

A QoS and Network Lifetime Aware Reliable Multicast Routing Protocol Using a Chaos Integrated Cuckoo Search Rider Optimization Algorithm

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Abstract—In MANET, the multicast routing is considered as a non-deterministic polynomial (NP) complexity, it contains assorted objectives and restrictions. In the multicast issue of MANET, the Quality of services (QoS) based upon cost, delay, jitter, bandwidth, these are constantly deemed as multi-objective for intending multiple cast routing protocols. Conversely, mobile node has finite battery energy and the lifetime of network depending on its mobile node battery energy. If the mobile node has high battery energy consumption, it automatically reduces the network's life time because of their route breaks. Alternatively, node's battery energy has to be consumed to ensure higher level quality of services in multicast routing for transmitting the accurate data anywhere and anytime. Therefore, the network lifespan is deemed as multi-objective in the multicast routing (MR) problem. To overcome these issues, QoS and Dr. Valli Kumari Vatsavayi2 2Professor, Department of Electronic Communication and Engineering, Andhra University, visakhapatnam,Andhra Pradesh ,India. 2Email:vallikumariv001@yahoo.com Network Lifetime Aware Reliable Multicast Routing Protocol are proposed by applying Chaos integrated Cuckoo Search Rider Optimization Algorithm for effectual data transmission in MANET (QOS-MRP-CSROA-MANET). The proposed method is the joint execution of both the Cuckoo Search Algorithm with chaos theory (Chaotic-CSA) and Rider Optimization (ROA) algorithm and hence it is called as Chaotic-CSA-ROA, which is utilized to solve the MR problem of MANET. Here, the MR problem of MANET have five objectives, viz cost, delay, jitter, bandwidth, network lifetime are optimized with the help of Chaotic-CSA-ROA. Then the proposed method is simulated in NS2 simulator for validating the performance of the proposed QOS-MRP- CSROA-MANET system. Here, evaluation metrics, via delay, delivery ratio, drop, Network lifespan, overhead and throughput are analyzed with node, rate and speed. The proposed QOS-MRP-CSROA-MANET provide higher throughput in node as 32.9496% and 65.5839%, higher throughput in rate as 16.6049% and 30.4654%, higherthroughput in speed as 10.1298% and 7.0825%, low packet drop in node as 63.7313% and 52.2255%, low packet drop in rate as 51.5528% and 25.6220%, low packet drop in speed as 18.0857% and 24.5953% compared with existing methods, like QOS aware of multicast routing protocol using particle swarm optimization algorithm in MANET (QOS-MRP-PSOA-MANET) and QOS aware of multicast routing protocol using genetic algorithm in MANET (QOS-MRP-GA-MANET) respectively.

Keywords—Chaos integrated Cuckoo Search Rider optimization algorithm, MANET, data transmission, Multicast routing protocol, cost, delay, jitter and bandwidth.

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1. Introduction

Mobile ad hoc network (MANET) is a self- structured, it forms directly through a set of mobile nodes, which are different from conventional infrastructure-based networks and the topology modifies in terms of node mobility [1]. So, it is hard to expand the network service flexibility and bandwidth utilization because of its mobility and heterogeneity [2]. As well, MANET enables several applications like vehicular network, video conferencing, aquatic applications and content distribution [3]. Therefore, data transmission with MANET structure is the great challenging job for researching [4]. In recent years, MR has drawn more attention, then it is a kind of data transmission service in MANET, here the data is sending from source to destination nodes via one or more path [5, 6]. It only sends the data packet once, then copies it and sends it to various multiple cast group members [7]. Transmissions with higher level of quality of service are primary assurance of media applications in multicast routing [8,9]. The data transfer range in MANET is affected by node battery power [10,11]. If the mobile node has high battery power consumption, then it automatically reduces the network lifetime because of their route breaks [12, 13].

It leads to packet loss when packet sending in the multicast network. That's why the quality of service becomes lesser [14, 15]. That is, the greater node battery power, greater QoS. [16]. Generally, multicast routing problems includes the minimization of link delay, routing cost minimization, bandwidth maximization and link jitter minimization etc., By that, MR problem is considered as NP complexity for large-scale and wide area network [17-20].

In this manuscript, QoS and Network life time aware of multicast routing protocol is proposed with chaos integrated Cuckoo Search Rider optimization algorithm for constructing shortest-path multicast tree for maximizing the lifespan of network with bandwidth, minimizing the cost, delay, jitter. Here, it solves the multicast routing problem by constructing multicast tree with the help of chaos integrated Cuckoo Search Rider optimization algorithm, which transmits data from source to the destinations (multicast group nodes), lessening of cost, delay, jitter, raising of bandwidth, lifetime of network.

The major contributions of this manuscript are:

- In MANET, the MR is considered as a non-deterministic polynomial complexity, it have assorted objectives and restrictions.
- The quality of services in the multicast issue based upon cost, delay, jitter, and bandwidth.
- The cost, delay, jitter, and bandwidth are constantly deemed as multi-objective for intending MR protocols.
- Conversely, mobile node has finite battery energy, then the lifetime of network depending on its mobile node battery energy. If the mobile node has high battery energy consumption, it automatically reduces the network's life time because of their route breaks.
- Alternatively, node's battery energy has to be consumed for ensuring higher level quality of service in MR for transmitting the accurate data anywhere and anytime.
- The network lifespan is deemed as a multi-objective in MR problem.
- To overcome these issues, QoS and Network Lifetime Aware Reliable Multicast Routing Protocol are proposed by applying Chaos integrated Cuckoo Search Rider Optimization Algorithm for effectual data transmission with the help of MANET (QOS-MRP-CSROA-MANET).
- The main objective of this work in MANET is to construct shortest-path multicast tree for maximizing the lifetime of network with bandwidth, minimizing the cost, delay, jitter.
- Here, the proposed method is the joint execution of both the Chaotic-CSA and Rider Optimization (ROA) algorithm, and hence it is called as Chaotic-CSA-ROA, which is used for solving multicast routing problem of MANET.
- Here the MR problem of MANET has 5 objectives: cost, delay, jitter, bandwidth, network lifespan are optimized with the help of Chaotic-CSA-ROA.
- Then the proposed method is simulated in NS2 simulator for validating the performance of the proposed QOS-MRP-CSROA-MANET system.
- The evaluation metrics, vizdelay, delivery ratio, drop, lifetime of network, overhead and throughput are analyzed with node, rate and speed.
- Then the evaluation metrics of proposed QOS-MRP-CSROA-MANET method is compared with existing method like QOS aware of multicast routing protocol using particle swarm optimization algorithm in MANET (QOS-MRP-PSOA-MANET) [21] and QOS aware of multicast routing protocol using genetic algorithm in MANET (QOS-MRP-GA-MANET) [22] respectively.

The rest of this paper is structured as: Section 2 presents the Literature survey. Section 3 illustrates about proposed multicast protocol depending on chaos integrated Cuckoo Search Rider optimization algorithm (QOS-MRP-CSROA-MANET). Section 4 demonstrates theresults of the proposed method. Section 5 concludes the paper.

2. Literature Survey

Several research works were presented in the literature based on multi-objective multicast routing protocol in MANET, a few works are reviewed here.

In 2019, *Y. Harold Robinson, et**.al.,*** [21] have presented the particle swarm optimization-based bandwidth as well as link accessibility prediction approach for MR in mobile ad hoc networks. In MANET, the presented algorithm was utilized to give the MR. At prediction phase, the parameters were employed to choose the node depending on its fuzzy logic. Among all the nodes, the chosen node contains broadcast information and before transmission the details were checked. If link was failure means, the nodes were saved in blacklisted link. Also, the routes were diverted and backward for finding a better link as a forwarder or intermediate node. The simulations were done using NS2.33 simulator. By utilizing PSOBLAP approach lessens the count of link errors. The multiple paths were detected to find the optimum path. MR mode has sustained about 60% packet delivery ratio (PDR).

In 2019, Qiongbing Zhang, et.al., [22] have presented a steady quality-of-service multicast mode for MANETs. The presented method assures the time period of connection in multicast tree was always longer than the delay time from the source node. In QoS, multicast model GA was designed to solve a newly crossover method known as leaf crossover (LC), which better than other crossover methods. The simulation shows that the presented method obtains a greater quality of service route with a significant lessening of implementation time when likened to other methods.

In 2021, S. SakenaBenazer,et.al., [23] have presented the Performance analysis of modified on-demand multicast routing protocol for MANET using non forwarding nodes. The presented multicast protocol was dependable. A nodes subset were not forwarding path rescreen received packets to nodes in its neighbor hoods to strike perceived node failure. This rebroadcasting creates superfluous forwarding paths to skirt unsuccessful areas in the network. Every node generates a forecast result with probability. The simulation outcomes show the unbiased PDR with minimal control in the clouds. MODMRP attained over 90% PDR.

In 2020, N.S. Saba Farheen, et.al., [24] have presented Improved Routing in MANET with Optimized Multi path routing fine tuned with Hybrid modeling. Here, a node location forecasting depending on sequential with spatial features regarding its region was employed to assess the credible locations utilizing hybrid mode. The MR protocol depends upon evaluated probability locations along pathdistraction at essential places. The performance was simulated in NS2.

In 2020,DoddiMadhuBabu, et.al., [25] have presented the MR protocol named cuckoo search along M-tree-based multicast ad hoc on-demand distance vector protocol for MANET. Here, the routing protocol contains 2 stage processes: (i) M-tree construction, (ii) optimum multicast route selection. Then build the M-tree with the help of 3 categories: destination flag, path inclusion factor, multifactor utilizing in divisional based cluster (DIVC) technique. After, cuckoo search algorithm was employed to select the optimum route by assuming the multi-objectives, viz energy, network lifespan, distance, delay. From the simulation results, 90.3513% maximum energy, 86.2226% throughput, 87.1606% PDR.

3. Proposed Qos and Network Lifetime Aware Reliable Multicast Routing Protocol Using a Chaos Integrated Cuckoo Search Rider Optimization (Cs-roa) Algorithm in Manet

In this section, QoS and Network Lifetime Aware Reliable Multicast Routing Protocol using a Chaos integrated Cuckoo Search Rider Optimization Algorithm (MRP-CSROA) for effective data transmission in MANET. Figure (1) demonstrates that overall work flow of proposedQoS and Network Lifetime Aware Reliable Multicast Routing Protocol using a Chaos integrated Cuckoo Search Rider Optimization (CS-ROA) Algorithm in MANET.

The quality of service MR protocol of MANET is modeled with weighted undirected graph $graph = (U, L)$, Here, U is the set of network nodes and L is the set of link connected such nodes. There is a weight vectors $Weight$ containing quality of service characteristic in proportion to every edge on L, viz cost, delay, jitter, bandwidth. It's characterized the real delay during the link transmission cost, real link transmission delay variation (jitter), assessed link band width.

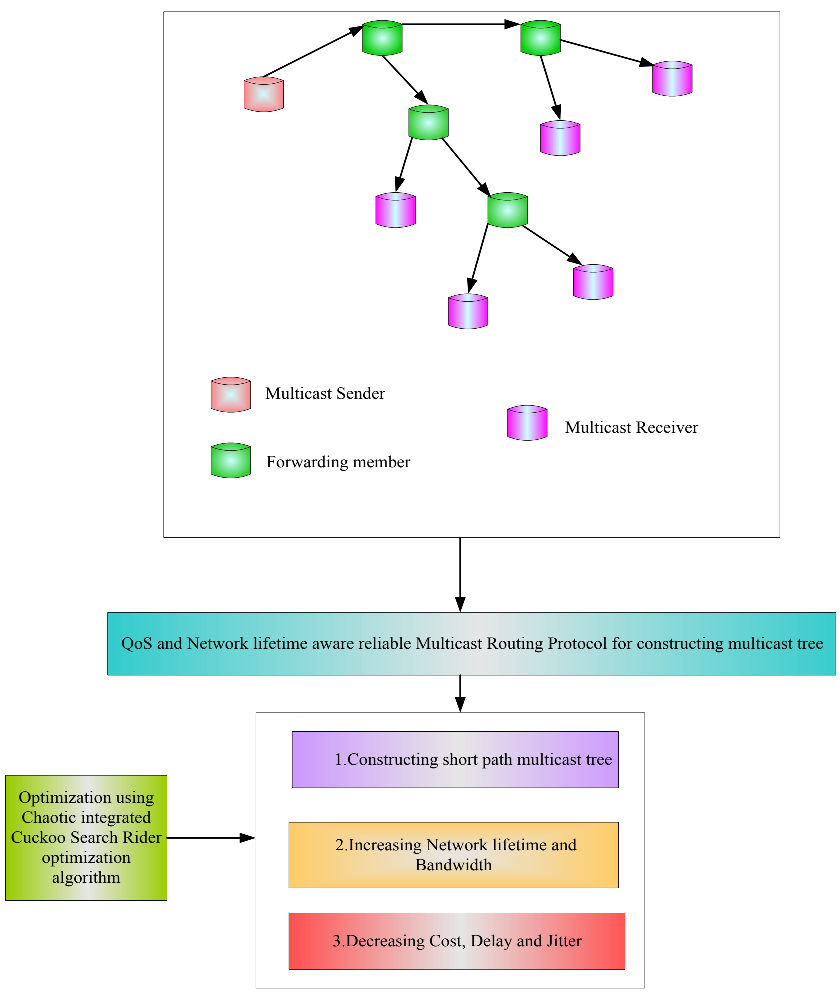

Figure 1: Overall workflow of proposed method

Consider, $S \in U$ as source node of multicast tree, $N = \{l_1, l_2, ...l_n\} \subseteq \{U - S\}$ remains the set of multicast tree destination nodes. Let, $W(S, N)$ express the multicast tree, total numbers of nodes were expressed as $|U|, |L|$ expresses the total count of links, P^+ as set of +ve real numbers. Hence, $W(S, N)$ be the source node which sends the data packets to multiple destination nodes.

It is visibly recognized that QoS includes, delay, cost, bandwidth and jitter, so for any link $l \in L$, these metrics of QoS are determined as following equation (1-4),

Delayfunction: $Delay(l) : L \rightarrow P^+$ (1)

Costfunction: $\mathrm{Cos}\,t(l) : L \rightarrow P^+$ (2)

Jitterfunction: $Jitter(l) : L \rightarrow P^+$ (3)

Bandwidth function: $Bandwidth\ (l) : L \rightarrow P^+$ (4)

In the multicast tree $W(S, N)$, assume $Q(S, w)$ as the routing path of $W(S, N)$ from the source node S to destination node $w\ (w \in N)$. Therefore, the entire quality of service metrics have been specified through the succeeding functions and it is given in the following equation (5-8)

$$Delay(Q(S, w)) = \sum_{l \in Q(S,w)} delay(l) \tag{5}$$

$$\mathrm{Cos}\,t(W(S, N)) = \sum_{l \in W(S,N)} \mathrm{Cos}\,t(l) \tag{6}$$

$$Jitter(Q(S, w)) = \sum_{l \in Q(S,w)} Jitter(l) \tag{7}$$

$$Bandwidth(Q(S, w)) = \min(Bandwidth(l)), l \in Q(S, w) \tag{8}$$

Furthermore, the degree of the node p is directed as Deg_p ,the remaining battery energy of node p is expressed as Egy_p , the data flow from node p to node q, ϑ_{pq} represents the energy consumption of node p transfer the unit of datagram to the node q is expressed as ξ_{pq}. Consider, for all nodes the value of ϑ_{pq} and ξ_{pq} are equal, then the flow rate of datagram is implied as $D_{pq} = \vartheta_{pq} * \xi_{pq}$. Since, the multicast tree's lifetime $W(S, N)$ is specified as follows in equation (9),

$$Network\ \ Lifetime(W(S, N)) = \min_{p \in W(S,N)} \left\{ \frac{Egy_p}{\sum_{q \in Deg_p}^{D_{pq}}} \right\} \tag{9}$$

Total life time of the MANET is scaled only for the multicast tree topology $W(S, N)$, in addition from equation (9), the greater the Deg_p, the higher is energy consumption. Let the set of nodes connected to node p through links are represented as Deg_p resulting higher Deg_p, lesser routing cost.

In MANET, there is a need to find a multicast tree $W(S, N)$ in order to delivers table QoS, which maximizes the network lifetime and bandwidth, and it also minimizes the cost, delay and jitter. On the other hand, in order to extend the lifetime of the network, energy consumption must be reduced. Consequently, the cost, delay, jitter, bandwidth, network lifespan are supposed as 5 intentions. The five intentions can be optimized with the help of Chaos integrated Cuckoo Search Rider Optimization Algorithm. The detailed discussion regarding the Chaos integrated Cuckoo Search Rider Optimization Algorithm are given below,

3.1 Chaos Theory

Chaos is the non-linear movement of a dynamic system that has the characteristics of periodicity, sensitive for initial population, stochasticity. Owing to these characteristics, chaos is a good initial population lead to quick convergence speed with accuracy to the global optimum, hence gathered the chaotic maps, which characterize using various equations to update the random variables in optimization methods is called chaotic optimization algorithm (COA). In this paper, one-dimensional including non-invertible maps are selected represented in Table 1, then applied to generate a set of chaotic values to identify the best map for the Cuckoo Search Rider Optimization Algorithm parameters as well as raise the efficiency of Cuckoo Search Rider Optimization Algorithm, where 'a' is control parameter and 'z' is considered as chaotic variable.

Table 1: Chaotic map details

No	Map Name	Equation
Map 1	Chebyshev	$z_{i+1} = \cos(i \cos^{-1}(z_i))$
Map 2	Sine	$z_{i+1} = \frac{a}{4}\sin(\pi z_i), a = 4$
Map 3	Tent	$z_{i+1} = \begin{cases} \frac{z_i}{0.7} & z_i < 0.7 \\ \frac{10}{3}(1 - z_i) & z_i \geq 0.7 \end{cases}$
Map 4	Sinusoidal	$z_{i+1} = a z_i^2 \sin(\pi z_i), a = 2.3$
Map 5	Logistic	$z_{i+1} = a z_i (1 - z_i), a = 4$

Table 2 tabulates the parameters utilized in the optimization.

Table 2: Chaos integrated Cuckoo Search Rider Optimization Algorithm parameters

Parameter	Value	Description

n	20	Count of solutions for each generation
dim	5	The dimension of Chaos integrated Cuckoo Search Rider Optimization Algorithm
$Freq_{MIN}$	0	Minimum Frequency
$Freq_{MAX}$	10	Maximum Frequency

Generally, the Chaos integrated Cuckoo Search Rider Optimization Algorithm is a meta-heuristic optimization algorithm. It individually deals several engineering with scientific issues owing to its flexibility. Chaos integrated Cuckoo Search Rider Optimization Algorithm (MRP-CSROA) gives early convergence, also attains the optimum fitness solution by minimizing cost, delay, jitter and maximizing the bandwidth and network lifetime. The stepwise process for constructing shortest-path multicast tree from QoS and Network Lifetime Aware Reliable Multicast Routing Protocol of MANET are specified below,

3.2 Step by Step procedure for constructing shortest-path multicast tree formation via Chaos integrated Cuckoo Search Rider Optimization Algorithm

Here, the stepwise procedure for constructing shortest-path multicast tree formation from QoS and Network Lifetime Aware Reliable Multicast Routing Protocol of MANET is described. The related flow chart is represented in Figure 2. First, the Chaos integrated Cuckoo Search Rider Optimization approach creates uniformly distributed path initial population from multicast tree of QoS and Network Lifetime Aware Reliable Multicast Routing Protocol from MANET. After the initialization procedure, generates randomly the parameters and compute the fitness function. Based on Updation of Cuckoo position, Evaluation of success rate and Updation of rider parameter of Chaos integrated Cuckoo Search Rider Optimization Algorithm; it optimizes the shortest-path multicast tree formation for data transmission in MANET. The best fitness function is updated via the Chaos integrated Cuckoo Search Rider Optimization Algorithm. The above procedure is repeated until get the optimal solution.

Step 1: Initialization

Initialize the maximum number of iterations 'T', build the chaotic map values with size 1 × T, path population by repetitive implementation of QoS and Network Lifetime Aware Reliable Multicast Routing Protocol using Chaos integrated Cuckoo Search Rider Optimization Algorithm based on initial chaotic number of the chaotic map. The QoS and Network Lifetime Aware Reliable Multicast Routing Protocol path population initialization is given by the following equation (10)

$$QoS - MRP\ path\ population = [path_1, path_2, ...path_b] \quad 10)$$

Where b denotes number of path population.

Step 2: Random generation

After the initialization process, the input parameters of QoS and Network Lifetime Aware Reliable Multicast Routing Protocol are randomly generated with the mobile nodes. In this step, greatest fitness values based on Chaos integrated Cuckoo Search Rider Optimization Algorithm are selected.

Step 3: Fitness Function

The random solution is generated from the initialized values. Fitness function of solution is assessed and the objective function signified in an optimization of optimal route multicast tree formationwhich is given in equation (11),

$$Fitness\ Function = [Minimum(cost,\ delay,\ jitter) + \max imum(bandwidth + network\ Lifetime)] \quad (11)$$

Subject to the equation (12),

$$\begin{aligned} &Delay\,(Q(S,w)) \le YD \\ &Jitter\,(Q(S,w)) \le YJ \\ &\min_{w \in W}\{Bandwidth\,(Q(S,w))\} \ge YB \end{aligned} \quad (12)$$

Here, the maximal delay with jitter is lesser or equivalent to the delay threshold YD, jitter threshold YJ respectively. The minimal $Bandwidth\ (Q(S,w))$ at each link in the entire multicast tree must be higher or equivalent to the minimal bandwidth threshold YB.

Step 4: Updation of Cuckoo position for solving multicast routing problem

Here, the updation of Cuckoo position for solving MR problem has discrete binary search space, which is considered as a local search (exploitation) from Chaotic cuckoo search optimization algorithm. So, the binary version of cuckoo search algorithm is required to handle the MR problem. In discrete binary space, position updating means a switching amid '0' and '1' values. The transfer function and discretization method are employed to do this. The updation of cuckoo position is computed by equation (13)

$$Cuckoo\ position\,updation(k+1) = \begin{cases} 1; & if\ ran(0,1) < sigmoid\ function(k+1) \\ 0; & if\ ran(0,1) \ge sigmoid\ function(k+1) \end{cases} \quad (13)$$

Where, $sigmoid\ function(k+1)$ denotes the sigmoid function and it is computed utilizing (14)

$$sigmoid\ function(Cuckoo\ position(k)) = \frac{1}{1+\exp(-Cuckoo\ position(k)} \quad (14)$$

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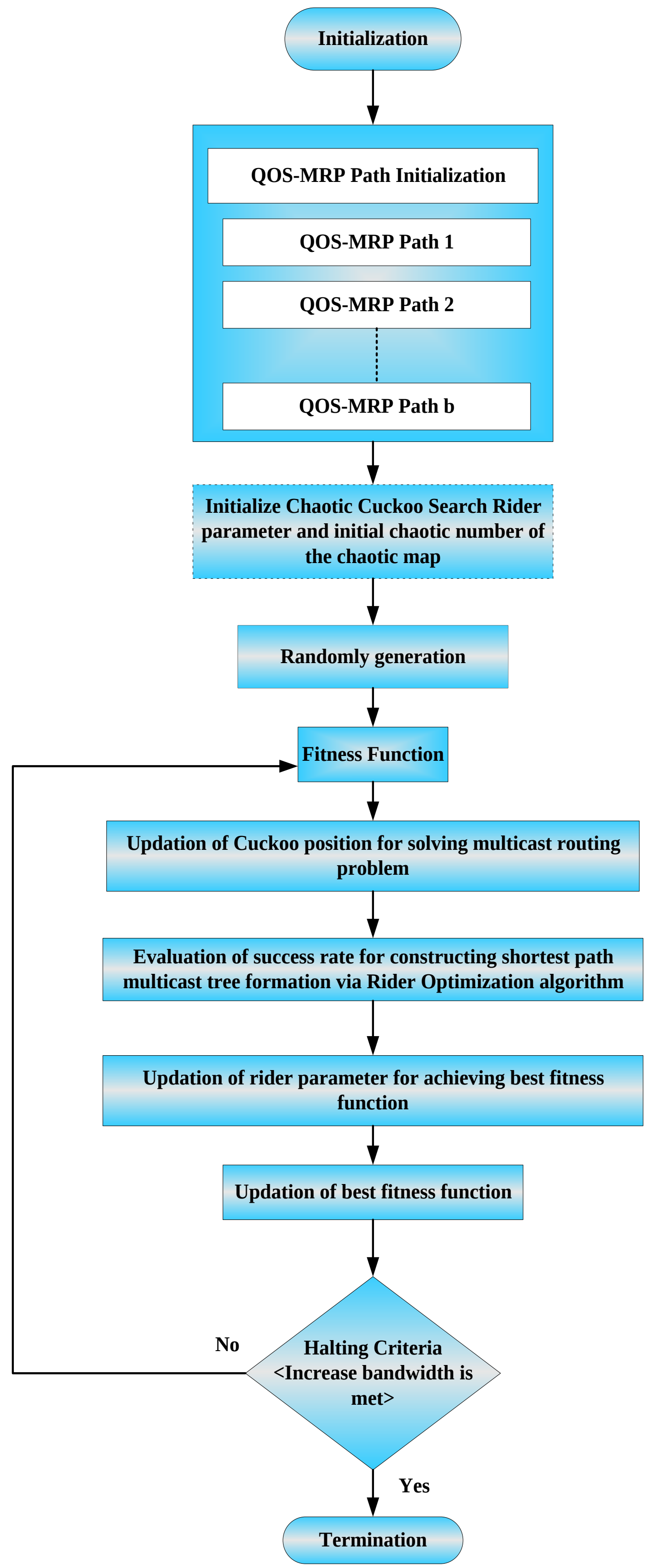

Figure 2: Flowchart for constructing shortest-path multicast tree formation via Chaos integrated Cuckoo Search Rider Optimization Algorithm

Step 5: Evaluation of success rate for constructing shortest path multicast tree formation via Rider Optimization algorithm

In this step, success rate of each path is evaluated. Here the success rate is used to build the shortest-path multicast tree and it can be determined with the help of following equation (15)

$$\text{Success rate for constructing shortest path multicast tree} = \frac{1}{\left\| path_b - \text{Destination node} \right\|} \quad (15)$$

Where $path_b$ represents the position of b^{th} $QoS-MRP\ path\ population$.

Step 6: Updation of rider parameter for achieving best fitness function

In this step, rider parameter such as activity counter, steering angle, gear, accelerator and brake represents the cost, delay, jitter, bandwidth and network lifetime. For reducing cost, the active counter is used and it is given in the equation (16)

$$\cos t_e^{T+1}(p) = \begin{cases} 1; & if\ path_{T+1}(p) > path_T(p) \\ 0 & otherwise. \end{cases} \quad (16)$$

Where $path_{T+1}(p)$ represents success rate of the rider at time $T+1$ and $path_T(p)$ represents success rate of the rider at time T. For reducing delay, the steering angle is used and it is given in the equation (17)

$$delay_{p,q}^{T+1} = \begin{cases} delay_{p+1,q}^{T}; & if\ \cos t_e^{T+1}(p) = 1 \\ delay_{p-1,q}^{T}; & if\ \cos t_e^{T+1}(p) = 0 \end{cases} \quad (17)$$

For reducing jitter, the gear is used and it is given in the equation (18)

$$jitter_p^{T+1} = \begin{cases} jitter_p^T + 1; & if\ \cos t_e^{T+1}(p) = 1\ \&\ jitter_p^T \neq |jitter| \\ jitter_p^T - 1; & if\ \cos t_e^{T+1}(p) = 0\ \&\ jitter_p^T \neq 0 \\ jitter_p^T; & otherwise \end{cases} \quad (18)$$

For maximizing bandwidth, the Accelerator is used and it is given in the equation (19)

$$bandwidth_p^{T+1} = \frac{jitter_p^{T+1}}{|jitter|} \quad (19)$$

For maximizing network lifetime, the Brake is used and it is given in the equation (20)

$$network\ lifetime_p^{T+1} = \left[1 - \frac{jitter_p^{T+1}}{|jitter|}\right] \quad (20)$$

Step 7: Termination

Here, the optimum shortest route multicast tree formationof QoS and Network Lifetime Aware Reliable Multicast Routing Protocol along with Chaos integrated Cuckoo Search Rider Optimization Algorithm for minimizing cost, delay, jitter and maximizing the bandwidth and network lifetime in a MANET can repeat iteratively step 3 till satisfied the halting criteria $b < \max iteration$. At last, the output of QoS and Network Lifetime Aware Reliable Multicast Routing Protocol using a Chaos integrated Cuckoo Search Rider Optimization (CS-ROA) Algorithm in MANET are attained depending on optimal shortest path multicast tree formationfor data transmission in MANET.

4. Result and Discussions

Here, the simulation performance of proposed QOS and network lifetime aware reliable multicast routing protocol using a chaos integrated cuckoo search rider optimization (MRP-CS-ROA) algorithm is proposed to overcome multicast routing problem in MANET. In the experiment, the data of mobile nodes are sent to the gateway utilizing IEEE 802.15.4 standard protocol to collect data for saving the database. The simulations are carried out in PC with Intel Core i5, 2.50 GHz CPU, 8 GB of RAM, Windows 7. The proposed system is activated in NS-2 tool as well as coded are carried out in MATLAB. The evaluation metrics, vizdelay, delivery ratio, drop, network lifespan, overhead, throughput are examined.

Table 3: Simulation parameter

Parameter	Value
Simulation region	1200m
Count of user node	20,40,60,80,100
No of rate	200,400,600,800,1000
No of Speed	10,20,30,40,50
Packet Size for transmission	1024 bytes
Overall Population size	100
Transmission range	250m
Bandwidth	25MHz
Count of frames per packet	5
Data rate to transmit in network	50 Mbps

Here, the performance of proposed QoS and Network Lifetime Aware Reliable Multicast Routing Protocol by applying Chaos integrated Cuckoo Search Rider Optimization (CS-ROA) Algorithm for effective data transmission in MANET (QOS-MRP-CSROA-MANET) is likened with existing models, like QOS aware of multicast routing protocol using particle swarm optimization algorithm in MANET (QOS-MRP-PSOA-MANET) [21] and QOS aware of multicast routing protocol using genetic algorithm in MANET (QOS-MRP-GA-MANET) [22] respectively. Table 3 shows the simulation parameters of proposed algorithm.

4.1 Performance Metric

4.1.1 Delay

This is directly proportional to the distance between the source and destination node.

4.1.2 Delivery ratio

Delivery ratio is defined as the ratio between the packets of destinations arrived and source generated.

4.1.3 *Drop*

This is nothing but packet loss rate. The given equation (21)

$$Drop = \frac{Total\ packet - total\ no\ of\ \ packet\ \ received}{Total\ \ packet} \quad (21)$$

4.1.4 Overhead

Each transmission contains supplementary information, specially it needs to direct the data for appropriate destination.

4.1.5 Throughput

This is defined as the overall number of data packets, which transmits during data transmission at MANET.

4.2 Simulation phase: performance comparison of various methods

Figure 3-5 shows the simulation result for the QOS and network lifetime aware reliable multicast routing protocol in MANET. The performance of proposed MRP-CSROA method was analyzed and compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET mode by distinguishing the number of nodes, speed and rates utilizing 50 Mbps fixed data rate over the network.

Figure 3(a) portrays the analysis of node delay. Here, the QOS-MRP-CSROA-MANET method shows the 23.5676% and 38.9293% lower node delay at node 20, 28.1683% and 36.7325% lower node delay at node 40, 3.9402% and 15.4505% lower node delay at node 60, 27.3086% and 30.9924% lower node delay at node 80, 13.2207% and 18.5326% lower node delay at node 100 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 3(b) shows the node delivery ratio analysis. Here the proposed QOS-MRP-CSROA-MANET method shows the 2.3529% and 4.9295% higher node delivery ratio at node 20, 5.0322% and 8.6301% higher node delivery ratio at node 40, 5.0681% and 8.7943% higher node delivery ratio at node 60, 5.3872% and 8.8954% higher node delivery ratio at node 80, 4.7209% and 13.6062% higher node delivery ratio at node 100 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 3(c) shows the node drop analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 74.6666% and 77.3809% lower node drop at node 20, 77.6470% and 77.3809% lower node drop at node 40, 53.4552% and 49.1111% lower node drop at node 60, 63.1675% and 20.6349% lower node drop at node 80, 49.7206% and 36.6197% lower node drop at node

100 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

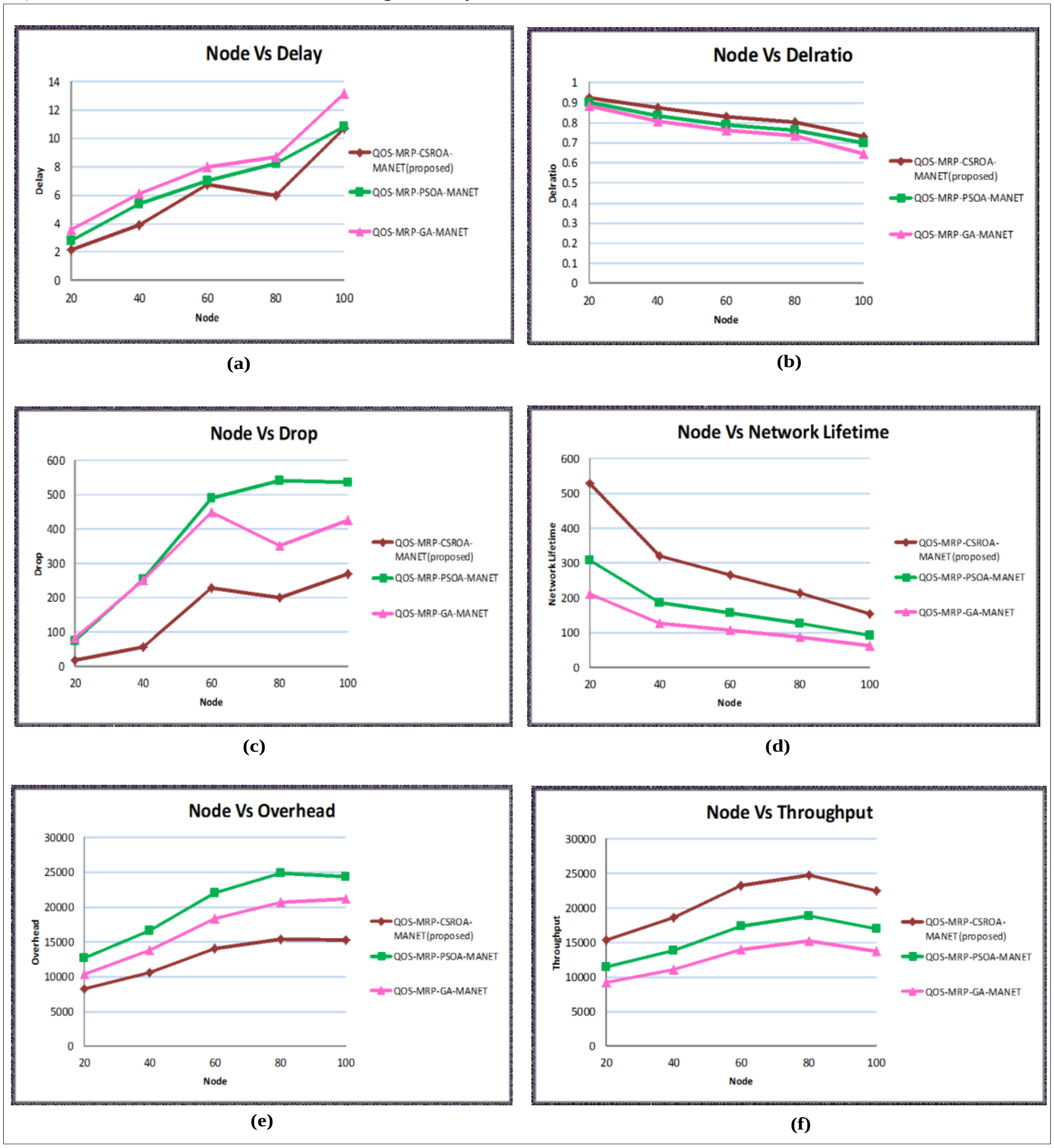

Figure 3: Node Performance metrics

Figure 3(d) shows the node network lifetime analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 70.8737% and 150.2369% higher node network lifetime at node 20, 71.6577% and 150.7812% higher node network lifetime at node 40, 71.1538% and 149.5327% higher node network lifetime at node 60, 68.5039% and 145.9770% lower node network lifetime at node 80, 68.4782% and 150% higher node network lifetime at node 100 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

Figure 3(e) shows the node overhead analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 34.8158% and 20.5345% lower node overhead at node 20, 36.1381% and 22.9827% lower node overhead at node 40, 36.2025% and 23.3859% lower node overhead at node 60, 37.7684% and 25.2126% lower node overhead at node 80, 37.0159% and 27.7233% lower node overhead at node 100 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

Figure 3(f) shows the node throughput analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 33.4437% and 66.7755% higher node throughput at node 34.1510% and 67.3277% higher node throughput at node 40, 34.0664% and 66.7096% higher node throughput at node 60, 31.1723% and 62.8854% higher node throughput at node 80, 31.9150% and 64.2215% higher node throughput at node 100 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

Figure 4(a) depicts the analysis of rate delay. Here, the QOS-MRP-CSROA-MANET method shows 11.8897% and 20.2015% lower rate delay at rate 200, 10.8733% and

15.4748% lower rate delay at rate 400, 9.2719% and 13.8204% lower rate delay at rate 600, 6.9898% and 15.8742% lower rate delay at rate 800, 16.5409% and 20.2074% lower rate delay at rate 1000 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 4(b) shows the rate delivery ratio analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 8.7800% and 22.1349% higher rate delivery ratio at rate 200, 8.1329% and 17.6498% higher rate delivery ratio at rate 400, 12.1648% and 22.1669% higher rate delivery ratio at rate 600, 10.1556% and 18.5837% higher rate delivery ratio at rate 800, 15.4427% and 34.9390% higher rate delivery ratio at rate 1000 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 4(c) shows Figure shows the rate drop analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 39.0243% and 2.6279% lower rate drop at rate 200, 55.6506% and 38.3669% lower rate drop at rate 400, 52.8214% and 32.8742% lower rate drop at rate 600, 52.8214% and 32.8742% lower rate drop at rate 800, 57.4464% and 21.3671% lower rate drop at rate 1000 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

Figure 4(d) shows the rate network lifetime analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 47.5409% and 91.4893% higher rate network lifetime at rate 200, 56.7567% and 107.1428% higher rate network lifetime at rate 400, 55.1724% and 104.5454% higher rate network lifetime at rate 600, 50% and 111.7647% higher rate network lifetime at rate 800, 45% and 81.25% higher rate network lifetime at rate 1000 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 4(e) shows the rate overhead analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 35.5738% and 22.9274% lower rate overhead at rate 200, 34.1403% and 20.0635% lower rate overhead at rate 400, 34.3468% and 17.4773% lower rate overhead at rate 600, 37.5783% and 19.7972% lower rate overhead at rate 800, 35.3212% and 19.8058% lower rate overhead at rate 1000 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 4(f) shows the rate throughput analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 14.7651% and 26.2113% higher rate overhead at rate 200, 21.0653% and 35.8900% higher rate throughput at rate 400, 20.5563% and 36.0983% higher rate throughput at rate 600, 15.9708% and 35.2682% higher rate throughput at rate 800, 10.6674% and 18.8593% higher rate throughput at rate 1000 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

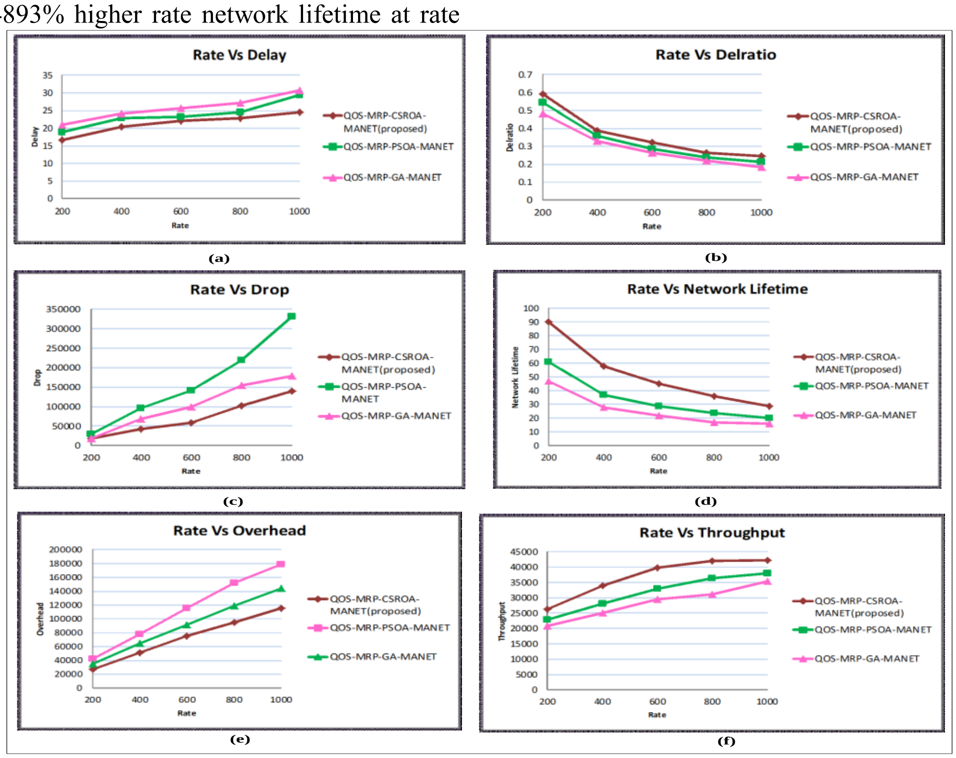

Figure 4: Rate Performance metrics

Figure 5(a) shows the speed delay analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 9.0408% and 18.9604% lower speed delay at speed 10, 3.0337% and 6.3764% lower speed delay at speed 20, 5.1545% and 10.3997% lower speed delay at speed 30, 9.4650% and 15.9681% lower speed delay at speed 40, 3.2031% and 13.6667% lower speed delay at speed 50 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method. Figure 5(b) shows the analysis of speed delivery ratio. Here, the proposed QOS-MRP-CSROA-MANET method shows 60.1220% and 123.0742% higher speed delivery ratio at speed 10, 71.6233% and 96.5360% higher speed delivery ratio at speed 20, 64.0689% and 112.8619% higher speed delivery ratio at speed 30, 42.3448% and 72.4103% higher speed delivery ratio at speed 40, 27.7867% and 89.5180% higher speed delivery ratio at speed 50 compared with existing method like QOS-MRP-

PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 5(c) shows the speed drop analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 17.3256% and 26.5246% lower speed drop at speed 10, 26.5087% and 34.5366% lower speed drop at speed 20, 20.1068% and 28.7515% lower speed drop at speed 30, 24.2404% and 22.1576% lower speed drop at speed 40, 2.2471% and 11.0062% lower speed drop at speed 50 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

Figure 5(d) shows the speed network lifetime analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 31.0913% and 83.4813% higher speed network lifetime at speed 10, 53.6764% and 88.288% higher speed network lifetime at speed 20, 39.4117% and 88.0952% higher speed network lifetime at speed 30, 44.4444% and 83.6956% higher speed network lifetime at speed 40, 20% and 70.1492% higher speed network lifetime at speed 50 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

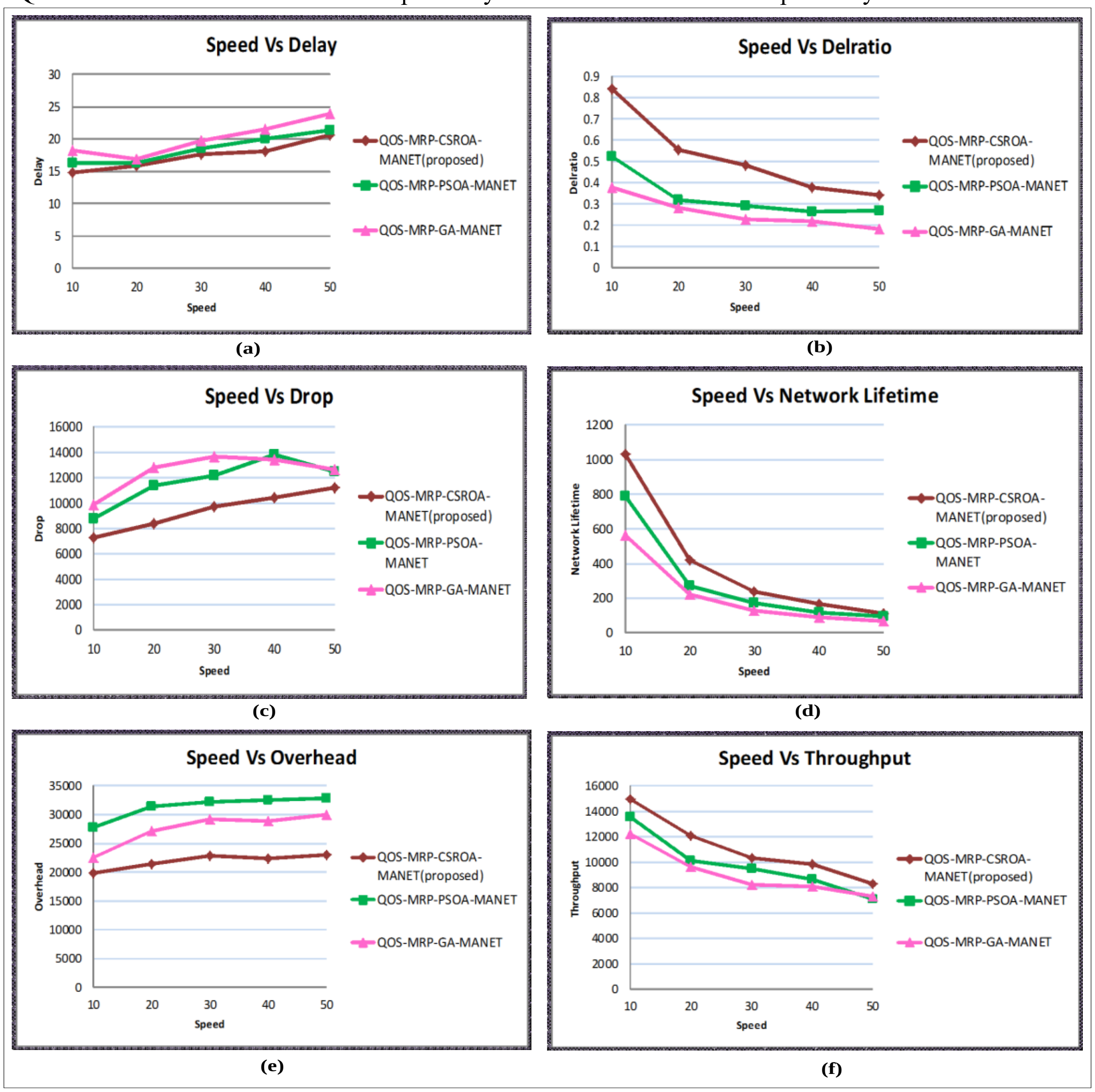

Figure 5: Speed Performance metrics

Figure 5(e) shows the speed overhead analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 28.5112% and 12.2801% lower speed overhead at speed 10, 31.7942% and 21.1614% lower speed overhead at speed 20, 29.1140% and 21.8720% lower speed overhead at speed 30, 31.4474% and 22.8046% lower speed overhead at speed 40, 29.9926% and 23.5885% lower speed overhead at speed 50 compared with existing method like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively. Figure 5(f) shows the speed throughput analysis. Here the proposed QOS-MRP-CSROA-MANET method shows 2.6313% and 22.2213% higher speed throughput at speed 10, 19.9544% and 25.4137% higher speed throughput at speed 20, 9.2743% and 25.3179% higher speed throughput at speed 30, 13.1988% and 21.6852% higher speed throughput at speed 40, 5.5902% and 13.7276% higher speed throughput at speed 50 compared with existing methods, like QOS-MRP-PSOA-MANET and QOS-MRP-GA-MANET method respectively.

5. Conclusion

In this manuscript, QoS and Network life time aware of multicast routing protocol with chaos integrated Cuckoo

Search Rider optimization algorithm is successfully implemented for constructing shortest-path multicast tree, which maximizes the lifetime of network with bandwidth, minimizes the cost, delay, jitter. Here, it solves the multicast routing problem by constructing multicast tree with the help of chaos integrated Cuckoo Search Rider optimization algorithm which transmits data from source to the destinations along lessening of cost, delay, jitter, rising of bandwidth including the lifetime of network. The simulations are carried out in NS2 simulator. The QOS-MRP-CSROA-MANET method provide high network lifetime in node as 70.1333% and 149.3055%, high network lifetime in rate as 50.894% and 99.2384%, high network lifetime in speed as 37.7247% and 82.7418%, low overhead in node as 36.3881% and 35.3920%, low overhead in rate as 35.3920% and 20.0142%, and low overhead in speed as 30.1718% and 20.3413%, compared with EECM-CGT and EECM-COA respectively.

Data availability statement
Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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