhaskar, M. Alabbad, and R. Khedri, “A formal approach to network segmentation,” *Computers and Security*, vol. 103, 2021, doi: 10.1016/j.cose.2020.102162.

[3] M. W. Falah *et al.*, “Compressive strength prediction using coupled deep learning model with extreme gradient boosting algorithm: environmentally friendly concrete incorporating recycled aggregate,” *Complexity*, vol. 2022, 2022, doi: 10.1155/2022/5433474.

[4] N. B. M. Nawawi, A. M. S., M. N. Junita, and S. R. Abdullah, “Performance evaluation of VLC system using new modulation approach,” *Bulletin of Electrical Engineering and Informatics*, vol. 8, no. 2, pp. 630–636, Jun. 2019, doi: 10.11591/eei.v8i2.1428.

[5] M. A. Saad, M. H. Ali, S. Alani, A. H. Ali, and Y. A. Hussein, “Performance evaluation improvement of energy consumption in adhoc wireless network,” *International Journal of Advanced Science and Technology*, vol. 29, no. 3, pp. 4128–4137, 2020.

[6] E. Amiri, E. Alizadeh, and M. H. Rezvani, “Controller selection in software defined networks using best-worst multi-criteria decision-making,” *Bulletin of Electrical Engineering and Informatics*, vol. 9, no. 4, pp. 1506–1517, Aug. 2020, doi: 10.11591/eei.v9i4.2393.

[7] B. S. Hassen, S. A. S. Lafta, H. M. Noman, “Analyzing the performances of WSNs routing protocols in grid- based clustering,” *International Journal on Advanced Science, Engineering and Information Technology*, vol. 9, no. 4, pp. 1211–1216, Aug. 2019, doi: 10.18517/ijaseit.9.4.8900.

[8] R. A. Lara-Cueva and M. S. Simba-Herrera, “Performance evaluation for outdoor wireless scenarios based on IEEE 802.11b/g in the presence of co-channel interference,” *Bulletin of Electrical Engineering and Informatics*, vol. 9, no. 1, pp. 187–197, Feb. 2020, doi: 10.11591/eei.v9i1.1649.

[9] M. A. Saad, M. S. T, M. H. Ali, M. M. Hashim, M. Bin Ismail, and A. H. Ali, “Spectrum sensing and energy detection in cognitive networks,” *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 17, no. 1, pp. 464–471, Jan. 2020, doi: 10.11591/ijeecs.v17.i1.pp464-471.

[10] M. B. Lehocine and M. Batouche, "Flexibility of managing VLAN filtering and segmentation in SDN networks," *2017 International Symposium on Networks, Computers and Communications (ISNCC)*, Marrakech, Morocco, 2017, pp. 1-6, doi: 10.1109/ISNCC.2017.8071999.

[11] E. M. Elgohary, M. Galal, A. Mosa, and G. A. Elshabrawy, “Smart evaluation for deep learning model: churn prediction as a product case study,” *Bulletin of Electrical Engineering and Informatics*, vol. 12, no. 2, pp. 1219–1225, Apr. 2023, doi: 10.11591/eei.v12i2.4180.

[12] B. Hasan, S. Alani, and M. A. Saad, “Secured node detection technique based on artificial neural network for wireless sensor network,” *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 11, no. 1, p. 536, Feb. 2021, doi: 10.11591/ijece.v11i1.pp536-544.

[13] E. Kalogeiton, Z. Zhao and T. Braun, "Is SDN the solution for NDN-VANETs?," *2017 16th Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net)*, Budva, Montenegro, 2017, pp. 1-6, doi: 10.1109/MedHocNet.2017.8001643.

[14] A. Hameed and A. N. Mian, “Finding efficient VLAN topology for better broadcast containment,” in *2012 3rd International Conference on the Network of the Future, NOF 2012*, 2012, pp. 108–113, doi: 10.1109/NOF.2012.6464001.

[15] K. Chellappan and M. S. A. Razak, "Adapting Service Robot Mechanism in Designing Movable Makerspace for Knowledge Society Building," *2021 6th International Conference on Robotics and Automation Engineering (ICRAE)*, Guangzhou, China, 2021, pp. 339-343, doi: 10.1109/ICRAE53653.2021.9657792.

[16] S. Z. M. S. Mukari, Y. Yusof, W. S. Ishak, N. Maamor, K. Chellapan, and M. A. Dzulkifli, “Relative contributions of auditory and cognitive functions on speech recognition in quiet and in noise among older adults,” *Brazilian Journal of Otorhinolaryngology*, vol. 86, no. 2, pp. 149–156, Mar. 2020, doi: 10.1016/j.bjorl.2018.10.010.

[17] N. Adnan, N. Kamal, and K. Chellappan, “An IoT based smart lighting system based on human activity,” in *2019 IEEE 14th Malaysia International Conference on Communication (MICC)*, Dec. 2019, pp. 65–68, doi: 10.1109/MICC48337.2019.9037601.

[18] A. Kumar, K. Chellappan, A. Nasution, D. Pawar, M. K. Patel, and R. Kanawade, “Diffuse reflectance-based spectroscopic technique for real-time estimation of localized blood oxygenation parameters from human fingertips: a preliminary study,” *Sensors and Diagnostics*, vol. 1, no. 6, pp. 1236–1242, 2022, doi: 10.1039/d2sd00126h.

[19] I. Radhakrishnan, R. Souay, M. R. Palattellaz and T. Engel, "An efficient service channel allocation scheme in SDN-enabled VANETs," *2017 16th Annual Mediterranean Ad Hoc Networking Workshop (Med-Hoc-Net)*, Budva, Montenegro, 2017, pp. 1-7, doi: 10.1109/MedHocNet.2017.8001644.

[20] P. V. Krishna and N. C. S. N. Iyengar, “Optimal channel allocation algorithm with efficient channel reservation for cellular networks,” *International Journal of Communication Networks and Distributed Systems*, vol. 1, no. 1, 2008, doi: 10.1504/IJCNDS.2008.017203.

[21] M. A. Saad *et al*., "Total energy consumption analysis in wireless Mobile ad hoc network with varying mobile nodes," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 14, no. 2, pp. 1397-1405, doi: 10.11591/ijeecs.v20.i3.pp1397-1405.
[22] B. H. Hameed, A. Y. Taher, R. K. Ibrahim, and Y. A. Hussein, "Based on mesh sensor network: design and implementation of security monitoring system with Bluetooth technology," *Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)*, vol. 26, no. 3, pp. 1781-1790, 2022, doi: 10.11591/ijeecs.v26.i3.pp1781-1790.
[23] A. Ram and S. K. Chakraborty, "Analysis of Software-Defined Networking (SDN) Performance in Wired and Wireless Networks Across Various Topologies, Including Single, Linear, and Tree Structures," *Indian Journal of Information Sources and Services* vol. 14, no. 1, pp. 39-50, 2024, doi: 10.51983/ijiss-2024.14.1.3926.
[24] A. K. Rangisetti, R. Dwivedi, and P. Singh, "Denial of ARP spoofing in SDN and NFV enabled cloud-fog-edge platforms," *Cluster Computing*, vol. 24, no. 4, pp. 3147–3172, 2021, doi: 10.1007/s10586-021-03328-x.
[25] Z. H. Ali, N. El-Rashidy, M. A. Elhosseini, and S. M. Ayyad, "SDN-based Reliable Emergency Message Routing Schema Using Digital Twins for Adjusting Beacon Transmission in VANET," *Journal of Network and Computer Applications*, 2024, doi: 10.1016/j.jnca.2024.103944.

BIOGRAPHIES OF AUTHORS

Younus Hasan Taher was born in Iraq 1994. He achieved his B.S. degree in Computer and Communication (2011-2015) from Al Mansour University-Baghdad- Iraq then He has got his master's degree in Engineer Telecommunication and Computer from University Kebangsaan Malaysia (UKM). And now he is currently pursuing his Ph.D. in UKM in communication and computer engineering. He current research interests in artificial intelligent, information technology, q-learning, and intelligent transportation system. He can be contacted at email: You1993nis@gmail.com.

Israa Alsaadi received her B.Sc. degree in Computer Science from the University of Technology (2002-2006) in Baghdad. She obtained her M.Sc. Degree in Computer Science and Information Technology from the University of Bedfordshire in the United Kingdom (2012-2014). Currently, she is working at the University of Baghdad, College of Science for Women, Department of Computer Science. She is a regular reviewer of the International Journal of Computing and Digital System (IJCDS). Her research interests focus on the computer vision, pattern recognition, neural networks, machine learning, data analysis, and identities' verification. She can be contacted at email: israamh_comp@csw.uobaghdad.edu.iq.

Mohammed Ayad Saad received his B.S. degree in Computer and Communication (2011-2015) in Iraq. He earned his master's degree in Engineer Telecommunication and Computer from University Kebangsaan Malaysia (UKM). He is currently pursuing his Ph.D. at University Kebangsaan Malaysia. He is a lecturer of the University Al-Kitab at Technical Engineering College of the Medical Instruments Technical Engineering and also the coordinator .He was also appointed as Director of Training and Development at Al-Kitab University. His research area includes information technology and wireless communication, VANET, WSN, power electronic circuit systems, wireless networking, IoT smart healthcare, mobile sink, data gathering e cognitive radio networks, sensor networks, and network security. He can be contacted at email: mohmmad9alani@gmail.com, m.a.saad@uoalkitab.edu.iq.

Adnan Hussein Ali is Professor at the Middle Technical University, Baghdad, Iraq, where he has been a faculty member since 2007. Graduated with a B.Sc. degree in Electronic Engineering from University of Technology- Baghdad, Iraq, in 1987, and an M.Sc. in Electronic and communication technology from University of Technology Baghdad in 1999, and Ph.D. from Laser and Opto-electronics Department University of Technology Baghdad in 2007. His research interests in the area of optical communication, cloud computing, RoF, WSN, and PV. Iam an author/co-author of over 60 research publications. He can be contacted at email: dr.adnan@mtu.edu.iq and aaddnnaann63@gmail.com.

Mohammed Essa whose photo is affixed above Received his B.Sc. degree in Computer Engineering Technology (2017-2018) Form Al-Maaref University. He obtained his M.Sc. degree in Electric and Computer Engineering from the University of Altinbas University (2019-2020). Currently, he is working at the Janat Al-Iraq College, Department of Medical Instrumentation Engineering Tech. He research interests focus on the computer vision, pattern recognition, neural networks, machine learning, data analysis and identities' verification. He can be contacted at email: mohammed.essa@jic.edu.iq.

Ahmed Hashim Rashid was born in Iraq 1994. He has complete graduation B.S. degree in Computer and Communication from Al Mansour University-Baghdad-Iraq in (2011-2015). Graduated master's degree in Engineering Telecommunication and Computer From University Kebangsaan Malaysia (UKM). Currently he doing Ph.D. in UKM in Communication and Computer Engineering. His research area blockchain, smart healthcare, cybersecurity, wireless communication, information technology. He can be contacted at email: p109034@siswa.ukm.edu.my.