A Creative Method for Vanet Traffic Distribution Information

Alyaa Ali Hameed Kjwan

Tikrit University, College of Dentistry, Department of Basic Sciences,
Salaheddin , Iraq
Email: alyaa.ali@tu.edu.iq

ABSTRACT

Researchers have become interested in vehicular ad hoc networks (VANETs) because they are crucial for developing intelligent transportation systems (ITS). The network packets are being send by all of the vehicles. As a result, the network bandwidth is heavily utilized, which causes the problem known as a network traffic. Duplicated rebroadcasting messages during message transmission via VANET networks increased message delivery time, increased channel busy ratio, increased collisions, wasted bandwidth, decreased packet delivery ratio, increased packet volume, etc. A suggests a two new method that should be taken into account for lowering the quantity of messages that are retransmitted or re-broadcast throughout the VANET network in the first technique while used elephant swarm water search algorithm (ESWSA) is proposed for node clustering in VANETs to achieve optimal cluster network vehicular nodes (CH) selection. This ESWSA technique minimizes network overhead in unexpected node density. Simulation results of ESWSA showed superior transmission range, node density, network area, and number of clusters than competitive other swarm clustering protocols. In order to manage re-broadcast traffic while reducing the quantity of duplicated traffic throughout the network, a new technique and algorithm for the effective dissemination of broadcast traffic of applications in VANET communication systems are proposed in this study. The vehicle will rebroadcast the packet if the timer expires and no duplicate message is received. The suggested algorithm instructs the vehicles to look for other nearby vehicles that are transmitting. With this procedure, the vehicles close to the transmitting vehicle are protected from packet retransmission.

Keywords: ITS, TTL, VANETs, V2V, V2I, ESWSA, IVC, MANETs, OBU, RSU, FCC, MAC.

1. Introduction

According to a WHO study, population expansion, driver irresponsibility, excessive traffic congestion, traffic law violations, and lack of street knowledge cause most road traffic injuries and fatalities [1]. To prevent these events, there needs to be an intelligent transportation and traffic facility. The Intelligent Transportation System (ITS) services offered by VANET to end users are useful for reducing traffic congestion [2]. VANET is a cutting-edge network technology solution.

One of MANET's (Mobile Ad-hoc Network) most significant classes is VANET [3]. In order to deploy these applications through the utilization of information and communication technologies, vehicle networking is the primary ITS facilitator. ITS is solving transportation issues with contemporary network technologies. ITS strives to reduce travel time and costs while also ensuring traffic safety, preserving the environment, etc [4]. According to [5], VANET may have two important communication types: vehicle to vehicle (V2V) and vehicle to infrastructure (V2I). Different applications that rely on geographic broadcasting and target "all" vehicles as beneficiaries in specific areas are used as the foundation for vehicle networking. Reliability in the conveyance of information is crucial for many different types of applications, notably in safety-critical [6]. Safety for people and cars is the major objective of VANET. VANET confronts numerous difficulties, including the following (Volatility, Mobility, Network scalability, Bootstrap). Several service messages may be in circulation at once on VANET. These messages shouldn't use up bandwidth while they are being broadcast and shouldn't be repeated after a certain amount of time. The broadcast methods in use today are ineffective because of this. Therefore, it is essential to create a re-broadcasting protocol technique that re-broadcasts the signals in an organized way. The targeted research will address issues such as high bandwidth uses by rebroadcast messages, irregularity in packet TTL values, lack of a clear decision-making process for rebroadcasting, and proper node coverage utilization.

Inter-vehicular communication (IVC), a component of Mobile Ad Hoc Networks (MANETs) that allows automobiles, roadside devices, and nearby pedestrians to share information within a certain range, is one of the numerous functionalities that VANET offers. Alternatively put, it belongs to a higher class of applications for intelligent transportation systems. Vehicles on VANETs can communicate within a 100–1000 m range. As a result, the design of these networks includes two communication units: an on board unit (OBU) and a road side unit (RSU). OBUs are fixed inside of the vehicles, while RSUs are stationary nodes positioned close to the intersection.

of a street or a traffic light. RSUs serve as a distribution point for the messages, and the vehicle serves as a router, source, or destination [7]. In light of the aforementioned information, the Federal Communication Commission (FCC) in the United States has suggested a frequency range of 5.850–5.925GHz to facilitate V2V and V2I communication. The 5.9GHz frequency spectrum allotted to it is divided into 7 channels, each with a 10MHz bandwidth. Dedicated short range communication (DSRC) is being developed to meet high mobility conditions while minimizing communication delay, maximizing data flow, and establishing links quickly [8]. An IEEE research committee produced WAVE standards for VANETs. WAVE uses CSMA/CA protocols for medium access control, allowing for high mobility and dynamic network topology changes (MAC). Gathering routing information is tough [9]. VANETs use IEEE 802.11p and IEEE 1609 for wireless access [10]. AODV and DSR are used as routing protocols to identify vehicles' source-to-destination routes.

This paper's organization: Section 2 summarizes current studies, and Section 3 explains our technique. Section 4 explains our simulation information and test situations. Section 6 concludes.

2. Literature Review.

Wireless technologies cannot be directly used to VANETs due to high mobility, road setup restrictions, frequent topology alterations, enough energy storage, failed network links, and timely data communication [11-12]. Inter-vehicle communication requires an efficient routing protocol to meet all the above objectives. Vehicle networks have used many routing systems for decades [13–15].

The broadcasting technique in this suggested approach [16] relies on the location of the cars to distribute emergency messages throughout a vast VANET. The proposed protocol's goal is to provide messages to the vehicles that are most relevant to them, hence reducing the amount of time that has to be spent broadcasting while still making effective and efficient use of those channels. The suggested technique can be used in urban settings in addition to situations on the highway. It permitted the vehicles to decide on their own whether to disseminate the message after receiving it. Figure 1 shows the message propagation model. This protocol's fundamental flaw is that it does not account for bandwidth usage, which causes packet losses during periods of high network traffic. The Backfire algorithm and the congestion detection algorithm are both used in the MHVB algorithm that the authors [17] have created. A congestion detection system eliminates pointless communications, while a backfire algorithm enables the precise delivery of packets. The VANET network's communication becomes more precise thanks to MHVB (Multi-Hop Vehicle Broadcast). However, the hidden node issue cannot yet be resolved by the MHVB protocol. The use of network packet numbering allows for the determination of network congestion levels. According to what is described below, the numbering dynamically alters the time window and enhances performance [18], boosts VANET accuracy through high reliability, low congestion, reduced collision, and low contention.

According to Karimi et al. [19], network longevity was a crucial consideration in the design of Wireless Sensor Networks and dependent on the energy of the sensor nodes, which was in turn constrained by the node's battery. For wireless sensor networks, clustering is seen as an energy management method. As a result, one of the most widely used clustering mechanisms is Leach (Low-Energy Adaptive Clustering Hierarchy) [19]. Random cluster selection hampered this method's efficiency. Karimi et al. [19] proposed HS-leach and GP-leach. Network partitioning allowed them to increase energy consumption. While taking into account the position data and the remaining energy of the WSN nodes, additionally used the evolutionary algorithms to optimize the selection of the cluster heads. The MATLAB simulation results showed that the proposed algorithms had higher efficiency and extended the lifetime of the network. However, this concept may face difficulties due to overhead, packet loss ratio, and complexity. Kots and Kumar published a heuristic for OLSR MPR selection [20]. An important aspect of the OLSR procedure was thought to be the MPR selection. The researchers suggested selecting the MPRs using a brand-new Fuzzy logic-based routing metric. Their suggested procedure assisted in choosing the QMPRs (quality multipoint relays) for the OLSR protocol in the MANET setting. For estimating the quality nodes in the OLSR routing protocol in the MANET context, employed the fuzzy-based approach. They added up quality criteria including stability, energy, and buffer occupancy to determine the node quality within the network

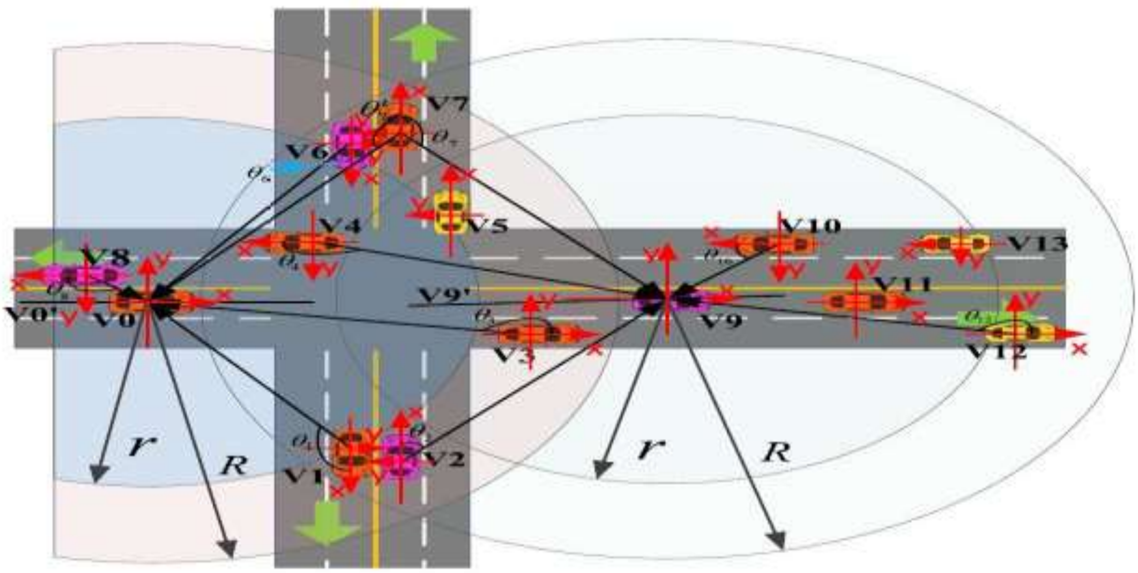

Figure 1 Message Propagation Model [16]

They recorded these metrics during the OLSR protocol setup and updated them whenever a new MPR was chosen. With the use of a statistical analysis of the projected values, the method was validated, and MATLAB was used to confirm the procedure. The technique made sure that the network was more efficient and used less power in a MANET environment. To verify network effectiveness and energy consumptions, a laboratory experiment is necessary. Kashif Nasear et al. recommended B-PFP for metropolitan areas. The authors of this proposal transmit packets using a beaconless packet forwarding technique. The direction of the vehicle and the quality of the link are taken into account when transmitting packets. One way of data forwarding in the protocol is at the intersection, and the other is between the intersections. Two beacon-based protocols, such as CAIR and IGRP, as well as two beaconless protocols, BRAVE and LIATHON, are compared with B-PFP. Using the NS2.34 simulator, the suggested procedure is assessed for the two parameters PDR and EED. According to a simulation result, BPFP performs better in terms of PDR and EED.

Sourav Chhabra et al. proposed the Dynamic Vehicle Ontology Based Routing protocol (DVOR) [21]. This protocol finds the shortest way routing that shortens the time that cars must wait in traffic congestion. It finds the best path using an activity file and RSU-based strategy. Due to DVOR's primary focus on trip duration, waiting times are reduced automatically. Two proactive routing techniques, OLSR and DSDV, are contrasted with DVOR. Three criteria are used to assess the proposed protocol: PDR,

The VANET QoSOLSR protocol, used by Wahab et al. [22], may preserve vehicular network stability while meeting QoS standards. The three parts of this protocol were: (1) QoS-based clustering with the aid of Ant Colony Optimization; (2) MPR recovery algorithm; and (3) the cheating prevention mechanism. Wahab et al. [22] represented mobility metrics within the QoS functions by include the vehicles' distance and speed in order to guarantee cluster stability. Using the local maximum QoS values, the protocol chose the cluster heads. The Ant Colony Optimization algorithm's cluster heads selected a set of optimized MPRs that could meet the mobility and routing criteria.

Wahab et al[22] .'s selection process incorporated a cheating prevention device to ensure that it was trustworthy and fair. In order to avoid link failure, they chose backup MPRs and kept their network connections active using the MPR recovery technique. The use of the newly proposed protocol might extend the network's life by 12%, reduce the proportion of the selected MPRs by 20%, demonstrate a 10% improvement in the PDR,

and also shorten the path length by two hops, according to simulation findings and performance analysis.

The purpose of this article [23] is to create a VANET employing a hardware component known as an Electronic Control Unit (ECU). The controlled transmission of emergency message packets to the targeted group of vehicles was done using the proposed transmission technique. According to the bearing angle and location of the planned vehicles in reference to the original vehicle, the suggested protocol chooses the intended vehicles. The automobiles are grouped in accordance with road segments and the original vehicle's direction of travel in a controlled flood protocol. The Electronic Control Unit transmits the emergency packet (ECU) Figure 2: A time synchronization scheme 25 event warning example of concurrent transmission. The data was handled by planned groups of cars, which resulted in the network characteristics behaving as desired at various vehicle concentrations.

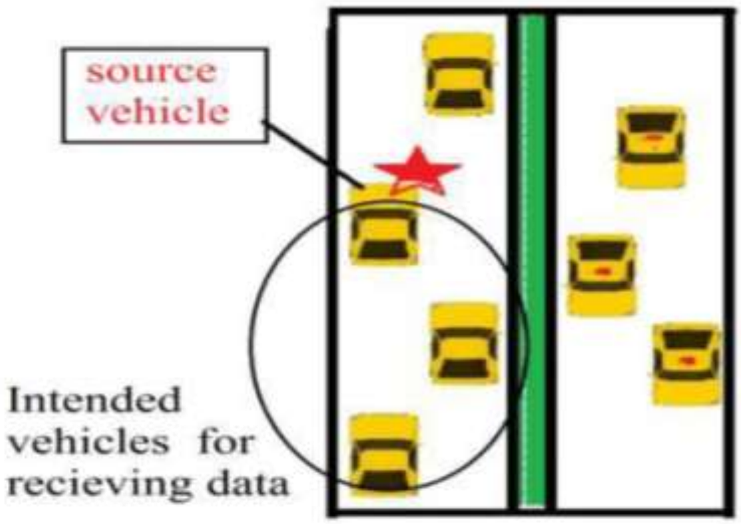

Figure 2 Controlled Flooding Protocol Scenario

3. Methodology

In this paper two approaches are studies, first are rebroadcast message in the crowed street inside city, and the second applied swarm intelligence method based on elephant swarm water search optimization in clustering in urban and highway road.

Rebroadcasting traffic messages would swamp the VANET and cause congestion. Broadcast storms are brought on by this flooding. As a result, this study effort suggests a cutting-edge method for managing the rebroadcasting of traffic messages in the VANET. The algorithm that is suggested in this paper is a member of the class of probabilistic, parametric broadcasting techniques. The fundamental idea behind the suggested technique is to create a delay for incoming broadcast messages, the value of which varies depending on the Signal to Interference & Noise Ratio (SINR) value measured by each node when a message is received.

VANET's broadcast storm scenario. IEEE 802.11p will be used for this data connection at the MAC layer, so no authentication or authorization is required. The message will be received by the nearby nodes, who will then relay it to additional nodes. The procedure will be carried out until a Time-to-Live (TTL) threshold is reached. The number of retransmissions in the VANET would decrease if an ideal Time to Live value was chosen for packets. The suggested method determines an accommodating TTL to regulate rebroadcasting messages, which in turn lowers the quantity of rebroadcast packets. The following values form the basis of the TTL value: The most effective method for achieving the greatest information distance is the multi-step rebroadcasting of signals (D max). The Time to Live (TTL) packet lifetime must be restricted in stages (transfers between nodes). The TTL value should be set to the minimal information distance for determining the necessary number of retransmissions. Many packets will be dropped when (Dmin)the TTL value is too small until they have reached the necessary distance. Delay Time (DT), Maximum Broadcast Time (MT), Channel Busy Ratio (CBR), and SINR determine these variables' values. SINR measures the roadside unit-to-vehicle communication link. This quality indicator measures and optimizes network coverage and maximum packet transfer in automobiles. Different applications demand a specified SINR level. This parameter helps the user gauge message acceptance against external effects.

Time to Live (TTL) is the number of hops a packet has before a router drops it. Informing road users prevents accidents and increases accident participants. A VANET-based road safety system must meet maximum notification time and broadcast frequency parameters. These specifications must allow driving at v to avoid an accident. Thus, the system's main purpose was to create a control algorithm that filters duplicate broadcast messages. Information distance is the minimum distance from the initiator node to which a warning message should spread. VANET is an Ad-hoc network, hence no routers or switches are needed to connect the nodes. When a data packet is generated and sent through VANET, the message may be sent from vehicle to vehicle forever. Packages have a lifetime or hop restriction to prevent this. TTL tells the sender how long a packet has been circulating and its journey across the VANET network. If TTL counter becomes 0 after subtraction. Figure 3 shows TTL in VANET.

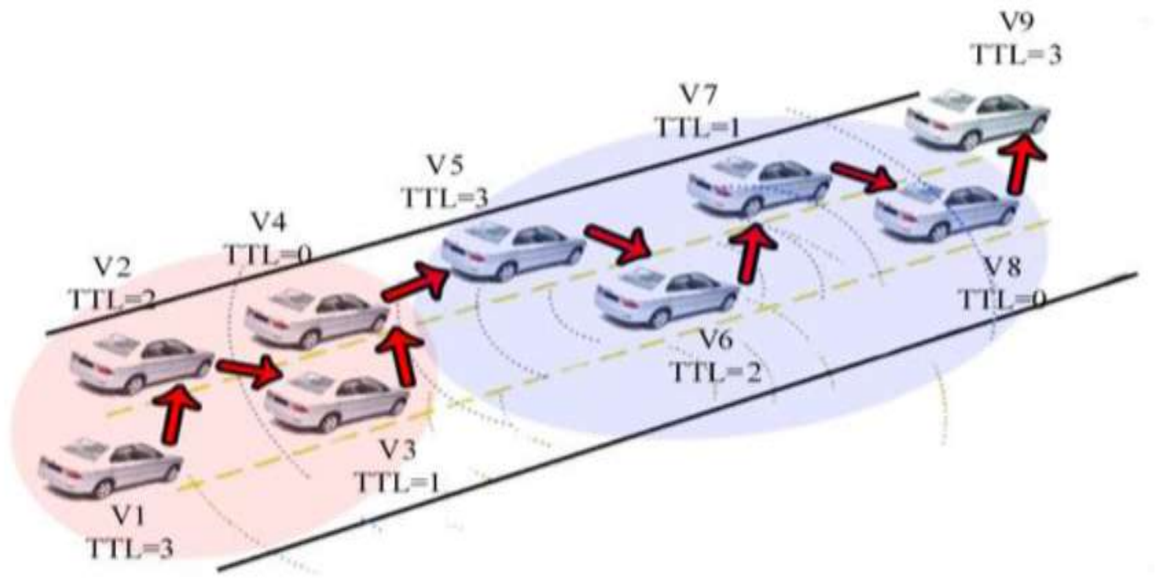

Figure 3 TTL Principle in VANET

Figure 3 shows what happens when a vehicle gets a broadcast packet. Every packet has TTL. If a packet's TTL is less than the static TTLmax, the receiver buffers it. If the buffer is free, the delay time is set and the packet is set into a counter for other nodes. If the buffer isn't free, it's checked. If the buffer has the same ID, the duplication flag is checked (which is the variable defined as a Boolean and set as a false value). Once the flag is false, it's changed to True and the packet is removed. If the flag is false, the packet is delayed until the delay time finishes. If there was no packet with the same ID in the buffer, the delay timer and duplication flag will be set to false, and the time will be initialized to prepare for rebroadcasting packets to neighbor nodes. If TTL is larger than TTLmax, the packet is received and not rebroadcast to nearby nodes.

The second model used for urban and highway road, the proposed Elephant swarm water search algorithm (ESWSA) is presented as an effective clustering approach that manages the settings of the dynamic network and unpredictable traffic density to enhance the stability of the entire network. Since fewer clusters were created during the clustering process, communication efficiency was raised, it is suggested that the network lifetime be extended with minimal cluster building. Since it acts as an anchor node for information transfer among the cluster member nodes in the network, it specifically makes for improved communication in densely populated vehicle contexts. As a result, the ESWSA method can be used with the swarm-based optimization algorithm to provide a better solution set that helps to achieve large CHs for VANETs. For the purpose of clustering in this clustering framework, Elephant imitates the parasitic traits of water, as seen in figure 4. Each search agent in ESWSA specifically indicates a solution set in the complete route representation that includes the names of the vehicles that are chosen as CHs in the network.

Every group's leader, whether a matriarch or an elderly elephant, is qualified to use a search option to find the largest water source. (i) When the elephant group finds a water source, the matriarch informs the neighboring groups about the resource's quantity and quality. The following legal move is indicated by good water depth. Elephants have rather robust memories (ii). Several elephant groups are still aware of some of the locations of the water sources that were once known to them privately (local best solution). Additionally, they are able to recall the precise location of the finest water source that was discovered by all of the groups (global best solution). (iii) Decisions about regional and worldwide water exploration represented by a probabilistic constant P. The matriarch chooses actions to switch between global and local search choices according on this parameter. Local water exploration may have a higher P value due to specific physical and ecological characteristics [24][25]. The elephant is able to recognize and pick out different visual and auditory signals. There are a number of methods, such as auditory, seismic, and chemical communications, that elephant groups employ to communicate at distances of up to 10–12 km.

The ith group of elephants from a swarm can be located and its velocity used to define the d-dimensional optimization problem (composed of N members). The position can be represented by $X_{i,d}^{t}$, = (X_{i1}, X_{i2},..., X_{id}) in the tth iteration. The velocity can also be written using the formula $V_{i,d}^{t}$, = (V_{i1}, V_{i2},..., V_{id}). Based on these, $P_{best,i,d}^{t}$ = (P_{i1}, P_{i2},..., P_{id}) describes the best local solution for the current iteration of the elephant group for I while Gbest expresses the best global solution. $G_{best,i,d}^{t}$ (G_1, G_2,..., G_d). Elephant group positions and starting velocities were assigned at random throughout the exploring area. The places and speeds of the elephants changed throughout iteration. The best water search decision-making should take place at both the global and local levels. According to Equations (1) and (2) below, while iteration continues, the member velocities are updated using a variety of ways during local and global search. The type of search is determined by the value of switching probability p:

$$V_{i,d}^{t+1} = V_{i,d}^{t} w^{t} + rand\ (1, d).(G_{best,d}^{t} - X_{i,d}^{t}) \quad (1)$$

if rand>p [global search]

$$V_{i,d}^{t+1} = V_{i,d}^{t} w^{t} + rand\ (1, d).(P_{best,d}^{t} - X_{i,d}^{t}) \quad (2)$$

If [local search] rand > p.

Rand is a value that generates a d-dimensional array of random values in [0,1] in equations (1) and (2).

w^t is the weight of inertia for compromising exploitation and exploration throughout the current iteration, and expresses multiplication of elements one by one. The location of the elephant herd is then modified in accordance with the following formula [26]:

$$X_{i,d}^{t+1} = V_{i,d}^{t+1} w^{t} + X_{i,d}^{t}) \quad (3)$$

The parameters t_{max}, X_{max}, and X_{min} in (3) denote the maximum iteration number, lower and upper bounds for positions, respectively. Three factors, particularly current velocity ($V_{i,d}^{t}$), current t particle memory commands ($P_{best,d}^{t}$), and current t swarm memory instructions ($G_{best,d}^{t}$), have an impact on a search path [24].

However, with ESWSA, the new search path is chosen based on the current speed as well as the impacts of the elephant memory and swarm memory. In order to find the optimum overall solution, the velocity update in the global search is based on the elephant's optimal position. The Random Inertia Weight (RIW) [25] method randomly selects the weight of the inertia values, which is incredibly helpful for a dynamic system that seeks the optimum. The weight of inertia in RIW is chosen using the formula below:

w^t = (rand * 0.5) + 0.5 (4)

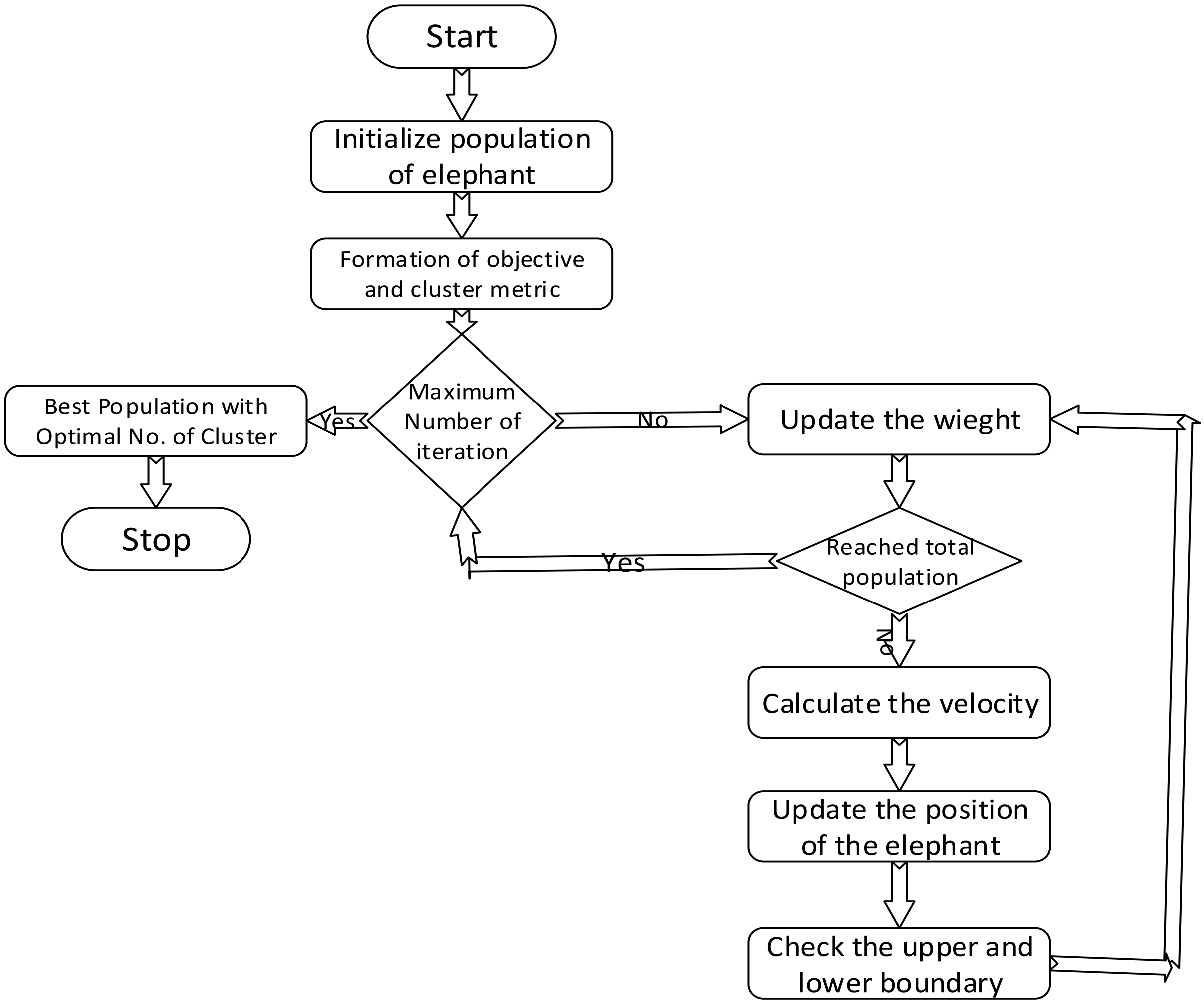

Figure 4 Clustering Process involved in the Proposed Elephant swarm water search algorithms

Rand is a uniform random number in the range [0,1] in [4]. The Linearly Decreasing Inertia Weight (LDIW) method is effective [24]. This process can be utilized to create some useful tuning characteristics for the optimization. Equation [25-28]: The weight of inertia values in LDIW depend on the value (W_{max}) and an eventual tiny value (W_{min}).

Where t denotes the iteration index and t_{max} denotes the maximum number of iterations.

It should be noted that whereas the position change in the ESWSA is based on Equation, the PSO approach uses the random repair strategy, which entails jumping randomly throughout the search space (3).

4. Experimental Result and Analysis

OMNeT++, Veins, and SUMO are simulators. Network modeling lets you mimic network topologies before real-time deployment. In this experiment, the collision scenario and alarm controller must interact through a broadcast vehicle network. Network simulators can test network protocol performance and transmitted traffic based on traffic and link conditions. Discrete event simulation is used to identify network protocols virtually always. Open source tools like NS2, OMNeT++, J-SIM, and JiST /SWANS are examples of such frameworks. Figure 5 shows the proposed algorithm's throughput, crossing nodes, average packet delay, total transmitted messages, channel busy ratio, and packet delivery ratio. The following graphs compare the proposed technique to MBED [26], DPEB [16], and floods. Figure 6 compares how many vehicles the message crossed. The graph demonstrates that the proposed strategy

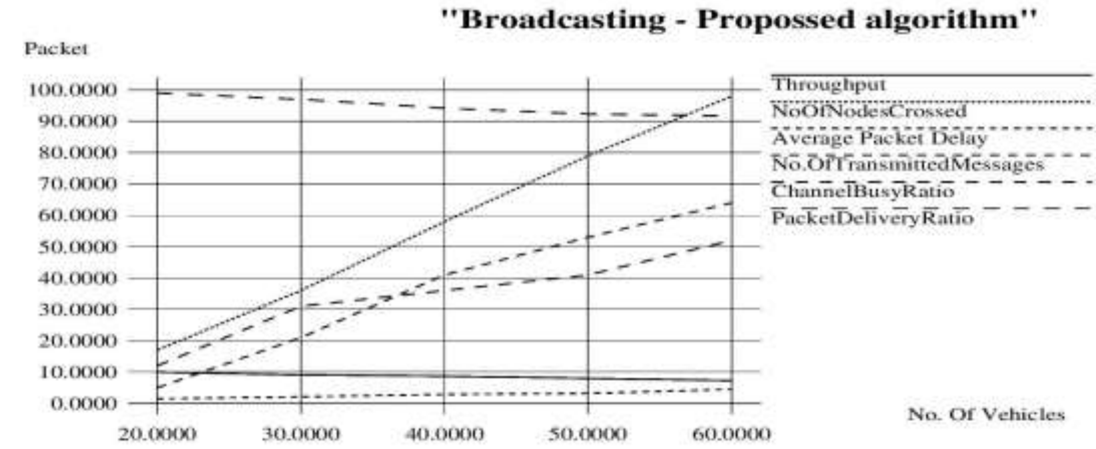

Figure 5 Cumulative Values of Simulation of CRM

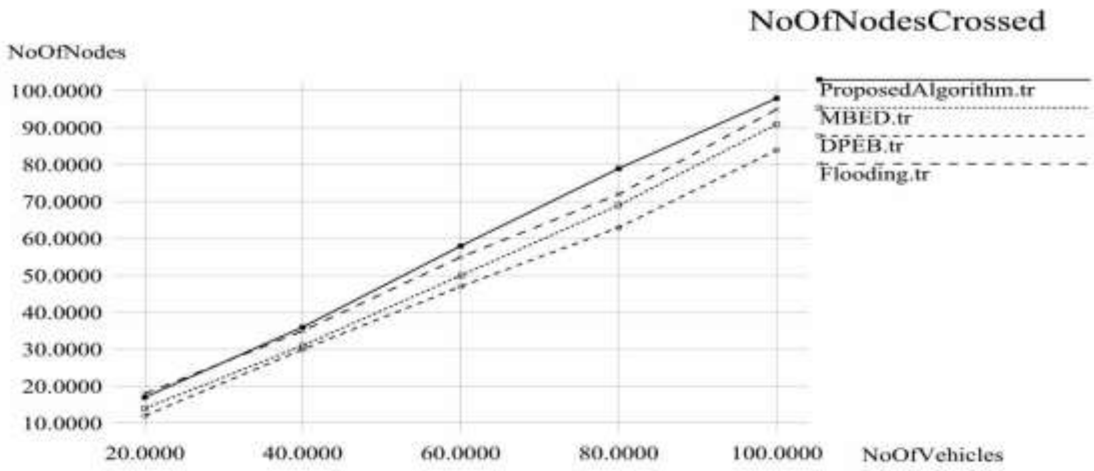

Figure 6 Comparison of Message Propagation Distance

makes the emergency message cross more vehicles. VANET should also study throughput. Figure 7 compares the traffic message's vehicle throughput. The graph illustrates that the proposed strategy maximizes bandwidth.

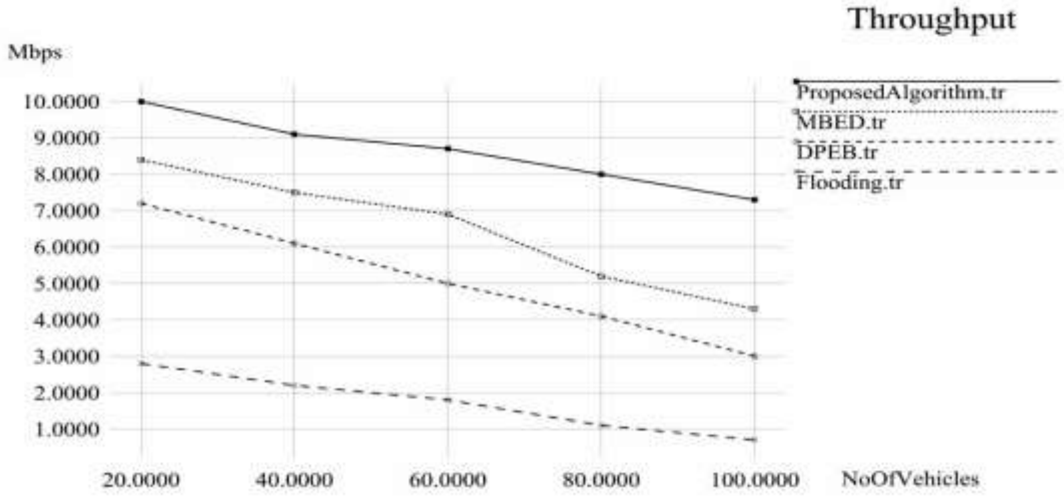

Figure 7 Network Throughput Comparison

In the second proposed method using a network size of 1000 m 1000 m, simulation experiments for the proposed ESWSA and the benchmarked SAMNET, CACONET, ROAONC and CAMONET techniques are carried out. 400 vehicles, having a maximum and minimum velocity of 40 m/s and 80 m/s respectively, are used in the experimental analysis. They are scattered at random over the whole network. Figure 8 shows the number of clusters created with 400 vehicle nodes during the initial experimental examination under various transmission ranges ranging from 100 to 400 m[30].

Regardless of the number of vehicle nodes available in the implementation environment, the results from Figure 8 proved that the suggested ESWSA is always superior to the benchmarked SAMNET, CACONET, ROAONC, and CAMONET techniques. The host feeding phase's achievement of the exploration and exploitation process as well as the inclusion of the WOA strategy throughout the clustering process are mostly responsible for ROAONC's potential performance. The suggested ESWSA demonstrated its ability to reduce the number of clusters by 12.3%, 13.21%, 15.89%, 17.42%, and 19.13% when compared to the benchmarked SAMNET, CACONET, ROAONC, and CAMONET techniques. The suggested ESWSA reduces the number of clusters by 14.5%, 14.89%, 16.79%, 18.32%, and 20.16% at 200 m. The benchmarked vehicular nodes clustering approaches are lowered by 11.24, 12.84, 14.56, 16.942, and 18.04 percent compared to the 300-m ESWSA. The proposed ESWSA's 400 m transmission range reduced clusters by 15.2%, 15.78%, 17.14%, 19.64%, and 20.32% compared to SAMNET, CACONET, ROAONC, and CAMONET.

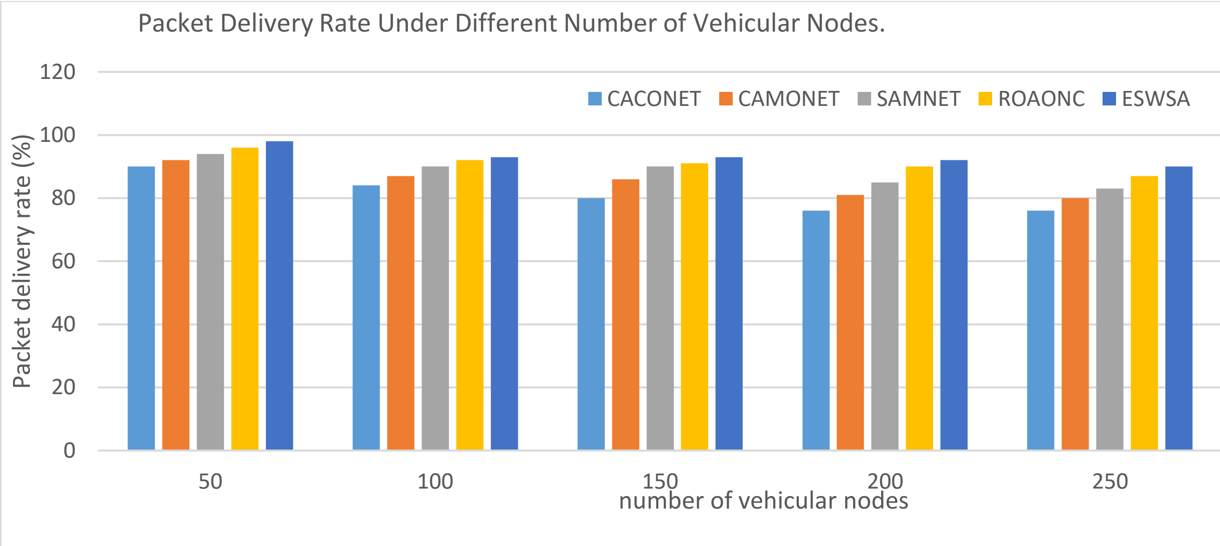

Figure 9 Packet delivery rate under different number of vehicular nodes.

Also shown in Figures. 9 and 10 are the packet delivery rate and packet loss rate that the proposed ESWSA achieved with various numbers of vehicular nodes. Since it used a multi-dimensional host feeding mechanism that mimicked the exploitation process in a more dynamic way, the suggested ESWSA's packet delivery rate with a variety of vehicle nodes is always superior than the baseline techniques. It also utilized an SFOA and WOA technique to balance the level of exploration and exploitation throughout the clustering phase, which reduces the packet loss rate. The findings demonstrated that, compared to benchmarked alternatives, the proposed ESWSA scheme improves packet delivery rates by an average of 12.54%, 14.58%, 17.29%, 19.92%, and 22.18%. Results also showed that the suggested ESWSA method minimizes packet loss rates by an average of 12.12,13.21, 15.48, 17.62, and 19.24 percent, better than the benchmarked alternatives

.

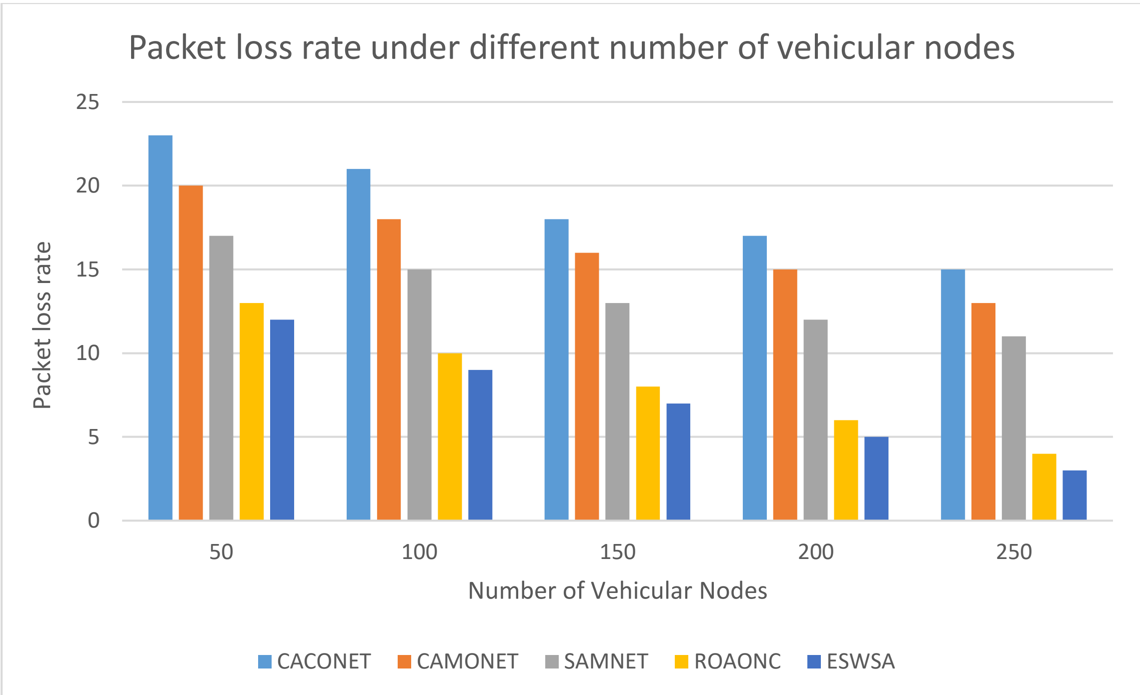

Figure 10 Packet loss rate under different number of vehicular nodes

5. Conclusion

This paper proposes a new way to reduce VANET rebroadcasting. First car generates and broadcasts emergency message using this method. The next-level vehicle calculates the packet's TTL using CBR and other characteristics. They adjust the message's location and rebroadcast it. Next-level cars receiving messages will check the sender's location. Vehicles buffer incoming packets using the described method. If the message is in the buffer, the incoming packet is rejected. If the buffer is empty, the packet waits for the delay period to expire. If another copy of the message is received before expiration, the vehicle assumes the packet has been retransmitted and discards both the buffered and duplicate packets.

With the best CH selection method, the suggested ESWSA strategy efficiently clustered nodes in VANETs. In cases when node density was unpredictable, this ESWSA technique reduced network overhead. By more effectively utilizing the method, the exploration and exploitation capabilities of ESWSA enable the minimizing of network overhead. Comparing the proposed ESWSA with a transmission range of 400 m to benchmarked SAMNET, CACONET, ROAONC, and CAMONET techniques, the simulation results showed that the suggested ESWSA can reduce the number of clusters by 12.3%, 13.21%, 15.89%, 17.42%, and 19.13%. The outcomes shown that, compared to benchmarked alternatives, the proposed ESWSA scheme improves packet delivery rates by an average of 12.54%, 14.58%, 17.29%, 19.92%, and 22.18%. Furthermore, the findings showed that the suggested ESWSA method minimizes packet loss rates on average by 12.12,13.21, 15.48, 17.62, and 19.24 percent, better than the benchmarked alternatives. It has been agreed to create a node clustering scheme based on Mayfly and compare it to the proposed ESWSA scheme with heterogeneous implementation modes as part of the future plan of scope.

References

1) WHO, Fact-sheet for Road Traffic Injuries, 2017 accessed May 2017, http://www. who.int/news-room/fact-sheets/detail/road-traffic-injuries/.
2) F. Cuomo, I. Rubin, A. Baiocchi, P. Salvo, Enhanced VANET broadcast throughput capacity via a dynamic backbone architecture, Ad Hoc Netw. 21 (2014) 42–59.
3) Mahajan, A., Saproo, D., & Khedikar, R. “Analysis and Comparison of VANET Routing Protocols using IEEE 802.11 p and WAVE”. International Journal of Engineering Research and Applications (IJERA), 3(4) (2013), 1556–1561.
4) C. M. Raut and Satish R. Devane, "Intelligent transportation system for smartcity using VANET", 2017 International Conference on Communication and Signal Processing (ICCSP), pp:1602-1605, 2017.
5) Uzcategui, R.A., Jiang, D., Salleh, U., Karnadi, F.K., Chou, C., Murthy, S.R., & Royer, E.M. (2014). Analysis of Routing Protocols for VANET using Real City Map Scenarios. Proceedings on International Conference on Current Trends in Advanced Computing.
6) Banerji, S., & Chowdhury, R. S. (2013). On IEEE 802.11: Wireless LAN technology. ArXiv Preprint ArXiv:1307.2661.
7) X. Ma, J. Zhang, X. Yin, K.S. Trivedi, Design and analysis of a robust broadcast scheme for VANET safety-related services, IEEE Trans. Veh. Technol. 61 (1) (2012) 46–61.
8) Dedicated Short Range Communications, 2018. http://www.leearmstrong.co m/DSRC/DSRC Homeset.htm.
9) Q. Xu, T. Mak, J. Ko, R. Sengupta, Vehicle-to-vehicle safety messaging in DSRC, in: Proc. 1st ACM Int. Workshop on Vehicular Ad Hoc Networks, 2004,pp. 19–28.
10) IEEE Draft Std, P802.11p/D9.0, Sep. 2009 [Online]. Available: http://ieeexplo re.ieee.org/servlet/opac?punumber¼5 325056.

11) R. Hussain, J. Lee, and S. Zeadally, "Trust in VANET: a survey of current solutions and future research opportunities," IEEE Transactions on Intelligent Transportation Systems, pp. 1–19, 2020.
12) M. Oche, A. B. Tambuwal, C. Chemebe, R. M. Noor, and S. Distefano, "VANETs QoS-based routing protocols based on multi-constrained ability to support ITS infotainment services," Wireless Networks, vol. 26, no. 3, pp. 1685–1715, 2020.
13) I.G. Erdagi, M.A. Silgu, H.B. Celikoglu, Emission effects of cooperative adaptive cruise control: a simulation case using SUMO, SUMO User Conf. – Simulating Connected Urban Mobility (2019).
14) Yuan, Y.; Zheng, G.; Wong, K.K.; Letaief, K.B. Meta-reinforcement learning based resource allocation for dynamic V2X communications. IEEE Trans. Veh. Technol. 2021, 70, 8964–8977.
15) Abdeen, M.A.R.; Beg, A.;Mostafa, S.M.; AbdulGhaffar, A.; Sheltami, T.R. and Yasar, A. "Performance Evaluation of VANET Routing Protocols in Madinah City". Electronics 2022, 11, 777.
16) Tian, D., Liu, C., Duan, X., Sheng, Z., Ni, Q., Chen, M., & Leung, V. C. (2018). A distributed position-based protocol for emergency messages broadcasting in vehicular ad hoc networks. IEEE Internet of Things Journal, 5(2), 1218–1227.
17) Marinov, Tsvetan Miroslavov, Maria Nenova and Georgi Iliev. "Comparative Analysis of Broadcasting Protocols in VANET." 2018 IX National Conference with International Participation (ELECTRONICA) (2018): 1-4.
18) B. F. Ibrahim, M. Toycan and H. A. Mawlood, "A Comprehensive Survey on VANET Broadcast Protocols," 2020 International Conference on Computation, Automation and Knowledge Management (ICCAKM), 2020, pp. 298-302.
19) [19] M. Karimi, H. R. Naji, and S. Golestani, "Optimizing clusterhead selection in wireless sensor networks using genetic algorithm and harmony search algorithm," in Proceedings of the 20th Iranian conference on electrical engineering (ICEE 2012), pp. 706–710, Tehran, Iran, May 2012.
20) [20] A. Kots and M. Kumar, "the fuzzy based QMPR selection for OLSR routing protocol," Wireless Networks, vol. 20, no. 1, pp. 1–10, 2014.
21) [21] L. Rivoirard, M. Wahl, P. Sondi, M. Berbineau, D. Gruyer, Performance evaluation of AODV, DSR, GRP and OLSR for VANET with real-world trajectories, in: Int. Conf. ITS Telecommuni. (ITST), 2017, pp. 1–7. Warsaw.
22) [22] O. A. Wahab, H. Otrok, and A. Mourad, "VANET QoS-OLSR: QoS-based clustering protocol for vehicular ad hoc networks," Computer Communications, vol. 36, no. 13, pp. 1422–1435, 2013.
23) [23] Pareek, Sumeet and R. Shanmughasundaram. "Implementation of Broadcasting Protocol for Emergency Notification in Vehicular Ad hoc Network(VANET)." *2018 Second International Conference on Intelligent Computing and Control Systems (ICICCS)* (2018): 1032-1037.
24) [24] Kareem, S. W., & Okur, M. C. (2020). Evaluation of Bayesian Network Structure Learning Using Elephant Swarm Water Search Algorithm. In S. Cheng, & Y. Shi (Ed.), Handbook of Research on Advancements of Swarm Intelligence Algorithms for Solving Real-World Problems (pp. 139-159). IGI Global. https://doi.org/10.4018/978-1-7998-3222-5.ch008.
25) [25] Kareem, S. W., & Okur, M. C. (2020). Structure Learning of Bayesian Networks Using Elephant Swarm Water Search Algorithm. International Journal of Swarm Intelligence Research (IJSIR), 11(2), 19-30.
26) [26] Kareem, S. W. (2022). A Nature-Inspired Metaheuristic Optimization Algorithm Based on Crocodiles Hunting Search (CHS). International Journal of Swarm Intelligence Research (IJSIR), 13(1), 1-23.

27) [27] Kareem, S., Mohammed, A., Khoshabaa, F. (2022). Novel nature-inspired meta-heuristic optimization algorithm based on hybrid dolphin and sparrow optimization. International Journal of Nonlinear Analysis and Applications, (), -. doi: 10.22075/ijnaa.2022.27519.3635
28) [28] Awla, H. Q., Kareem, S. W., & Mohammed, A. S. (2022). Bayesian Network Structure Discovery Using Antlion Optimiza-tion Algorithm. International Journal of Systematic Innovation, 7(1), 46-65.
29) [29] Bi, Y., Shan, H., Shen, X. S., Wang, N., & Zhao, H. (2016). A multi-hop broadcast protocol for emergency message dissemination in urban vehicular ad hoc networks. IEEE Transactions on Intelligent Transportation Systems, 17(3), 736–750.
30) [30] Swathi Konduru, M. Sathya, "Remora optimization algorithm-based optimized node clustering technique for reliable data delivery in VANETs", International Journal of Intelligent Networks, Volume 3,2022, Pages 74-79,