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Tom and Jerry Based Multi-path Routing with Optimal K-medoids for Choosing the Best Cluster Head in MANET

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Abstract

Given the unpredictable nature of a MANET, routing has emerged as a significant challenge in recent years. For effective routing in a MANET, it is necessary to establish both the route discovery and the best route selection from among many routes. This investigation's primary focus is finding the best path for data transmission in MANETs. This research proposes an efficient routing technique for minimising the time spent passing data between routers. Here, the study employs a routing strategy based on Tom and Jerry Optimization (TJO) to find the best path via the MANET's routers, called Ad Hoc On-Demand Distance Vector (AODV). The AODV-TJO acronym stands for the suggested approach. Distance, residual energy and number of hops are three different objective functions for this routing strategy. Rerouting must be done when a node or connection fails in a network. To prevent packet loss, the MANET employs this rerouting technique. Analyses of AODV-efficacy TJOs are conducted, and results are presented in terms of energy use, end-to-end latency, bandwidth, and the proportion of living and dead nodes. Vortex Search Algorithm (VSO) and cuckoo search are compared to the AODV-TJO approach in terms of performance. Based on the findings, the AODV-TJO approach uses 580 J less energy than the Cuckoo search algorithm with 500 nodes.

Keywords: Energy Consumption, Mobile Ad-hoc Network, Routing, Tom and Jerry Optimization, Cluster Head

1. Introduction

Rather than relying on a preexisting network infrastructure and a single administrator, a mobile ad hoc network (MANET) is made up of autonomous; no two nodes are the same. Their form factors, processing power, and frequency ranges all vary. Where cellular infrastructure is either unavailable or unreliable, the military and other tactical organisations turn to the MANET [3]. The following are some of the difficulties encountered by the MANET: It is possible for a node in a MANET to join or leave the multicast tree at any moment, and the nodes are free to move anywhere they choose. Therefore, in wireless MANETs, preserving the group membership function and constructing the best possible multicast tree isn't easy. Network partitioning and unreliability are consequences of the MANET's dynamic topology. The short battery life, random mobility, and widely varying received signal intensity in MANET nodes all contribute to the instability and susceptibility of the links and nodes [4].

In a MANET, routing protocols may be categorised as also (1) proactive, (2) reactive, or (3) hybrid, depending on whether they take an active role in the routing process or simply react to it [5]. Popular proactive routing methods include Destination Sequenced Distance Vectors (DSDV) [6] and (OLSR), both of which immediately broadcast the network's health when the malicious nodes connect. Reactive routing methods, such as Ad hoc on-demands distances vector (AODV) [7] and Dynamics Sources Routing (DSR) [8], begin immediately when nodes need data packet transmission and reduce bandwidth costs. Optimal route selection for communication is difficult due to the dynamic nature of the node and frequent changes in the topology [9]. Furthermore, the whole network will be disrupted by the node's malevolent or self-serving behaviour. Averting the network from such rogue nodes is crucial since MANET is used in a wide variety of applications. A node might have either an intentional or unintentional selfish or malignant cause. To extend the NLT of the network, it is crucial to detect such activity on the network. Typically, a selfish node will either disseminate false information about the other nodes or render those nodes unreachable. Without network- or link-layer security [10], the MANET is vulnerable to various malicious assaults. That is why MANET will be a primarily undirected medium.

MANET [11] is a network of mobile devices that function independently and interact with one another through erratic wireless connections. It does not rely on any particular set of facilities. A network connection is managed, and data transformation is realised through coordination between mobile nodes with a limited communication range [12]. This is a low-cost, high-power alternative to traditional wireless network infrastructure in situations where such networks are impractical [13]. Due to its adaptability and ease of deployment in a hostile environment, MANET finds widespread use in the military, Bluetooth operations, personal areas, vehicle network sectors, and industrial settings [14]. This has prompted the need for a trustworthy MANET. The routing technique is the brains of the MANET network. This is because the routing protocol performs essential tasks such as shortest pathfinding, Route Discovery (RD), and data transfer based on the source and destination nodes in an open wireless environment [15]. Following is a summary of the significant advances made by this approach.

Utilising optimum K-medoids to partition the nodes in the network, the most qualified candidate for the role of cluster head is chosen.

Combining AODV with TJO forms an efficient path inside the MANET. Here, AODV uses a barrage of RREQ signals sent across the route to discover the routes available. The AODV pathways are then evaluated using the TJO to determine the best choice.

Locating the shortest route in a network may decrease the latency and the power needed to transmit data. During the route-generating process, distance, energy, and the number of hops are all considered to provide the optimal shortest path.

The structure of this research paper will be as follows: This paper's second section provides a survey of existing MANET routing techniques. The proposed model is thoroughly discussed in Section 3. The experimental and comparative results for the proposed technique are presented in Section 4. A conclusion is presented in Section 5.

2. Related Works

Neenavath and Krishna [16] suggest that using the MANET optimisation approach, a multi-path routing protocol may be more power-efficient. Using fuzzy clustering for head collection and fuzzy NB for intrusion detection presents a significant challenge to the MANET's energy efficiency. Combining the strengths of BSA and WOA, this algorithm is known as the Bird Swarm-Whale Optimization Algorithm (BS-WOA), and it is used to achieve optimal multi-path routing (BSWOA). Fitness metrics such as node connectivity, energy efficiency, complete route trust, and throughput determine the best paths. The suggested BSWOA significantly improved the energy efficiency of previous methods such as fuzzy Naive Bayes, K-means Naive Bayes, naive Bayes, and Naive Bayes Trust.

Using the optimal route selection (ORS) method proposed by Suresh Kumar et al. [17], a cluster head and a backup cluster head can be chosen, and an optimal path can be generated between the cluster head and a member node based on the reliability pair factor and the node's energy. A path with the fewest possible hops and the highest potential energy can be established in the event that the cluster head fails (minimum number of hops). With ORS, a member node provides the most efficient path between the base station and the cluster head, significantly improving the current systems in use. The results show that the proposed ORSMAN outperforms the state-of-the-art throughput, latency, jitter, and packet delivery ratio methods.

Alghamdi [18] presents a protocol that employs the cuckoo search technique to choose a route for data transmission based on the remaining power of each node, hence distributing routing costs equitably among all participating nodes. Energy-aware modifications have all been used as benchmarks against which the new protocol has been measured. After running simulations, it was found that the routing strategy dramatically improved packet delivery rates, battery life, and latency.

To deal with this issue and learn to live with network loss, Venkatasubramanian [19] proposed a Vortex Search method, which used a weighted deep learning model to find the multi-path routing and construct an effective including an energy metric for effective CH selection. Multi-path routing using predicted probability sites and path diversion is offered to improve routing presentation without increasing packet overhead. The most likely locations for nodes are identified using deep learning methods, and then a weighting function is applied. The next stage is for the route maintenance team to monitor data packet delivery and report any issues with the connection.

Sarkar [20] proposed MR-AOMDV for secure and mobile-aware data transfers; it builds multiple paths from source to destination while concurrently considering the mobility and reliability of nodes as routing metrics. During the route discovery phase, when routing pathways are discovered, the values of mobility and dependability are compared to the criteria provided by a trust management module. As part of the route maintenance process, nodes may be added, deleted, or modified to make the resulting paths more reliable and mobile-aware. Through modelling, it can see that the resulting circuits are reliable and sturdy. MR-AOMDV improves transfer rates and ensures data security by routing data through paths clear of malicious nodes. Throughput, energy consumption, packet delivery ratio, routing overhead, and end-to-end delay are all areas where MR-AOMDV is shown to improve upon existing protocols in simulation results for a wide range of MANET use cases.

It has been suggested by Sugitha et al. [21] that a protocol be created. Using a graph theoretic clustering procedure, the suggested approach first groups primary users (PU) and secondary users (SU). Next, the surrounding nodes are anticipated by estimating the weighted end-to-end latency, and a robust spatial Gabriel graph (RS-GG) is formed in each cluster. After the multi-path decision-making requirement has been met, the route way is determined, and communication is carried out according to the quality of service constraint. This might result from improved PDR, stable connections, and longer network life. To demonstrate the efficacy of the suggested design, a thorough performance study is conducted, taking into account PDR, control overheads, energy consumption, and End-to-End latency and comparing the results to those of previously used procedures. Simulation results show that the proposed approach works effectively and enhances data transfer.

3. Proposed System

Optimal K-medoids based on clustering and AODV-TJO multi-path routing comprise the proposed technique's two main parts.

3.1 Clustering Methods

Clustering is the process of dividing a data collection into similar groups. Largely, the characteristics of the pieces inside a cluster are consistent. The target cluster size, denoted by K, should be determined ahead of time. Centroids were recalculated once K was determined using an iterative procedure to determine the best possible partitioning. Our research centred on the K-medoids procedure, similar to the K-means and Clara methods.

3.1.1 K-medoids (PAM)

Medoids is an algorithm designed to address some of the issues with the K-Means approach. K-Medoids clustering is a procedure for breaking down massive datasets into more manageable pieces depending on how similar their contents are to one another. That unselected data may effectively replace medoids to boost clustering [23]. Clusters of K medoids are chosen randomly from a set of N data items, and the remaining data is distributed between them based on their proximity to the chosen medoids. To better grasp how K-medoids function, the study outlines the steps involved.

3.1.2 Cluster Validity

The optimal sum of clusters in a dataset must be defined before implementing numerous clustering techniques, including K-means, PAM, and Clara. The user must figure out and establish a value for k, and this is often regarded as the family's primary challenge. Oftentimes, the shape collection and the user's desired clustering resolution introduce ambiguity in the decision of the appropriate number of K of clusters. Selecting the best value for k means finding a happy medium between packing as many observations into a single cluster as possible and treating each observation as an independent cluster. If you don't know enough about the dataset's attributes to guess a good number for k, you may need to resort to trial and error. The optimal number of clusters may be established using cluster analysis. Cluster analysis seeks to locate groupings of related items to understand better the distribution of patterns and intriguing relationships in massive data sets. The investigations planned centred on the cluster analysis for the optimum selection technique described below.

3.1.2.1 Silhouette Technique

The average silhouette of the observations is calculated using the silhouette technique for varying k. The goal is to find the value of k (clusters) that optimises the average silhouette over all possible values for k. The silhouette value of a point indicates the degree to which this point is similar to other points within the same cluster. For the ith point, the study has the silhouette value S I defined as in Equation (1):

$$S_i = \left(\frac{a_i - b_i}{\max\,(a_i, b_i)}\right) \quad (1)$$

From the above definition, it is clear that: $-1 \leq S_i \leq 1$

The ith node's average distance to the other nodes in its cluster is denoted by a i, while the ith node's minimum average distance to nodes in a different cluster is denoted by b i.

The silhouette value might generally be negative (-1) or positive (+1). If I have a high silhouette value, it fits in well with its cluster but could be better with the clusters around it. If the silhouette value of the majority of the points is high, then the clustering solution is correct. If numerous data points have a negative or small silhouette value, the resulting clustering solution might have an uneven number of groups. Any distance metric may be utilised in the silhouette clustering evaluation criteria.

3.2 Multi-path Routing Using AODV-TJO Methodology

The best path for data transmission is determined using this approach, which combines AODV with TJO optimisation. The routing method uses the goal functions of residual energy, the sum of hops, and distance. Getting the round-trip time in a MANET down to a minimum is the primary focus of this AODV-TJO technique. Taking router distance into account helps decrease overall network latency.

3.2.1 Route Generation Using AODV with TJO

The routers are first spread out over the MANET. Based on the available data about the routers, the AODV chooses one of many feasible routes between the source and destination routers. After generating a set of potential AODV routes, the TJO chooses the best one. When used together, AODV and TJO choose the most efficient path across the network.

3.2.2 Route Discovery Using AODV

New destination routes may be discovered using the AODV routing protocol, eliminating the need for routers to keep track of deactivated connections. One of AODV's main benefits is how quickly and easily it can adjust to any changes in the topology of a network. When a source router needs to send data packets to a destination router, it starts the path discovery process to find the nearest node. Route reply (RREP) and routing error as its messaging methods (RERR).

The router first looks in its routing database to see whether there is a path to the destination. When the routing database has a route for the source router, data packets are sent straight to their final destination. If the route does not already exist in the routing table, the RREQ message is sent out into the network to initiate the routing process to find and set up the proper routing. In the AODV process, the RREP is sent by the intermediate and final routers. The packets are returned to their source through the reverse route discovered during route discovery. An RREQ packet contains the source router's serial number, which keeps the reverse route to the source router active. All routers in the network will build the reverse route to the source if the source router sends the RREQ packet to many destinations. The router determines the next hop router's address in the first RREQ packet. When an RREQ packet reaches its final destination router, it triggers the creation of a corresponding RREP packet. The TJO method sends RREP packets back to the original router. In this way, the best route for sending data from the source to the receiver may be determined. This section provides a detailed explanation of TJO and how TJO generates routes.

3.2.3 Route Optimisation Using Tom and Jerry

The residual energy hops are used to determine the shortest optimum path from the source router to the destination router. This section introduces the theory behind the Tom and Jerry Optimization Algorithm (TJO) before providing its mathematical model for issue optimisation.

Inspiring its creation, the TJO is a population-based algorithm that mimics the dynamics of a real-world scenario in which a cat bites a mouse, and the mouse flees to a safe refuge. Both cat and mouse-like search agents are used in the proposed approach to explore the search space for the issue at hand randomly. The proposed approach has two distinct iterations where population members are updated. Tom's approach to Jerry is modelled in the first stage, while Jerry's flight to safety is modelled in the second.

From a purely mathematical perspective, each individual in the population represents a single candidate answer. A population member provides values for the issue variables based on where it stands in the search space. In this way, the population is a set of vectors whose values define the problem's parameters. In equation (2), a unique matrix called the population matrix is used to calculate the algorithm's population.

$$X = \begin{bmatrix} X_1 \\ \vdots \\ X_i \\ \vdots \\ X_N \end{bmatrix}_{N\times m} = \begin{bmatrix} x_{1,1} & \cdots & x_{1,d} & \cdots & x_{1,m} \\ \vdots & \iddots & \vdots & \iddots & \vdots \\ x_{i,1} & \cdots & x_{i,d} & \cdots & x_{i,m} \\ \vdots & \iddots & \vdots & \ddots & \vdots \\ x_{N,1} & \cdots & x_{N,d} & \cdots & x_{N,m} \end{bmatrix}_{N\times m} \quad (2)$$

Where N is the total sum of population members, m is the total sum of issue variables, X is the TJO population matrix, X i is the ith search agent, and x (i,d) is the value for the dth problem variable retrieved by the ith search agent. As previously indicated, the suggested values for the issue variables are decided by each population member. This means that the goal function must be assigned a value for each population member. A scalar vector represents the objective function values in equation (3).

$$F = \begin{bmatrix} F_1 \\ \vdots \\ F_i \\ \vdots \\ F_N \end{bmatrix}_{N\times m} \quad (3)$$

Where F is the set of all possible values for the objective function and F i is the value of the objective function for the ith search agent.

A population's individuals are ordered from best to worst based on the values of their goal functions, starting with the individual with function. By solving Equations (4) and (5), it gets the sorted population matrix and the sorted objective function (5).

$$X^s = \begin{bmatrix} X_1^S \\ \vdots \\ X_i^S \\ \vdots \\ X_N^S \end{bmatrix}_{N\times m} = \begin{bmatrix} x_{1,1}^s & \cdots & x_{1,d}^s & \cdots & x_{1,m}^s \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ x_{i,1}^s & \cdots & x_{i,d}^s & \cdots & x_{1,m}^s \\ \vdots & \iddots & \vdots & \ddots & \vdots \\ x_{N,1}^s & \cdots & x_{N,d}^s & \cdots & x_{N,m}^s \end{bmatrix}_{N\times m} \quad (4)$$

$$F^S = \begin{bmatrix} F_1^S & \min(F) \\ \vdots & \vdots \\ F_N^S & \max(F) \end{bmatrix}_{N\times 1} \quad (5)$$

Where Xs is the sorted population matrix according to the value of the objective function, XiS is the i-th member of Xs, x(i,d)s is the value for the d-th problem variable retrieved by the i-th search agent of the sorted population matrix, and Fs is the sorted vector of an objective function.

Two populations of cats and mice make up the matrices in the proposed TJO. According to the TJO, the population of mice consists of those individuals who offered higher values for the goal function, whereas the population of cats consists of those individuals who provided lower values for the objective function. Calculating mouse and cat statistics using this idea yields Equations (6) and (7).

$$M = \begin{bmatrix} M_1 = X_1^S \\ \vdots \\ M_i = X_i^S \\ \vdots \\ M_{Nm} = X_{Nm}^S \end{bmatrix}_{Nm\times m} = \begin{bmatrix} x_{1,1}^s & \cdots & x_{1,d}^s & \cdots & x_{1,m}^s \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ x_{i,1}^s & \cdots & x_{i,d}^s & \cdots & x_{1,m}^s \\ \vdots & \iddots & \vdots & \ddots & \vdots \\ x_{Nm,1}^s & \cdots & x_{Nm,d}^s & \cdots & x_{Nm,m}^s \end{bmatrix}_{Nm\times m} \quad (6)$$

$$C = \begin{bmatrix} C_1 = X_{Nm+1}^S \\ \vdots \\ C_i = X_{Nm+j}^S \\ \vdots \\ C_{Nc} = X_{Nm+Nc}^S \end{bmatrix}_{Nc\times m} = \begin{bmatrix} x_{Nm+1,1}^s & \cdots & x_{Nm+1,d}^s & \cdots & x_{Nm+1,m}^s \\ \vdots & \ddots & \vdots & \iddots & \vdots \\ x_{Nm+j,1}^s & \cdots & x_{Nm+i,d}^s & \cdots & x_{Nm+1,m}^s \\ \vdots & \iddots & \vdots & \ddots & \vdots \\ x_{Nm+Nc,1}^s & \cdots & x_{Nm+Nm,d}^s & \cdots & x_{Nm+Nm,m}^s \end{bmatrix}_{Nc\times m} \quad (7)$$

Where C is the cat population matrix, Nc is the total number of cats, C j represents the ith cat, M is the mouse population matrix, Nm is the total number of mice, and M I represents the jth mouse.

As a preliminary step in updating the search criteria, we simulate cats' natural behaviour by having them walk toward mice. Equations (8)-(10) represent the current iteration of the planned TJO upgrade.

$$C_j^{new}: c_{j,d}^{new} = c_{j,d} + r \times \left(m_{k,d} - I \times c_{j,d}\right) \& \; j = 1{:}\,Nc, d = 1{:}\,m, k \in 1{:}\,Nm \quad (8)$$

$$I = \text{round}(1 + \text{rand}) \quad (9)$$

$$C_j = \begin{cases} C_j^{new}, |F_j^{c,new} < F_j^c \\ C_j, |else \end{cases}$$

(10)

C_j^{new}: represents the updated status of the jth cat, $c_{j,d}$ new represents the updated value of the dth problem variable obtained by the jth cat, r represents a random number in the interval [0, 1], $m_{k,d}$ represents the updated kth mouse dimension, and $F_j^{c,new}$ represents the updated value of the objective function.

As part of the TJO's planned second phase, a mouse population is simulated as it flees to safety. It is presumed in TJO that each mouse has a safe haven of its own and that the mice will seek shelter there if necessary. Havens are placed in the search space randomly depending on patterns established by the algorithm's many components. Equations (11)-(13) are used to represent this iteration of Jerry's position update.

$$H_i: h_{i,d} = x_{l,d} \& i = 1: N_m, d = 1: m, l \in 1: N$$

(11)

$$M_i^{new}: m_{i,d}^{new} = m_{i,d} + r \times (h_{i,d} - I \times m_{i,d}) \times sign(F_i^m - F_i^H)$$

$$\& i = 1: N_{m,} d = 1: m$$

(12)

$$M_i = \begin{cases} M_i^{new}, |F_i^{m,new} < F_i^m \\ M_i, |else \end{cases}$$

(13)

H I denote the ith mouse's safe house, and its goal function is expressed as F_i^H. The objective function value $F_i^{m,new}$ is defined as the new status M_i^{new} of the ith Tom.

The procedure enters the next iteration when all population members have been updated, and the iterations continue until the stop condition is met based on Equations (6)-(13). Optimisation algorithms may be terminated after a predetermined number of iterations or after reaching an acceptable error level between successively generated solutions. In addition, a predetermined amount of time may be used as a threshold for terminating the algorithm. After running the optimisation process through its entire set of iterations, the TJO yields the best possible quasi-optimal solution.

3.2.3.1 Fitness Function Evaluation

The fitness function in this AODV-TJO approach takes into account three separate values: energy.

3.2.3.2 Residual Energy

An essential part of the AODV-TJO approach is considering the routers' total residual energy (Re). This is because data loss in the MANET will be caused by routers that run out of power while transmitting data. High-residual-energy routers are favoured for network data transmission.

3.2.3.3 Distance

Distance (Dist) is also considered in the fitness function, which is utilised to lessen the amount of energy consumed during data transmission. Because the quantity of energy required to transmit data increases linearly with its distance. It's more efficient in terms of energy use if the route chosen has a shorter distance.

3.2.3.4 Number of Hops

AODV-ultimate TJO's goal is to maximise the number of neighbour routers, denoted by N c. If you want to keep your network up for as long as possible, use a router with fewer neighbours.

Equation (14) gives the TJO's HSI/fitness value equation.

$$HSI = R_e + Dist + N_c \quad (14)$$

After computing HSI values, the immigration and emigration rates of each species are revised accordingly.

In addition, the optimal route is chosen by determining which fitness value is the highest. The RREP message is sent back to the original router through the identified transmission line. The data packets are then sent from the sending router to the receiving router.

Traditional AODV's route table creation time is longer, and a growing network slows down. The TJO is incorporated into the AODV to counteract these shortcomings of the standard implementation. Three values of the fitness function, including residual energy, distance, and the sum of hops, are taken into account during route generation with the AODV-TJO method.

3.2.4 Route Maintenance

Route maintenance is used to deal with the failures of a route that are caused by node mobility or by nodes that are often malfunctioning. The alternate optimal path is used for data transmission.

4. Results and Discussion

Network Simulator 2 is the tool used in the proposed work. Parameters used in simulations of the proposed model are listed in Table 1.

Table 1. Simulation Settings

Value	**Parameter**
50 nm	Communication ranges from each router
0.2 PJ/bit/m2	E_T
250x250 m2	Area
200	Routers
0.5 J	The initial energy of the router
0.1 PJ/bit/m2	E_R
4000 bits	Packet Size
ts	Message size

4.1 PDR Calculation

Data packet acquisition and transmission rates can be calculated using equation (15) (for an approximate result).

$$PDR = \frac{No.of\_attained\_datapackets}{No.of\_transmitted\_datapackets} \quad (15)$$

Table 2 and Figure 1 present experimental validation of the projected model with the current practices in terms of PDR, respectively.

Table 2. Comparative Evaluation of PDR

No. of Nodes	**Packet delivery ratio (%)**			
	VSA	Cuckoo search	BSWOA	Proposed
100	89.57	94.87	87.56	99.80
200	90.78	93.93	88.98	99.80
300	88.69	93.54	87.75	99.56
400	88.94	94	85.83	98.36
500	87.56	95.5	84.67	96.67

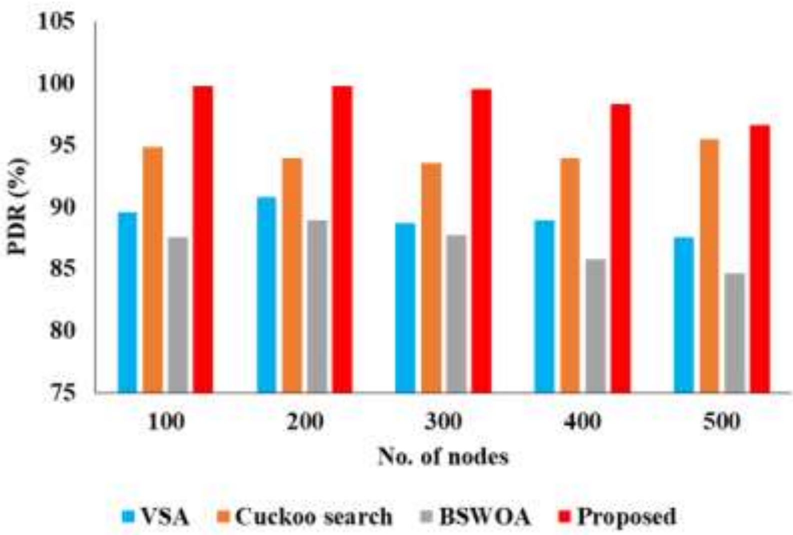

Figure 1. PDR Comparison

To determine the sum of data packets achieved by the sum of data packets sent across fitting nodes, the study relied on the PDR calculation, one of the assessment metrics. The PDR calculation was analysed relative to the total number of vertices. As shown in Table 1, the suggested AODV - TJO routing improves the PDR rate over the baseline in scenarios with 100 and 300 nodes. With 400 nodes, the PDR for VSA, Cuckoo search, BSWOA, and the proposed model is 88.94%, 94%, 85.83%, and 98.36%, respectively.

4.2 Throughput

The speed with which packets travel between nodes can be estimated using the throughput ratio metric. Here, the study calculates the ratio of throughput using equation (16):

$$\text{Throughput (bps)} = \frac{\text{Received\_packet (bytes)} * 8}{1024 * (\text{Endtime} - \text{startingtime})} \times 100 \quad (16)$$

Table 3 and Figure 2 show the results of comparing the proposed model with several current validation methods.

Table 3. Comparative Assessment of throughput

No. of nodes	**Throughput (bps)**			
	VSA	Cuckoo search	BSWOA	Proposed
100	67	250	95	700
200	38	148	70	520
300	45	125	74	425
400	40	178	69	345
500	35	185	73	240

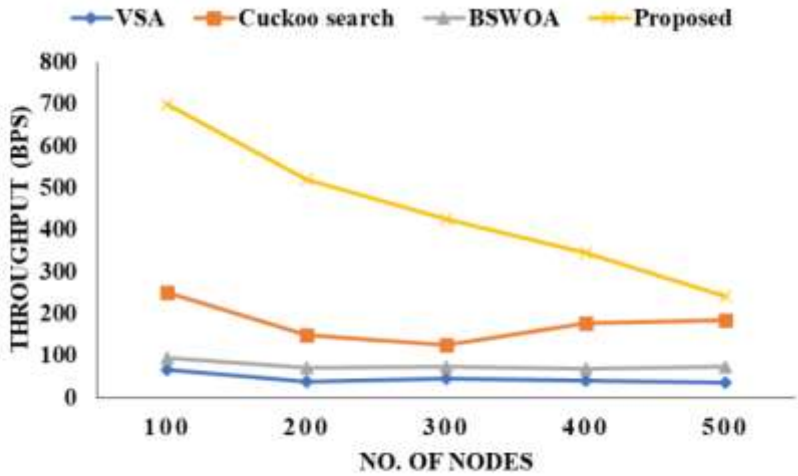

Figure 2. Throughput Comparison

Table 3 demonstrates that the proposed AODV-TJO AODV-TJO consumed less time and more throughput of 700J, 520J, 425J, 345J, and 240joule for the nodes 100 to 500, while the other existing technique called BSWOA attains throughput of 95J, 70J, 74J, 69J and 73 joules at 100 to 500 nodes.

4.3 Energy Consumption

Table 4 and Figure 3 indicate that the suggested model's energy usage is much lower than that of conventional methods because of routine route upkeep. The nodes' energy consumption is evaluated based on how long the simulation runs.

Table 4. Assessment of Energy Consumption

No. of nodes	Energy Consumption (J)			
	VSA	Cuckoo search	BSWOA	Proposed
150	10	10	11	6
200	16	17	15	9
250	19	21	18	12
300	25	27	23	16
400	33	34	26	19
500	39	43	30	21

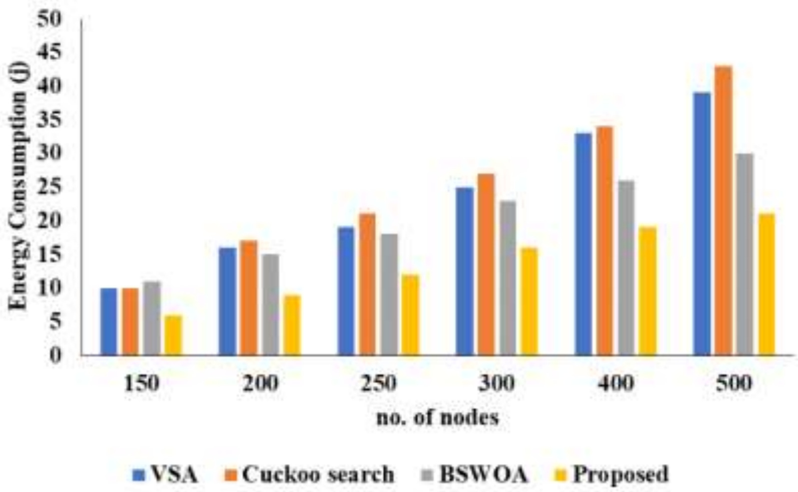

Figure 3. Graphical Comparison of Energy Consumption

This research places a premium on efficiency. Therefore, it suggests a routing protocol that uses as little power as possible while maintaining enough performance, all to extend the network's lifespan. Compared to the other currently-used protocols, the rate of increase in planned AODV-TJO energy consumption is lower (Table 4). The study also finds that the suggested AODV-TJO uses less energy than the current cuckoo search approach, which uses 10, 17, 21, 27, 34, and 43 joules at 150, 200, 250, 300, 400, and 500 nodes, respectively.

4.4 Network Lifetime

With MANETs, network lifetime is a critical factor in ensuring reliable communication. High energy consumption by nodes prevents them from communicating with one another, which might reduce the network's longevity. The suggested method's low energy usage increases the network's lifetime. Experiment results comparing the proposed model to the state-of-the-art methods for measuring network lifespan are shown in Table 5 and Figure 4.

Table 5. Assessment of Network Lifetime

No. of nodes	Network Lifetime (s)			
	VSA	Cuckoo search	BSWOA	Proposed
100	60	119	98	150
200	75	140	115	300
300	86	186	140	420
400	94	230	167	530
500	120	265	198	580

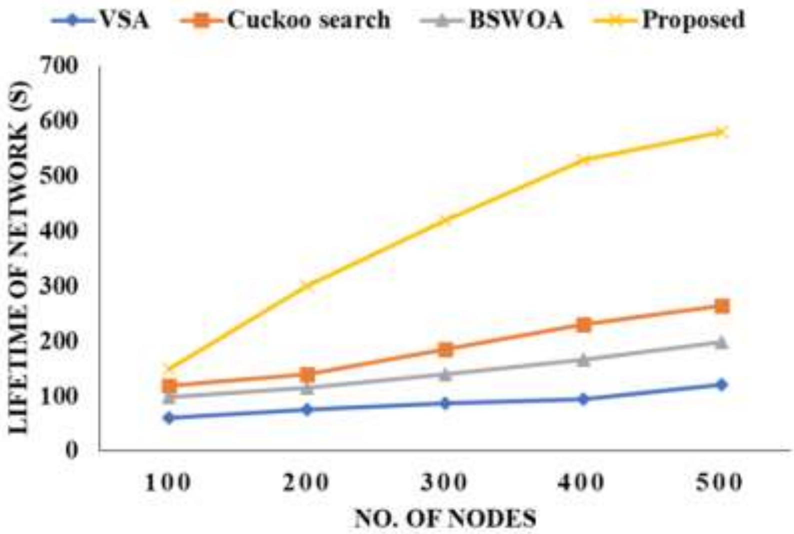

Figure 4. Lifetime of Network

Network Lifetime is the most efficient communication protocol that suffers from high energy consumption performed at every round, where many packets cannot communicate, which is evident from Table 5. The method can notice that the three existing protocols attain less lifetime network than the AODV-TJO. For example, at 400 nodes, VSA, Cuckoo search, and BSWOA are 94s, 230s and 167s, respectively. But, concerning 400 nodes, the proposed system achieves a 530s life span, which is high compared to others.

5. Conclusion

The most critical challenge in MANET is the appropriate route selection for effective packet delivery. After an optimal k-medoid cluster selection, the best route across the MANET's routers may be determined with the help of AODV and TJO. Fitness in the TJO is measured by residual energy, distance, and the total number of hops. In this case, AODV is utilised to rapidly distribute route request messages over all feasible pathways between the source and the destination. The TJO is then used to choose the best route out of those that AODV has uncovered. This causes the destination router to receive the route reply message. Based on this AODV with TJO, the best possible shortest route is generated in each simulation iteration. The AODV-TJO approach is evaluated next to the VSA, the cuckoo search, and the BSWOA method to determine its efficacy. The results show that the AODV-TJO tactic outperforms the other methods by selecting the best possible routes. Future iterations of the AODV-TJO may use an optimisation method to reduce power usage further. Also, it found that the suggested AODV-TJO uses less energy than the other current approach, cuckoo search attain, which uses 10, 17, 21, 27, 34, and 43 joules at 150, 200, 250, 300, 400, and 500 nodes, respectively.

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