Hybrid Optimization Technique for Multipath Routing Mechanism in Internet of Things

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Abstract. The rising desires of progressive services in one-of-a-find regions led for the im- provement of superior intelligent systems the usage of the several technologies developed using the IoT. It is focuses on network integration to enable seamless human services. The interaction between protocols and mobility styles significantly alters the act of the system. In order to extend the network lifetime, this study advises a routing protocol based on the SFG set of criteria. The simulation is the first step, after which the system starts using multi-path routing. The SFG al- gorithm primarily considers network longevity, energy, throughput and delay while choosing the multi-path for routing.

Keywords: Network Mechanism, Hybrid Optimization.

1 Introduction

The term IoT refers to growing technique that examines how technology is being used to human life in the future. IoT components include things like refrigerators and cars that are firmly embedded in the technological realm. The IoT expanded the idea of the internet over a network.

The IoT is a cutting-edge technology whose objective is to link anything, everywhere, and at any time. In order to connect to the internet,Particularly, IoT apps assist in sending IPv6 packets in WSN nodes and this function provided numerous advantages to the user. The greenhouse environment system is crucial to IoT applications. This technology can connect web-based services to the Internet and is simple to deploy in large networks. [11] Multipath routing must be in operation in order to provide enough network resources under various traffic scenarios to satisfy QoS measure requirements. The discovered paths failed to convey packets to the nearest neighbor, which compact network concert even though the traditional single path routing approach is working in routing data with less computing complexity. In fact, some routing systems use redundant network paths to the sink to decrease the possibility of packet loss. [13] This routing technique based on local knowledge. Unfortunately, this protocol was not created for real-time traffic analysis. As a result, when selecting different paths, it does not take deadlines for packet transmission delays into account. [12] A vital aspect of solving various routing problems, The routing systems are being implemented, especially in ad hoc networks.

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Providing multiple accessible channels for simultaneously establishing communication between nodes is any number of protocols, including disjoint and non-disjoint can be used to achieve the goal. [26] But since there aren't any effective load balancing techniques for routing. like (AODV) [23] and DSDV [24], Some nodes become overloaded while others become under loaded and are unable to utilize the resources. In order to balance the load, various multi-path routing protocols have been developed. The nodes remaining energy became their most precious resource. If nodes' energy is not taken into account, the network connectivity will suffer, which will increase network occupancy. In light of current routing techniques, more thought should be paid to detecting network energy loss [2]. The hybrid optimization technique called the SFG algorithm. The purpose of this project is to develop a multipath routing system. The goal of the study is to develop an innovative routing technique based on the hybrid technique. IoT is first simulated after that then routing is carried out utilizing the SFG suggested hybrid optimization technique, which integrates SFO and GWO while taking advantage of both methods. In order to transmit the data while maintaining node trust, It provides routing from the current node to the destination, A newly developed multi-objective fitness function to find optimal path. The research's objective is to create a revolutionary routing system.

2 Literature Survey

This section provides examples of the eight multipath routing-based techniques now use in IoT networks. A modified PMSO method was created by Mohammed Zaki Hasan and Fadi Al-Turjman[1] for building, recovering from and choosing k-disjoint pathways that accommodated failures while meeting the quality-of-service requirements. To improve load balance, the technique did not succeed.The RPL, Quan Le et al. [3] created the integrated ELB-FLR approaches. Two routing protocols are combined into the final protocol. which benefited from ELB and FLR's upgraded functionality. Ad- ditionally, by maintaining a well-balanced network, the strategy decreased the delay and overhead. The method produced good results, but a comparison with more methods was required. Based on the SMG, Qiu et al. [4] . The technique improved network performance, but it required a lot of energy and a large transmission range. A Multipath Planning for MPSS approach was created by Min Chen et al. [5] and used sink nodes and B-spline trajectories with inter-path distance to establish enviable numerous route pathways. To ensure QoS requirements, the approach minimized the cumulated error using a hop distance factor. Additionally MPMS has used to meet QoS requirements while providing significant energy savings. The method makes use of a QoS-aware MPR selection mecha- nism to flood topological data . Agile data delivery framework was created by Fadi Al-Turjman et al. [7] to share multimedia data in smart cities using service-based applications. Here, a routing tech- nique that is optimized for use with dynamic topologies has been developed. The method described the routes used by a data packet to identify the best use of available resources while still adhering to QoS requirements. The solution, however, was unable to solve the problems with massive-scale routing. The search algorithm was created by Amol V. Dhumane and Rajesh S. Prasad [8] The IoT network was chosen using the FGSA. Here, the fitness function that took into account many factors, such as connection lifetime, distance, energy, and delay, was used to choose the cluster. With a large number of active nodes and a large amount of network energy, the strategy increased the lifespan of nodes. The technique, however, required a wide transmission range.

3 Challenges

The difficulties that the current approaches encounter are described below. These difficulties are taken into account while developing a successful trust-based strategy. The routing produced performance that was competitive and effectively addressed issues. However, because of problems with convergence, the network's routing produced undesirable results [9]. A significant problem is the ability to compromise between the exploitation and exploration phases. Excessive investigation and exploitation, however, are not advised because doing so could lead to convergence [10] due to the usage of inefficient routing protocols. The network structure of the IoT networks presents new security challenges, and its non-uniformity leaves them open to shady network attacks. The vulnerability of properties with limited resources, mobility, and communication routes makes IoT security a difficult issue. In the Internet of Things (IoT) systems, trust mechanisms are used to guarantee secure data transmission.

3.1 IoT system model

IoT is made up of various things, such as smart gadgets, that are linked to one another across a network in order to exchange accumulated data. Since many of processing and transmission capa- bilities of smart devices are an issue for data transfer due to their resource limitations. IoT network system model shown in Fig 1 shows that the network's nodes are spread out in order to use the most effective routes. The source node chooses a path with high energy nodes. In order to route the data across confined pathways, As a result, routing and data transmission are essential components of the internet, which encourages the network to transmit data efficiently by utilizing computing power.

The network has nodes that are spread out across the region R. Here, G define that this section describes the link used to connect the nodes. The elements, including Link lifetime and the energy model, are taken into account when performing the routing procedure.

3.2 Main Contributions

• SFG algorithm it is designed by combining the update positions of both to find the world's best multipath routing solutions.

Create a multiobjective fitness function for the purpose of determining the best routing and to begin a routing utility function. It uses a number of variables as its parameters to aid multipath routing in an IoT network.

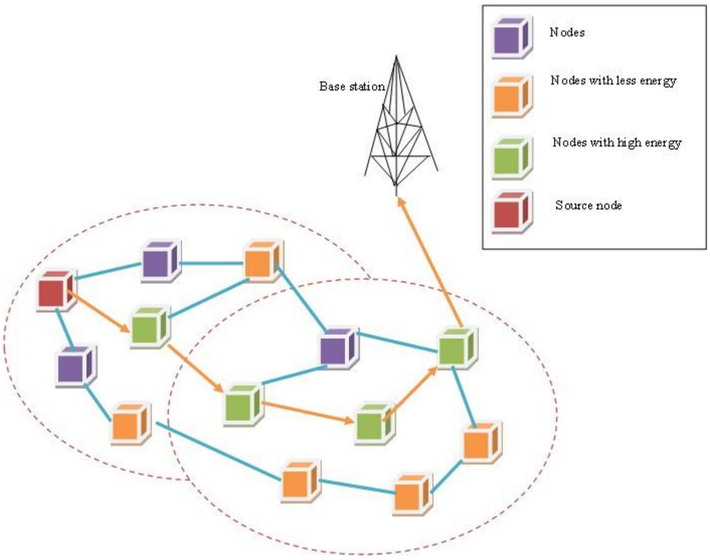

Fig. 1. Architecture of a typical Wireless sensor node

4 IoT Network Energy Model

The nodes starting energy[18] is fixed and that the batteries cannot be recharged. Depending on the transmission distance, energy is lost when The transmitter receives the data.The protocol is to controls data is transmitted across a network, while the transmitter's power amplifier and radio electronics are what cause energy to dissipate. The following formula serves as the foundation for the energy model. whenever a typical sensor node sends bits of a data packet.

$$Et (x) = Ee (x) + Ea (x, d) \quad (1)$$

Here,Ei refers to the energy consumed when the node uses the multipath fading to transmit a single bit of data and the amount of energy used by a node during data transmission in the free space paradigm.

$$d_0 = \sqrt{\frac{E_i}{E_j}} \quad (2)$$

Total Energy can be calculated by

$$TE = Et + Er \quad (3)$$

4.1 Link Lifetime Model

According to LM [19], the network link between two sensor nodes must be active for the duration of network with data packets presence. IoT network may experience routing failure as a result of a network. Additionally, the nodes' mobility, coordination and direction of movement are used to calculate the network link's lifespan. Let be V1,V2 the two mobile nodes located at Sv1,Tv1 and Sv2,Tv2 for which the LLT is calculated.

$$LLT = \frac{-[ab + cd) + \sqrt{(a^2 + d^2)x^2 - (ad - cb)^2}}{(a^2 + d^2)} \quad (4)$$

5 Hybrid Optimization Algorithm (SFG)

The suggested SFG uses newly developed multiobjective fitness to determine the best solution for action. To find the secure path, the function is designed with variables. For choosing the optimum approach, the parameters such as residual energy, link lifetime, throughput should be larger and the delay must be minimized. The following parts detail the solution encoding, which uses a newly designed fitness function for choosing the best path to achieve secured transmission.

5.1 Solution Encoding

In order to solve optimization problems in the best possible way, solutions must be encoded. The algorithm with the optimization techniques to select the best paths from the given options. The suggested SFG algorithm's solution displays a variety of paths, from which the best path is chosen using a newly developed fitness.

5.2 Multiobjective fitness function

In order to select the best outcome from a group of possible solutions, the fitness function is assessed. Four variables are used to calculate the fitness for the proposed SFG with energy, network lifetime, delay, throughput. The fitness is viewed as a function that can be maximized. As a result, the solution with the highest levels of link lifespan, energy, throughput and shortest delay is taken into account. Therefore, for IoT routing, the option offering the highest value of fitness is taken into account. The suggested SFG's fitness is expressed as

$$Fitness = \sum_{n=1}^{i} LM_{n,s} + E_{n,s} + TP_{n,s} + (1 - d_{n,s}) \quad (5)$$

5.3 Evaluation Metrics

In order to select the best outcome from a group of possible solutions, the fitness function is assessed

Throughput,Energy, Network lifetime and delay are the measures used to evaluate the approaches.

i) Throughput

The overall data rates sent in a certain period of time are referred to as the throughput

$$Throughput = \frac{Numberofpacketsreceived}{time} \quad (6)$$

ii) Delay

Regardless of the attacker, it specifies the entire time needed for data transmission. The delay formula looks like this

$$D = M_b / R \quad (7)$$

6 Multiobjective fitness based on SFG is suggested for picking the best solution

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Step1: Intial step Initializing the population of grey wolves and other algorithmic parameters, such as the iteration counter c, is the first stage. The total number of grey wolves is and is represented by,

$$W = \{W_1, W_2 \ldots W_u \ldots W_V\} \quad (8)$$

Step 2: Assessment of fitness performance Using the obtained fitness, the solutions' fitness is calculated from equation (5).

Step 3: Update equation represented by The suggested technique uses the GWO update rule to expand the search space. According to GWO [16], the location update used with the method is shown as

$$W(c+1) = \frac{\overline{W}_1 + \overline{W}_2 + \overline{W}_3}{3} \quad (9)$$

In proposed algorithm by adding

$$\overline{W}(c+1) = \frac{\overline{W}_1 + \overline{W}_2 + \overline{W}_3 + \overline{W}_4}{3} \quad (10)$$

Step 4: Evaluate the solutions' suitability Consider the function in equation (5), with maximal to choose the best solution, the fitness function is used. Nothing but the best routes for transferring data packets to the destination nodes may be considered a successful solution.

Step 5: Validate the stopping condition. The optimization process comes to a conclusion when the halting criterion is confirmed. The halting criterion, which includes the maximum iterations, improvement percentage, and execution duration, is established for improved convergence of the algorithm.

7 Results and Discussion

This section uses a model of an IoT network with 100 nodes to compare the proposed method with traditional methods. The analysis is carried out by changing a certain point in time.

7.1 Performance Analysis

This section assesses the performance analysis based on all characteristics. The analysis is carried out by changing the count from 1 to 1000. Analysis based on 100 nodes.

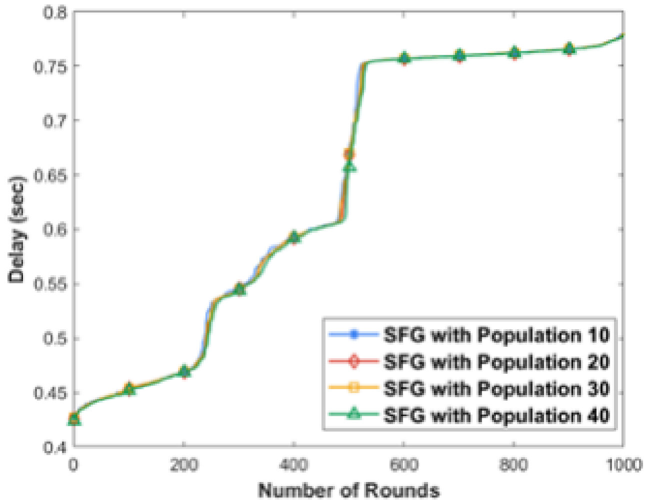

Fig. 2 Performance Evaluation of Delay using 100 nodes

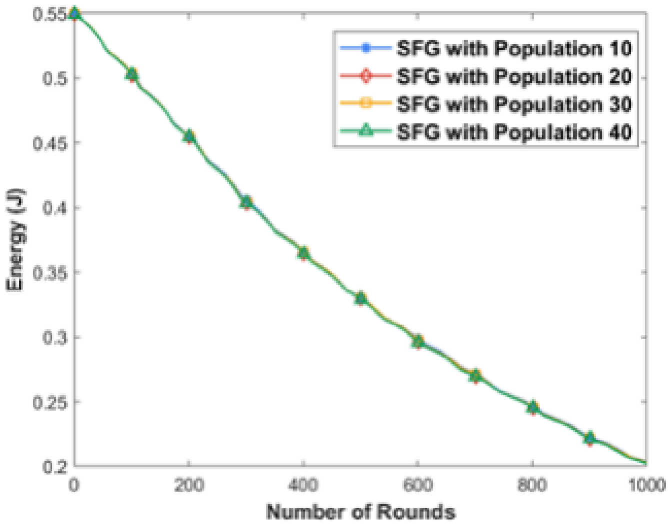

Fig. 3 Performance Evaluation of Energy using 100 nodes

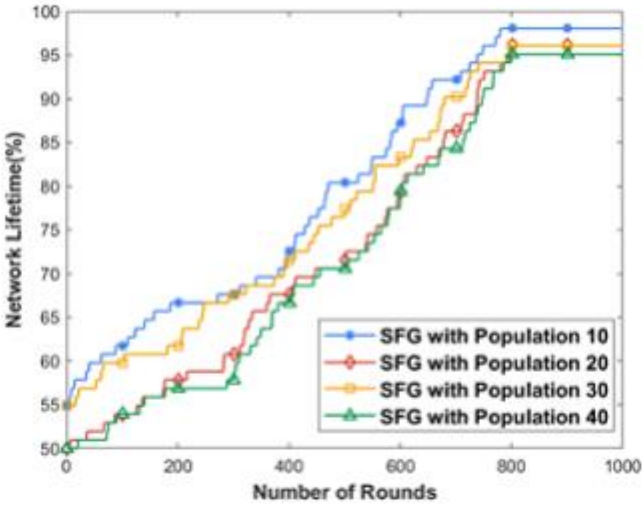

Fig 4. Performance Evaluation of Network Lifetime using 100 nodes

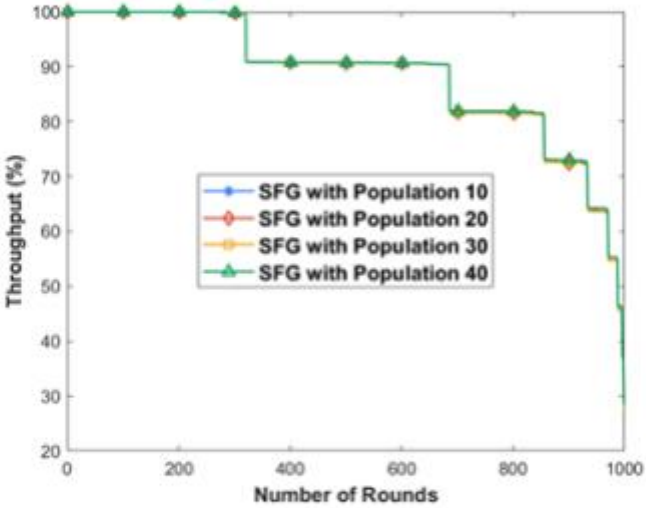

Fig 5. Performance Evaluation of Throughput using 100 nodes

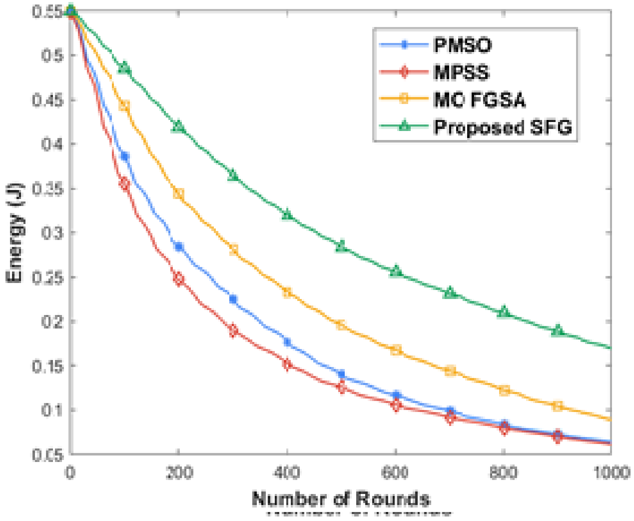

Fig 6. Energy using 100 nodes

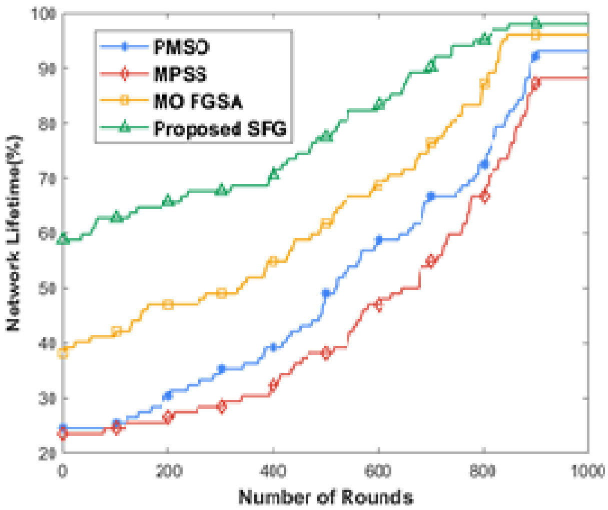

Fig 7. Network lifetime using 100 nodes

7.2 Comparative Analysis

The suggested SFG method is contrasted with the conventional methods in this section in terms of PMSO [1], MPSS [5], MOFGSA [8].Comparison of approaches employing 50 and 100 nodes and the metrics With 50 nodes, suggested SFG has the highest performance with the smallest delay of 0.785sec, while existing PMSO, MPSS, and MOFGSA exhibit delays of 0.788sec, 0.785sec, and 0.785sec, respectively. The proposed SFG, which has a maximum energy of 0.203 J, demonstrates the best performance, while the energies of the PMSO, MPSS, and MOFGSA, respectively. The proposed algorithm with a maximum lifetime of 96.153% , the lifetimes of the presentaly PMSO, MPSS, and MOFGSA are 92.30%, 90.38%, and 94.23%, respectively.

Table 1: Comparative Analysis with 100 node

Metrics	PMSO	MPSS	MOFGSA	Proposed SFG
Delay(sec)	0.791	0.780	0.788	0.779
Energy(J)	0.064	0.061	0.089	0.169
Network Lifetime	0.931	0.882	0.960	0.980
Throughput	0.274	0.371	0.308	0.379

8 Conclusion

In order to accomplish secure routing in the IoT context, this study suggests a brand-new optimization algorithm called the SFG algorithm. IoT simulation comes first, and then the multipath is created for routing. The best route is chosen using a developed multiobjective fitness function that takes into account criteria like Network lifespan, Residual Energy, throughput and Delay. The suggested technique allows for efficient performance and the identification of a viable and ideal route.The efficiency of the proposed SFG method is calculated and it displays the best performance. Hybrid sensor networks can be used to address large-scale routing challenges in future study.

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