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Research Article

Modified Mother Optimization Based Online K-Means Clustering and Routing Protocol In MANET

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ABSTRACT

The term Mobile Ad-hoc Network (MANET) refers to a multi-hop wireless networking system that uses mobile nodes with limited resources due to factors such as battery life, memory, and processing power. The routing in MANETs differs from traditional broadcasting networks in that the nodes act as both routers and end machines. As a result of the nodes' resource limitations, the routing protocols for MANETs must be lightweight and assume a reliable environment. This paper presents a Modified Mother Optimization based Online K-Means Clustering and Routing Protocol (MMO-OKMC) for optimal routing in MANET. The clustering is proceeding with Online K-Means Clustering (OKMC) for generating node clusters. For load balancing and dynamic clustering, this clustering is utilized. Created for processing data in real-time, this clustering is ideal for MANETs because it can adapt quickly to changes in the network environment, such as signal deterioration, enabling effective data transmission, mobility, and interference. In the process, the delivery ratio is improved and the overall communication overhead is decreased. Upon reaching optimal routing procedures, the MMOA comes into play. Several fitness functions are considered in this proposed method, including residual energy, node degree, and distance to the Mobile Sink (MS). The proposed method is implemented in NS2, and performance is evaluated by performance measures of energy consumption, end-to-end delay, throughput, average delay, loss ratio, and packet delivery ratio. The proposed method is compared with the conventional routing process.

Keywords: Mobile Ad hoc Network, mother optimization algorithm, online k means clustering, mobile sink, clustering and routing.

1. INTRODUCTION

The two types of wireless networks are infrastructure-less networks and networks with infrastructure. A mobile ad hoc network, or MANET, is a wireless network topology composed of mobile network nodes and moveable communication paths in infrastructure wireless communication networks. Or, to put it another way, because of their node mobility, MANETs are actual networks with active topology. There are two types of MANETs: heterogeneous and homogeneous [1]. MANETs have a number of restrictions in the network and node environments, which make the routing protocol crucial. MANETs have limited research due to their dynamic, flexible architecture, limited resources, and high quality of service (QoS). Self-organized or self-configured MANETs [2,3], like civilian MANETs, have nodes that act independently of one another and are not permitted to share aims. On the other hand, in an infrastructure-less or decentralized ad hoc wireless network, a mobile node functions as both a router

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and an end node during communication with other nodes [4]. A set of protocols is implemented by the proactive MANET protocol to periodically update the node's information table. Upon request, the node receives information updates from the reactive or on-demand approach [5].

Although MANETs appear to be simple and versatile in many different applications, building an efficient routing system for data transmission in such networks is still a challenging task. A significant obstacle in choosing the right forwarding node and sending the packets comes from the dynamic topology of the network[6] where nodes can be added or removed. Consequently,

it is crucial to provide effective, mobility-aware protocols that compute the best paths between nodes in communication and guarantee high network dependability and better routing with minimal overhead [7]. Classic topology-based routing protocols can be divided into three main categories: proactive (table-driven), reactive (on-demand) and hybrid. Numerous obstacles, including high node mobility [8], dynamic network structure, transmission power limitations, and energy constraints, have prompted the development of these routing systems. Because of MANET's dynamic topology, these approaches enable nodes to establish a complete path before forwarding data packets, which results in significant control overhead. On-demand routing (AODV), for instance, is a reactive routing technology that struggles to adapt in high-mobility contexts [9,10].

Numerous power-conscious routing techniques have been put out that consider the transmission energy consumption, the mobile nodes' remaining battery life [11], or both. To increase the MANET's energy efficiency, a variety of routing costs and path selection methods have been studied utilizing such power-aware routing protocols. In recent years, some routing protocols have been created to extend a route's lifetime and, consequently, the network's lifetime [12]. Among these advancements are protocols for multipath routing. During a single route discovery process, the source node can select the optimal route among a variety of routes thanks to multipath routing protocols. With backup routes already available, multipath routing will reduce the number of route discovery procedures while also decreasing end-to-end latency [13], energy consumption, and network lifetime if a route fails. Optimal routing in MANETs has been achieved in recent years through the use of optimization-based routing [14,15]. The main objective of this research is presented as follows,

This paper presents an MMO-OKMC for optimal routing in MANET. The clustering is proceeding with OKMC for generating node clusters. For load balancing and dynamic clustering, this clustering is utilized.

Created for processing data in real-time, this clustering is ideal for MANETs because it can adapt quickly to changes in the network environment, such as signal deterioration, enabling effective data transmission, mobility, and interference. In the process, the delivery ratio is improved and the overall communication overhead is decreased.

Upon reaching optimal routing procedures, the MMOA comes into play. Several fitness functions are considered in this proposed method, including residual energy, node degree, and distance to the MS.

Below is a pre-planned outline for the remaining half of the paper: Research on MANET routing is provided in Section 2. In Section 3, an explanation of the suggested system model is given. Present in Section 4 are the outcomes of the suggested methodology. Section 5 contains a summary of the paper.

2. RELATED WORKS

The authors propose a novel routing protocol to improve MANET's data transmission performance. The routing process chooses the path that data will take within a network, between networks, or between several networks. Cluster heads engage in multi-hop routing and select the best route following the intended protocol. Many studies have been done to address this problem. We have covered a couple of their techniques in this section. This section compares the methods currently in use.

To improve network longevity and energy efficiency, Mitha Rachel Jose et al. [16] have introduced two innovative strategies for clustering and routing in MANETs. To minimize overhead, improve network topology stability, and decrease collisions, the Hybrid Tasmanian Devil and Elephant Herding Optimization (HTDEHO) is used to cluster the MANET nodes. The HTDEHO finds the best cluster head (CH) among a set of nodes based on a number of criteria, such as mobility-based node ranking, residual energy, distance, node degree, and optimal next hop CH selection. The optimal routing cost from CH to the base station is found using the Dwarf Mongoose optimization algorithm with the Fuzzy variable (FDMO) approach, which takes into account a number of variables like as throughput, latency, and distance.

In a MANET network, B. Jaishankar et al. [17] introduced the SG-MFOA hybrid clustering strategy, which makes use of a multipath cross-layer design. Here, hybrid routing is used to pick several routes for the delivery of data packets. In addition, a cross-layer metric is obtained based on load balancing parameters, residual energy, and expected transmission time (ETT). For effective routing, a cluster head (CH) must be chosen based on this trade. Thus, the cluster head is most suited to make use of SG-MFOA. Consequently, the multi-objective functions comprising bandwidth, congestion delay, transmission delay, and, to guarantee the extension of network lifetime, queue delay at each connection access category from the available routes to a destination carry out the multipath route selection.

V. Senthil Murugan et al. have demonstrated a cluster-based routing system under energy prediction utilizing deep learning methodologies [18]. Here, we propose a novel energy prediction model called Concatenation of Convolutional with Max-Avg Pooling Layer in Deep Convolutional Neural Network (CCMAP-DCNN), where accuracy of energy prediction is ensured by adding extra layers to the existing DCNN structure. Thus, clusters are created by grouping the nodes together. Several factors are taken into account while choosing the cluster leader, including as trust, energy, latency, and distance. We introduce a novel hybrid Namib Beetle Upgraded Jellyfish Search Optimization (NBUJSO) algorithm for cluster head selection and optimal routing, which combines the JSO algorithm and the NBO technique to produce a more optimal selection process.

Edwin Singh C et al. [19] proposed Optimal Fuzzy Clustering and Trust-Based Routing (OFC-TR], a technique that can reduce energy consumption and latency while enhancing network security and longevity. The recommended OFC-TR approach is implemented in three parts. Using the upgraded Fuzzy C-means (IFCM) technique, which solves unequal distribution by assigning each sensor a particular level of cluster membership, the first step is grouping the sensors and selecting cluster leaders. The nodes will be effectively clustered using this set of rules, and the best cluster head will be selected. The second section computes trust values using a fuzzy cognitive medium (FCM) that considers the values of both direct and indirect trust.

An extended long short-term memory-squid game optimizer (ELSTM-SGO) has been presented by Marannan Udhayamoorthi et al. [20] as having a wide range of routing possibilities. The nodes' quality of service characteristic dictates which CH is selected among them. The weight placed on the CH will determine how long it will hold. In a cluster, The optimal CH is chosen using the ELSTM-SGO routing technique, which improves routing. The developed ELSTM-SGO protocol consists of three processes: cluster gateway, CH selection, and SGO. The recommended method makes use of the following features: buffer size, packet delivery ratio, routing overhead, end-to-end delay throughput, and the energy consumption of the wireless system.

The study mentioned above suggests that these methodologies may have certain limitations, such as the limited scope of work that MANET suggests to address these limitations. In this study, a novel approach is proposed.

3. PROPOSED SYSTEM ARCHITECTURE

Normal nodes make up the framework of the mobile network.An undirected graph $G = (N, E)$, where N is the pair of nodes that make up the network and E is the pair of edges, is what is known as a MANET. In this graph, a wireless link is defined by an edge, and each node represents a mobile terminal. Every node is then thought to be able to use a global positioning system to determine its location. Furthermore, it is assumed that full nodes broadcast a hello packet each time T and identify nearby nodes by receiving feedback. Because of this, each node is aware of its neighbor and can communicate with it. A neighbor is any collection of nodes that a node can connect with within a given period (T). A packet is first broadcast from a source node to a nearby node during the routing process. Until the packet is transported to its destination, the process is repeated, with one of the nodes that completes this packet being designated as the relay node.

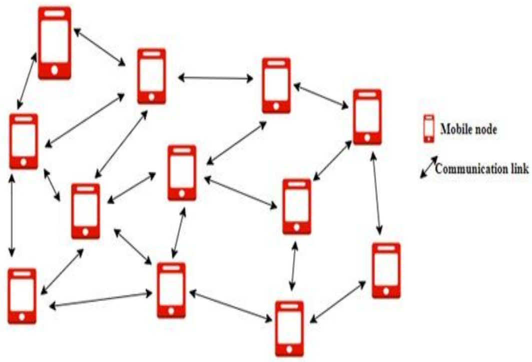

Figure 1 a): MANET architecture

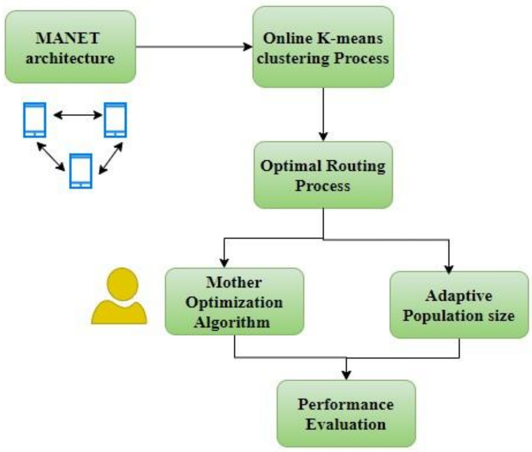

Figure 1 b). Proposed routing process

Because the aggregate energy of these mobile nodes equals the network's lifetime, a MANET needs to calculate a routing method that effectively uses their energy. As the distance between data transmission nodes rises [21], so does the transmission power. Here, the Friis free space equation was utilized to calculate this energy.

$$P_R(D) \propto \frac{\lambda^2}{4\pi D^2} P_T \qquad (1)$$

Here, λ is the wavelength of the radio frequency, D is the distance between the transmitter and receiver, P_T is a transmitted power and P_R is a receiver power. The energy that a node uses to send data to another node is proportional to the square of their distance from one another, according to the preceding formula. It is also necessary to normalize this energy as each node's transmission energy is unique. The normalized energy consumption in this scenario is determined by the following definition:

$$C_{UV} = \frac{P_{TMIN}(U,V)}{P_{MAX}(U)} \quad (2)$$

Here, $P_{TMIN}(U,V)$ is a minimum transmission power from node U to node V and $P_{MAX}(U)$ is a maximum transmission power of node U. Every node takes energy into account when sending data. As a result, over time, the total nodes' residual energy count drops. Normalizing the battery capacity is necessary since each node may have a different capacity. Here, the energy level is defined as the normalized battery capacity. The following is the definition of node U's energy level:

$$E_{Level\,(M)} = \frac{E_{RES}(U)}{E_{INIT}(U)} \quad (3)$$

Here, $E_{INIT}(U)$ and $E_{RES}(U)$ is an initial and residual energy of node U. The best clustering and routing procedure is made possible when the MANET is initialized by taking the suggested technique into account. In the section that follows, the suggested methodology is explained.

3.1. Online K-Means Clustering Process

The suggested routing algorithm for K-means online routing is broken down into two main steps in this section. The second step involves formulating the suggested algorithms, whereas the first stage involves designing the mathematical model. Furthermore, the implementation of this method aims to attain an ideal routing procedure.

3.1.1. K-means clustering for online learning with constraints

Assume that the number of mobile nodes in the network is $N = \{M1, M2, M3, \ldots MN\}$. The entire network is divided into multiple clusters to provide the best routing and data forwarding possible [22]. Initially, the K-means clustering approach is used in MANET to build clusters. The $K = \{K1, K2, K3, \ldots KM\}$ a number of clusters with different centroids is shown here. Euclidean distance is taken into account while determining each mobile node's location, and the mean formula—which is given as follows—is used to find centroids.

$$|M_J| = \sqrt{(MX_J - MX_I)^2 + (MY_J - MY_I)^2 + (MZ_J - MZ_I)^2} \quad (4)$$

Here, MX_I, MY_I and MZ_I is the 3D coordinates correlated to the point coordinates of MX_I, MY_I and MZ_I, M_J is the mobile node in the MANET network.

$$\mu_M = \left[\left(\frac{MX_1 + MX_2 + \cdots + MX_N}{M}\right), \left(\frac{MY_1 + MY_2 + \cdots + MY_N}{M}\right), \left(\frac{MZ_1 + MZ_2 + \cdots + MZ_N}{M}\right)\right] \quad (5)$$

By taking into account the 3D coverage as the volume $V(C)$, Based on the average distance and location of mobile nodes, the network's total coverage area is determined. The coverage distance can be represented as a 3D volume by adding the volumes that each mobile node covers with distance, since the nodes are moving inside a 3D coverage region. (M_J, μ_J) being the separation of each node from the centroid. (μ_J). Here's how this calculation can be completed:

$$V(C) = \sum_{K=1}^{M} \sum_{n=1}^{N} Coverage\ volume\ (M_J, \mu_J) \quad (6)$$

Here, N is the complete number of mobile nodes, K is the complete count of centroids, and $V(C)$ is the total Volume of 3D coverage for the MANET network. Additionally, if the coverage needs to be computed, think of it as a box or prism with rectangular coordinates in 3D X, Y, and Z. Initially, 3D volume is calculated as follows: width (W), height (H), and length (L) multiplied.

$$Volume = L \times W \times H \qquad (7)$$

The distances between the mobile node and the centroid in the X, Y, and Z directions must be calculated to calculate the coverage volume using cartesian coordinates. These distances will be referred to as the $Dz, Dy, and\ Dx$ directions.

$$L = \left|M_{J_X} - \mu_{JX}\right| + DX \qquad (8)$$

$$W = \left|M_{J_X} - \mu_{JY}\right| + DY \qquad (9)$$

$$H = \left|M_{J_X} - \mu_{JZ}\right| + DZ \qquad (10)$$

This time, positive lengths are enabled with the usage of the absolute parameter. The coverage that is impacted by the centroid-mobile node distance can be computed by entering these dimensions into the volume formula as follows.:

$$Vol(M_J, \mu_J) = \left(\left|M_{JX} - \mu_{JX}\right| + DX\right) \times \left(\left|M_{JY} - \mu_{JY}\right| + DY\right) \times \left(\left|M_{JZ} - \mu_{JZ}\right| + Dz\right) \qquad (11)$$

This formula calculates the volume of a rectangular cuboid by taking the distances in each direction. About the distance between the centroid and mobile nodes, the dimensions specify the coverage range or influence on each axis. Finding the mean square error—the difference in distance between the cluster's centroid and the provided point—comes next, following the computation of the cluster's coverage area and centroid.

$$MSE = \sum_{J=1}^{M} \sum_{I=1}^{N} \left|M_J - \mu_J\right|^2 \qquad (12)$$

The phrasing above is modified in the manner shown below:

$$MSE = \sum_{J=1}^{M} \sum_{I=1}^{N} M_{IJ} \left|M_J - \mu_J\right|^2 \qquad (13)$$

Reducing the Mean Square Error (MSE) is the primary goal in MANET networks to attain the optimal clustering value. Therefore, two factors have been considered in the analysis of MSSE differentiation.

$$\frac{\Delta MSE}{\Delta M_{IJ}} = \sum_{I=1}^{N} \sum_{J=1}^{N} M_J - \mu_J{}^2 \qquad (14)$$

The equation above has a centroid-related solution.

$$C_J = \frac{\sum_I^N \mu_J * M_J}{\sum_I^N M_J} \qquad (15)$$

Where, C_J is the cluster contains a centroid point it is computed from size and its MANET. Furthermore, Cluster generation under the MANET condition is challenging due to the iteration process, the size of each cluster, and the occurrence of similar MANETs in many clusters.. Online K-means clustering was created to lessen the overlapping problems and numerous iterations to address these problems.

$$MSE = \sum_{J=1}^{M}\sum_{I=1}^{N} M_{IJ}|M_J - \mu_J|^2 \qquad \forall \sum_{J=1}^{K} \mu_J \sum_{I}^{N} M_J < \tau \qquad (16)$$

Here. τ is defined as an upper bound represented by the iteration count and cluster size. Additionally, a matrix of two similarities has been constructed. The residual is the similarity score inside the clusters, and the number of iterations required to build a cluster.

The definition of the online cluster constraint function is as follows:

$$O_C = \sum_{C}\sum_{A}(S_C, C_A) \ \ \forall A \sum_{A=1}^{A=N} S_C \geq S_R \qquad (17)$$

Here, C_A and C_A is an iteration of data and similarity and O_C is defined as an online constraint for the formation of clusters. In the above equation, the iteration number is paired for a specific time, $S_C \geq S_R$ Should follow this scenario. The movable nodes are dispersed among different groups based on this clustering procedure. After the clustering process, the efficient routing process is enabled with the consideration of MMOA.

3.2. Modified Mother Optimization Algorithm

This algorithm is utilized to enable the optimal routing process of MANET. This algorithm is a combination of Adaptive population size and MOA [23]. Families are without a doubt the first educational institutions in society, and mothers are the primary educators of the children they raise. Her children build their capacities based on the wisdom that a mother imparts to them through her relevant life experiences and skills. Upbringing, guidance, and education are the three main areas of interaction between her mother and her children. For these reasons, the MOA makes use of mathematical design for elements of care and teaching.

3.2.1. Initialization Process

An iterative process is used by the suggested MOA, a population-based metaheuristic algorithm, to tackle optimization problems. Potential solutions, which are vectors in the issue space, are included in the population of the algorithm. Initialization of the population occurs at the beginning of the optimization process, and it is built using a matrix. Utilizing the population's search power, the optimal solution is computed after each member of the population computes the decision parameters associated with its location in the issue search space.

$$P = \begin{bmatrix} P_1 \\ \cdots \\ P_I \\ \cdots \\ P_N \end{bmatrix}_{N\times M} = \begin{bmatrix} P_{1,1} & \cdots & P_{1,J} & \cdots & P_{1,M} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ P_{I,1} & \cdots & P_{I,J} & \cdots & P_{I,M} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ P_{N,M} & \cdots & P_{N,J} & \cdots & P_{N,M} \end{bmatrix}_{N\times M} \qquad (18)$$

$$P_{I,J} = LB_J + RAND(0,1).\left(UB_J - LB_J\right), I - 1,2,..,N \text{ and } J = 1,2,..,M \qquad (19)$$

3.2.2. Adaptive population size

While variable population size has several benefits, it also adds complexity and computational load to the algorithm. In the early rounds of the search, a greater population size usually aspires to search the entire solution space; in later stages, a smaller population size is utilized to enable local exploitation. As a result, the population of solutions is reduced from a maximum size to a minimal value using a straightforward linear model, which is as follows:

$$N = N_{maximum} - (N_{maximum} - N_{minimum}) * \left(\frac{I_{cgn}}{I_{mgn}}\right) \quad (20)$$

Here, I_{cgn} and I_{mgn} are the current generation number and maximum generation number of the algorithm. For the next iteration, the population size, assuming it is now N, will also be N. The solutions can be sorted according to decreasing fitness parameters, with the least effective solutions being removed from the population as a whole. As so, it can support the algorithm in two manners:

- Initially, most people look for big areas in the early stages, and fewer people look for little areas in the latter stages. This process lessens premature convergence as compared to the fixed population size search strategy and helps achieve the ideal balance between global and local search.
- With every population decline, fewer fitness exams are needed by generation. Therefore, by using the variable population size theory, the algorithm can improve the correctness of the solution over a longer period by evolving over a smaller number of generations.

3.2.3. Fitness function

This proposed methodology is developed for reducing the fitness function of node angle, distance of mobile sink, and energy consumption. The fitness function is formulated as follows,

$$FF = MIN\,(W1 * Angle\,(node) + W2 * Distance\ of\ mobile\ sink + W3 * Energy\ consumption) \quad (21)$$

Here,

$$Energy\ consumption = \frac{Initial\ battery - current\ battery}{intial\ battery} \epsilon[0,1] \quad (22)$$

$$Distance\ of\ mobile\ sink = \frac{Distance\ (Node\ destination)}{Length\ of\ environment\ diagonal} \epsilon[0,1] \quad (23)$$

$$Angle\ (node) = \frac{Angle}{180} \epsilon[0,1] \quad (24)$$

Based on the fitness function, the optimal routing is selected in the MANET. According to the mother's engagement with her children, the optimization process involves three rounds of algorithm upgrades that are based on mathematical modeling. These are outlined as follows:

3.2.4. Stage 1: Exploration of education stage

The first phase of the suggested technique, known as population upgrade education, draws inspiration from children's education. By altering the population's geographic distribution significantly [24], it seeks to enhance worldwide search and exploration capabilities. The mother in the algorithm is thought to be the best member of the population, and the way she learns about her kids is intended to process the educational stage. This stage generates a new location for each member using the calculation below.

$$P_{I,J}^{S1} = P_{I,J} + RAND(0,1).\left(X_J - RAND(2).P_{I,J}\right) \quad (25)$$

$$P_I = \begin{cases} P_I^{S1} & f_I^{S1} \le f_I \\ P_I & Else \end{cases} \quad (26)$$

Here, $RAND(2)$ is a random function that uniformly creates a random number from the pair

{1,2}, f_I^{S1} is the objective function parameter, the function $RAND(0,1)$ creates a random uniform number in the interval [0,1], $P_{I,J}^{S1}$ is the dimension, P_I^{S1} is the new location computed for the population member related to the first stage of the MOA, $P_{I,J}$ is the dimension of the position of the population member and X_J is a dimension of the location of the mother.

3.2.5. Stage 2: Exploration of advice stage

Counseling children, rather than giving them the freedom to disobey, is one of a mother's main responsibilities when parenting them. The advice stage allows for notable changes in population member placements, which enhances the MOA's capacity for worldwide search and exploration. The placement of surviving population members with a greater parameter of the objective function than it contains, for each member of the population, identifies deviant features that should be avoided in MOA design. This new position modifies the prior location of the connected member by the following equation if it increases the goal function parameter.

$$bb_I = \{P_K, f_K > f_I \wedge K\epsilon\{1,2,..,N\}\}, \ here, I = 1,2,\dots,N \quad (27)$$

$$P_{I,J}^{S2} = P_{I,J} + RAND(0,1).\left(X_{I,J} - RAND(2).sbb_{I,J}\right) \quad (28)$$

$$P_I = \begin{cases} P_I^{S2} & f_I^{S2} \leq f_I \\ P_I & Else \end{cases} \quad (29)$$

Here, $RAND(2)$ is a random function that uniformly creates a random number from the pair {1,2}, f_I^{S2} is the objective function parameter, the function $RAND(0,1)$ creates a random uniform number in the interval [0,1], $P_{I,J}^{S2}$ is the dimension, P_I^{S2} is the new location computed for the population member related to the second stage of the MOA, $sbb_{I,J}$ is the dimension of the position of the population member [25], sbb_I is the chosen bad characteristic for the population member and bb_J is a dimension of the location of the mother.

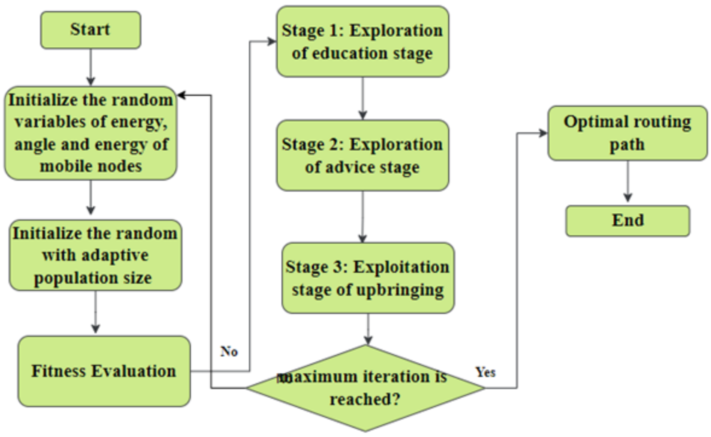

Figure 2: Flowchart of the proposed algorithm

3.2.6. Stage 3: Exploitation stage of upbringing

Mothers empower their children in various ways to improve their academic performance. The development facilitates an enhancement in the MOA stage local search and exploitation capacity. To process the upbringing stage, the following equation is used to generate a new location for each member of the population about the personality development design. The last location of the linked member is updated to the new one if the objective function parameter is increased in the new place.

$$P_{I,J}^{S3} = P_{I,J} + \left(1 - 2.RAND(0,1).\frac{UB_J - LB_J}{T}\right) \quad (30)$$

$$P_I = \begin{cases} P_I^{S3} & f_I^{S3} \leq f_I \\ P_I & Else \end{cases} \quad (31)$$

Here, T is the present parameter of the iteration counter, $RAND(0,1)$ creates a random number in the interval [0,1], f_I^{S3} is the objective function parameter, $P_{I,J}^{S3}$ is the dimension and P_I^{S3} is the new location computed for the population member related to the final stage of the proposed algorithm.

3.2.7. Computational complexity of algorithm

The validation of the computational complexity of the MOA is examined. The difficulty of MOA initialization for an optimization problem is equal to $O(NM)$, where M is the number of decision parameters and N is the number of population members. Members of the MOA population are upgraded to three levels during each cycle. The complexity of the MOA updating process is equal to $O(3NMT)$, where T is the algorithm's maximum number of iterations. Therefore, MOA's overall computing complexity is equal to $O(NM(1+3T))$. According to the suggested methodology, the algorithm is thought to make routing more efficient. The section below provides an evaluation of the results.

4. Outcome and Evaluations

In this section, the suggested approach is examined and verified. To achieve optimal routing and clustering in MANET, the suggested solution has been created. On the NS2 platform, the suggested methodology is put into practice. Furthermore, a comparison is made with traditional methods such as Particle Swarm Optimization (PSO), Grey Wolf Optimization (GWO), Slap Swarm Algorithm (SSA), and Kookaburra Node Aware Trustable and Enhanced Clustering (KNATEC). Numerous metrics, including energy consumption, drop, delivery ratio, latency, throughput, and network longevity, are taken into account throughout the validation process of the suggested methodology. Table 1 lists the parameters for the design and routing processes. Figures 3–7 examine and show the startup, cluster formation, cluster head selection, and routing with two data transfers.

Table 1: *implementation variables*

S.No	Description	Parameters
1	Data transmission rate	11Mb
2	Initial idle power	0.035
3	Initial receive power	0.395
4	Initial transmit power	0.660
5	Initial energy joules	10J
6	Simulation time	50
7	number of nodes	100
8	Routing protocol	AODV
9	Y dimension	1000
10	X dimension	1000
11	Channel	Wireless channel
12	Propagation	Two way round

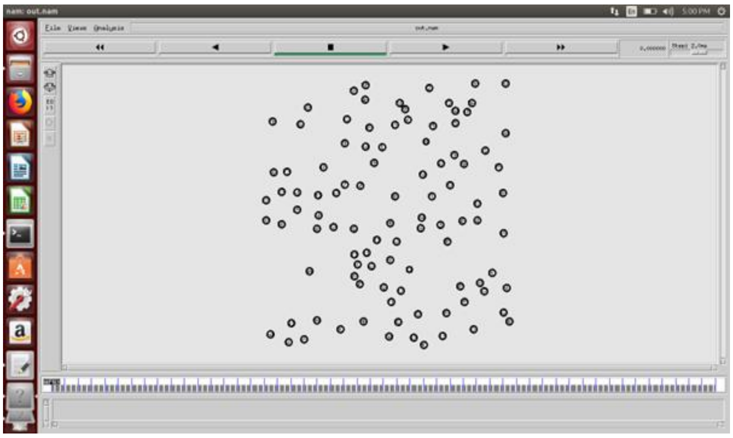

Figure 3: *Initialization*

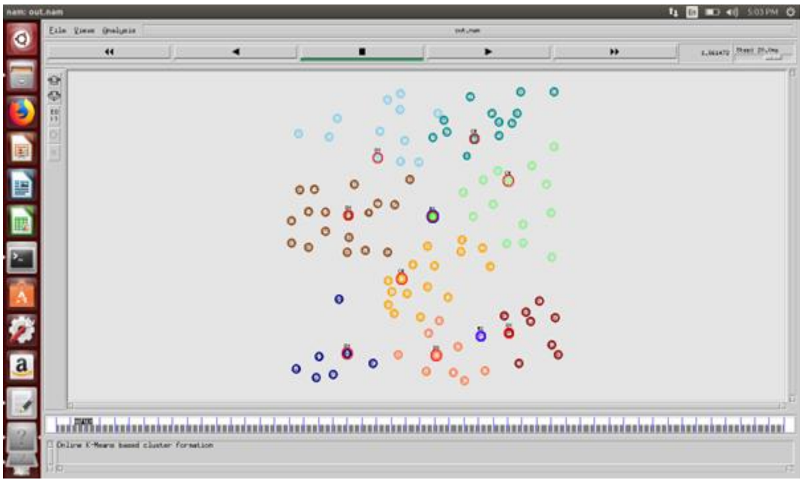

Figure 4: *Cluster Formation*

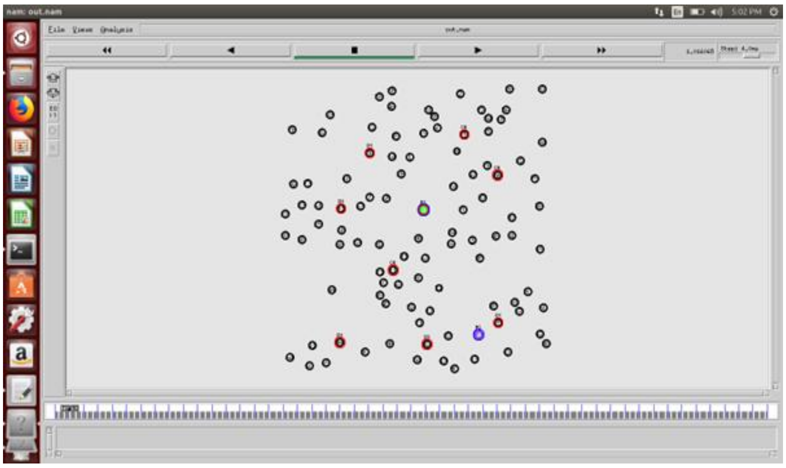

FIGURE 5: CLUSTER HEAD SELECTION

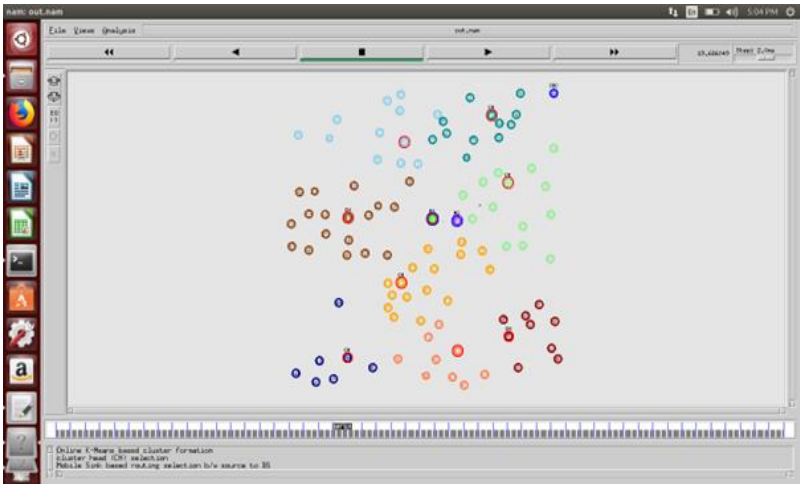

Figure 6: *Data Communication 1*

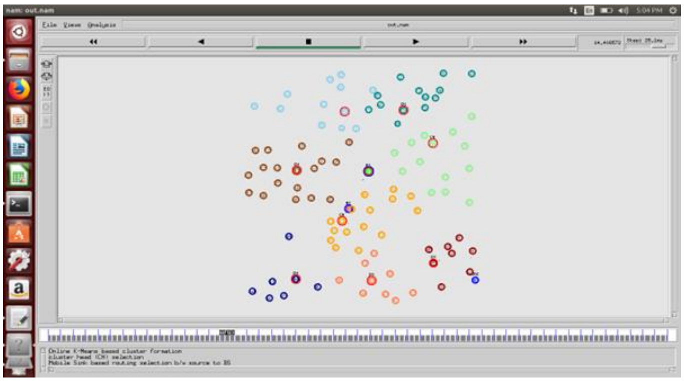

Figure 7: *Data Communication 2*

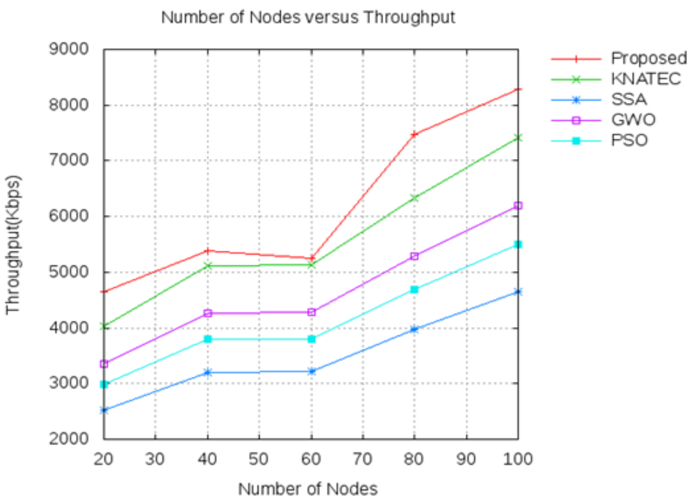

Figure 8: Throughput

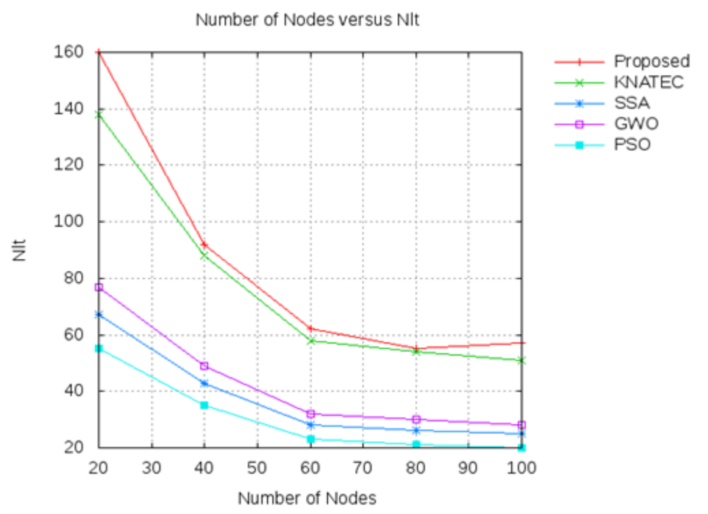

Figure 9: *Network lifetime*

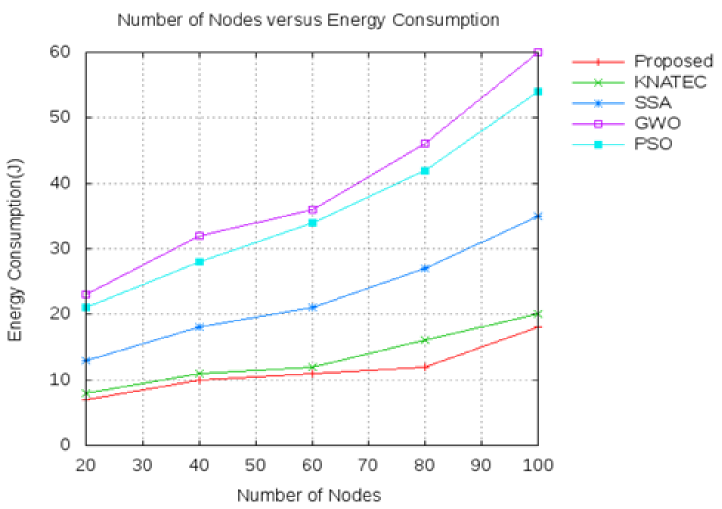

Figure 10: *Energy Consumption*

In the MANET routing process, the suggested technique is validated by taking the energy consumption metric into account and it is presented in Figure 9. The suggested approach is contrasted with traditional methods like PSO, SSA, GWO, and KNATEC. This metric is examined using various node counts. The suggested approach yields 11 at 60 nodes. Furthermore, energy consumption of 12, 21, 36, and 38 are achieved by the standard procedures. The suggested methodology produced the best energy consumption results in this validation. In the MANET routing process, the suggested technique is validated by taking the network lifetime metric into account and it is presented in Figure 10. The suggested approach is contrasted with traditional methods like PSO, SSA, GWO, and KNATEC. This metric is examined using various node counts. The suggested approach yields 62 at 60 nodes. Furthermore, network lifetime of 60, 38, 36, and 28 are achieved by the standard procedures. The suggested methodology produced the best network lifetime results in this validation.

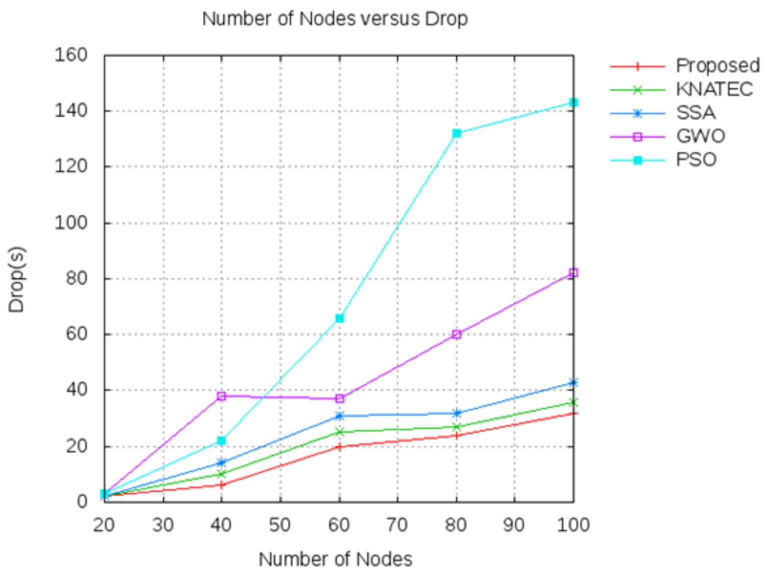

Figure 10: *Drop*

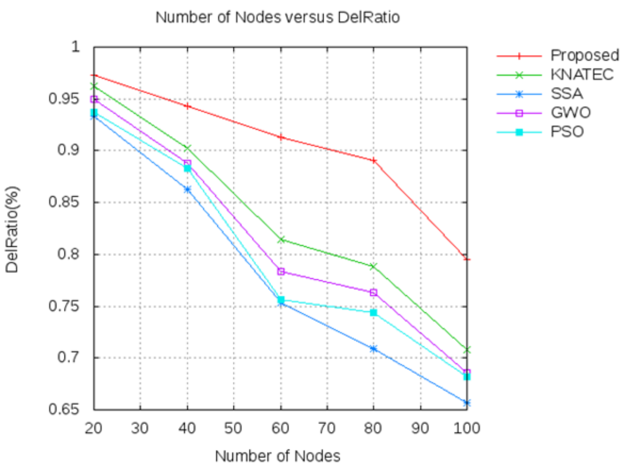

Figure 11: *Delivery ratio*

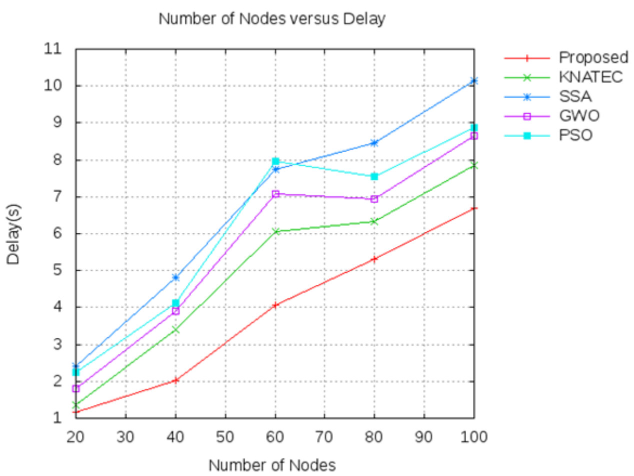

Figure 12: *Delay*

In the MANET routing process, the suggested technique is validated by taking the drop metric into account and it is presented in Figure 11. The suggested approach is contrasted with traditional methods like PSO, SSA, GWO, and KNATEC. This metric is examined using various node counts. The suggested approach yields 62 at 60 nodes. Furthermore, drops of 38, 36, 28, and 20 are achieved by the standard procedures. The suggested methodology produced the best drop results in this validation. In the MANET routing process, the suggested technique is validated by taking the delivery ratio metric into account and it is presented in Figure 12. The suggested approach is contrasted with traditional methods like PSO, SSA, GWO, and KNATEC. This metric is examined using various node counts. The suggested approach yields 0.92 at 60 nodes. Furthermore, delivery ratios of 0.82, 0.78, 0.76, and 0.75 are achieved by the standard procedures. The suggested methodology produced the best delivery ratio results in this validation. In the MANET routing process, the suggested technique is validated by taking the delay metric into account and it is presented in Figure 13. The suggested approach is contrasted with traditional methods like PSO, SSA, GWO, and KNATEC. This metric is examined using various node counts. The suggested approach yields 4 at 60 nodes. Furthermore, delays of 6, 7, 8, and 8.2 are achieved by the standard procedures. The suggested methodology produced the best delay results in this validation.

5. CONCLUSION

An MMO-OKMC for optimal routing in a MANET has been presented in this research. To create node clusters, the clustering process has been using OKMC. This clustering has been used for load balancing and dynamic clustering. Designed to handle data in real-time, this clustering has proven perfect for MANETs since it can immediately adjust to changes in the network environment, including signal degradation, allowing for efficient data transfer, mobility, and interference avoidance. Both the delivery ratio and the total amount of communication overhead have improved as a result of the process. Once optimal routing protocols are achieved, the MMOA becomes operational. This technique takes into consideration some fitness functions, such as distance to the MS, node degree, and residual energy. Performance metrics for energy consumption, end-to-end latency, throughput, average delay, loss ratio, and packet delivery ratio were used to assess the effectiveness of the suggested approach after it was deployed in NS2. The traditional routing procedure has been contrasted with the suggested approach. The proposed methodology has produced the best results in this validation. Real-time applications will be used to validate the MANET using the suggested approach in the future.

6. REFERENCES

[1]. Nirmaladevi, K., and K. Prabha. "A selfish node trust aware with Optimized Clustering for reliable routing protocol in Manet." Measurement: Sensors 26 (2023): 100680.

[2]. Saravanan, R., K. Suresh, and S. S. Arumugam. "A modified k-means-based cluster head selection and Philippine eagle optimization-based secure routing for MANET." The Journal of Supercomputing 79, no. 9 (2023): 10481-10504.

[3]. Vatambeti, Ramesh, Shridhar Sanshi, and D. Pramodh Krishna. "An efficient clustering approach for optimized path selection and route maintenance in mobile ad hoc networks." Journal of Ambient Intelligence and Humanized Computing 14, no. 1 (2023): 305-319.

[4]. Reka, R., A. Manikandan, C. Venkataramanan, and R. Madanachitran. "An energy efficient clustering with enhanced chicken swarm optimization algorithm with adaptive position routing protocol in mobile adhoc network." Telecommunication Systems 84, no. 2 (2023): 183-202.

[5]. Hai, Tao, Jincheng Zhou, Ye Lu, Dayang Jawawi, Dan Wang, Edeh Michael Onyema, and Cresantus Biamba. "Enhanced security using multiple paths routine scheme in cloud-MANETs." Journal of Cloud Computing 12, no. 1 (2023): 68.

[6]. Arulprakash, P., A. Suresh Kumar, and S. Poorna Prakash. "Optimal route and cluster head selection using energy efficient-modified African vulture and modified mayfly in manet." Peer-to-Peer Networking and Applications 16, no. 2 (2023): 1310-1326.

[7]. Kannan, K. R., and C. N. Marimuthu. "Energy efficient routing technique using enthalpy ant net routing for zone-based MANETS." IETE Journal of Research (2024): 1-13.

[8]. Baseera, A., Hari Kishan Kondaveeti, S. Gopikrishnan, B. J. Bejoy, C. G. Ravichandran, R. Santhosh, and R. Dhanapal. "Ieehr: Improved energy efficient honeycomb based routing in manet for improving network performance and longevity." Wireless Personal Communications 129, no. 3 (2023): 1753-1769.

[9]. Rathod, Jayantkumar A., and Manjunath Kotari. "Secure and efficient message transmission in MANET using hybrid cryptography and multipath routing technique." Multimedia Tools and Applications (2024): 1-24.

[10]. Prema, S., and M. P. Divya. "Two-Tier Architecture for Congestion-Free Routing in Manet Using a Hybrid Optimization Algorithm." Wireless Personal Communications 131, no. 1 (2023): 507-526.

[11]. Rajathi, L. V. "An advancement in energy efficient clustering algorithm using cluster coordinator-based CH election mechanism (CCCH)." Measurement: Sensors 25 (2023): 100623.

[12]. Rajathi, L. V. "An advancement in energy efficient clustering algorithm using cluster coordinator-based CH election mechanism (CCCH)." Measurement: Sensors 25 (2023): 100623.

[13]. Gopala Krishnan, C., S. Gomathi, G. Aravind Swaminathan, Y. Harold Robinson, and A. M. AnushaBamini. "Trust management framework and high energy efficient lifetime management system for MANET using self-configurable cluster mechanism." Wireless Personal Communications 128, no. 4 (2023): 2397-2417.

[14]. Devi, E. Ahila, S. Radhika, and A. Chandrasekar. "An energy-efficient MANET relay node selection and routing using a fuzzy-based analytic hierarchy process." Telecommunication Systems 83, no. 2 (2023): 209-226.

[15]. Sankar, S. M., D. Dhinakaran, C. Cathrin Deboral, and M. Ramakrishnan. "Safe routing approach by identifying and subsequently eliminating the attacks in MANET." arXiv preprint arXiv:2304.10838 (2023).

[16]. Jose, Mitha Rachel, and S. Maria Celestin Vigila. "Hybrid Tasmanian Devil and Elephant Herding Model-Based Optimal Cluster Head Selection and Routing in MANET." IETE Journal of Research (2024): 1-17.

[17]. Jaishankar, B., Bharathi Gururaj, A. Muruganandham, and G. Nagarajan. "Hybrid Clustering Approach (SG-MFOA) using Multipath Cross-Layer Design in MANET Network." IETE Journal of Research (2024): 1-9.

[18]. Murugan, V. Senthil, and Bhuvan Unhelkar. "Optimizing Mobile Ad Hoc Network cluster based routing: Energy prediction via improved deep learning technique." International Journal of Communication Systems (2024): e5777.

[19]. Singh, C. Edwin, S. Sharon Priya, B. Muthu Kumar, K. Saravanan, A. Neelima, and B. Gireesha. "Trust aware fuzzy clustering based reliable routing in Manet." Measurement: Sensors 33 (2024): 101142.

[20]. Udhayamoorthi, Marannan, Devadoss Prabakar, and Annadurai Karthikeyan. "Weighted cluster in mobile ad hoc network using enhanced long short-term memory-based squid game optimizer concept." International Journal of Communication Systems 37, no. 9 (2024): e5774.

[21]. Al Ajrawi, Shams, and Bang Tran. "Mobile wireless ad-hoc network routing protocols comparison for real-time military application." Spatial Information Research 32, no. 1 (2024): 119-129.

[22]. Ren, Zhi, Khalid Hussain, and Muhammad Faheem. "K-means online-learning routing protocol (K-MORP) for unmanned aerial vehicles (UAV) adhoc networks." Ad Hoc Networks 154 (2024): 103354.

[23]. Li, Shunlei, Xia Fang, Jiawei Liao, Mojtaba Ghadamyari, Majid Khayatnezhad, and Noradin Ghadimi. "Evaluating the efficiency of CCHP systems in Xinjiang Uygur Autonomous Region: an optimal strategy based on improved mother optimization algorithm." Case Studies in Thermal Engineering 54 (2024): 104005.

[24]. Rajeswari, Ch, and Eshwaraiah Punna. "Multi-response optimization of mechanical properties of MWCNTs fused GFRPs using RSM based GRA and mother optimization algorithm." Journal of Advanced Manufacturing Systems (2024).

[25]. Matoušová, Ivana, Pavel Trojovský, Mohammad Dehghani, Eva Trojovská, and Juraj Kostra. "Mother optimization algorithm: A new human-based metaheuristic approach for solving engineering optimization." Scientific Reports 13, no. 1 (2023): 10312.