International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8, Issue-1, May 2019

Optimized Artificial Intelligence Approach based Spectrum Aware Energy Efficient Routing (SAEER) for Device-to-Device IoT Communication

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Abstract*: With continually increasing demands for Internet of Things (IoT) communication, Device-to-Device communication (D2D-Communication) and energy efficient routing mechanisms are fundamental requirements of many IoT based applications. For these types of applications, spectrum aware energy efficient routing protocols must support mobility and discover optimal D2D routes along with the minimum energy consumption rate. The communicating nodes in IoT network have restricted energy resources and rapid energy reduction of communicating nodes leads to the formation of energy holes in the IoT network, which hinders the intended services to IoT based application. For this reason, Spectrum aware energy efficient mechanism is also one of the essential objectives of routing protocols. In the existing work, a lot of researchers have anticipated energy-efficient routing protocols that provide optimum D2D routes but most of them do not support recognition of malicious/fail nodes in the IoT network. In this paper, Spectrum Aware Energy Efficient Routing (SAEER) Protocol for IoT network is proposed that supports detection of malicious /fail nodes and discovers nearly most favorable routes with minimum energy consumption rate. The presented routing protocol also reduces the number of intermediate nodes in D2D route discovery mechanism which helps to decrease the energy consumption rate. In addition to that, it also offers an efficient approach to provide secure routing support with maximum routing capacity and end to end data transmission rate. So in this work, the concept of Genetic Algorithm (GA) along with Artificial Neural Network (ANN) is used for the secure D2D routing using novel fitness function. The QoS performance parameters of our routing protocol are analyzed with standard and existing work and with several routing protocols and the experimental results validating the concept of optimized artificial neural network. The results show that the proposed protocol provides 8.23% less energy consumption in comparison to existing work.

***Index Terms*: IoT (Internet of Things), Device-to-Device Communication (D2D-Communication), Genetic Algorithm (GA), Artificial Neural Network (ANN), Quality of Service (QoS), Power Consumption**

Revised Manuscript Received on 22 May 2019.

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I. INTRODUCTION

As the Internet of Things (IoT) technology is emerging [1],[2], billions of electronic devices are connecting with each other and managed by wireless networks powered by some specific energy sources. The gigantic explosion of electronic devices is mainly attributed to the vigorous growth of packet data traffic requirements, such as multimedia traffic. Significant number of electronic devices with vast network traffic demands triggers innovations in architectures and technologies of conventional IoT networks, which lead to the wireless networks. In IoT networks, much movement of packet data activity takes place within the network areas.

Device-to-device (D2D) communications [1] has been considered as one of the key technologies in IoT networks, that facilitates the detection of geographically close devices, allowing the reuse of licensed spectrum resources by enabling direct low-power communication between these proximate devices. Because of the potential reuse gain and physical proximity, D2D communication can improve spectrum efficiency and decrease energy consumption rate with fast data transmission rate.

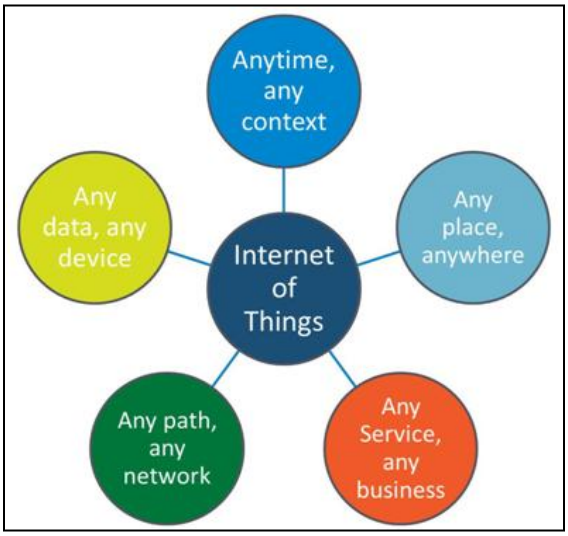

Fig. 1. IoT Services[3]

Above figure represents the services of IoT network and some specific issues that occurs in this network which is described below:

- **Authentication:** Authentication principle [4] helps to ensure the proof of identity. It involves the checking and identification of source of the message.
- **Access Control:** Access Control principle[5] specifies that what can be accessed and by whom.
- **Confidentiality:** Confidentiality [7] specifies that the message contents are only accessible to the sender and the intended receiver.
- **Integrity:** Integrity mechanism make sure that when the message reaches the receiver the data remains the same as sent by the sender.
- **Non-repudiation:** This principle specifies that the message sender cannot refute the claim of not sending the message.
- **Availability:** Availability mechanism defines that the authorized parties should have resources available whenever required.

IoT involves network creation of the items surrounded with electronics, software and network connectivity. Internet of Things is a model that encompasses everyday entities that have the capability of sensing and communicating with fellow devices via Internet. In IoT architecture the devices are resource constrained, have smaller size and low power. Because of the complexity and requirement of many rounds for encryption, the traditional encryption algorithms are usually expensive and also lots of energy of the IoT devices gets wasted. The services of IoT based network are given in the Fig. 1 and we are summarizing the main contributions of proposed work are as follows:

- ***To reduce the energy consumption rate:*** To achieve this performance, we are adding spectrum aware energy efficient based routing protocols.
- ***To maintain connectivity of devices to the IoT network:*** The proposed GA and artificial neural network maintains the connectivity of nodes to the IoT network. To discover D2D route within the network, fitness function of genetic algorithm helps within the IoT network.
- ***To detect the malicious/fail nodes:*** In this proposed scenario, only a few regions participates in D2D route detection mechanism. Participating regions are selected on the basis of region heads of source and destination node. To select the region head for D2D communication, artificial neural network helps in this selection process [6],[8],[10]-[11].

Spectrum Aware Energy Efficient Routing (SAEER): SAEER is a Spectrum aware energy efficient routing which helps in secure D2D communication scheme. Route detection process starts when route request is sent by an IoT device to the associated nodes in the sub region of IoT network. The node employs SAEER protocol that seeks to optimize two most important features in route assignment process: next hop and region selection for minimizing energy consumption and maximizing E2E data rate [13]-[15]. In SAEER protocol, depending on the relative location of source and destination node, a route can be of two kinds: intra-domain(i.e. when the source and target device lies in same region) and inter-domain (i.e. when devices lies under different regions).

Genetic Algorithm (GA): Genetic algorithm [15],[16] is an optimization technique, which is used to optimize the extracted features of communicating node and helps to create a secure route for data transmission.

The working flow of genetic algorithm is shown in Fig. 2 which helps to understand the working of GA and the output of GA is passed to artificial neural network.

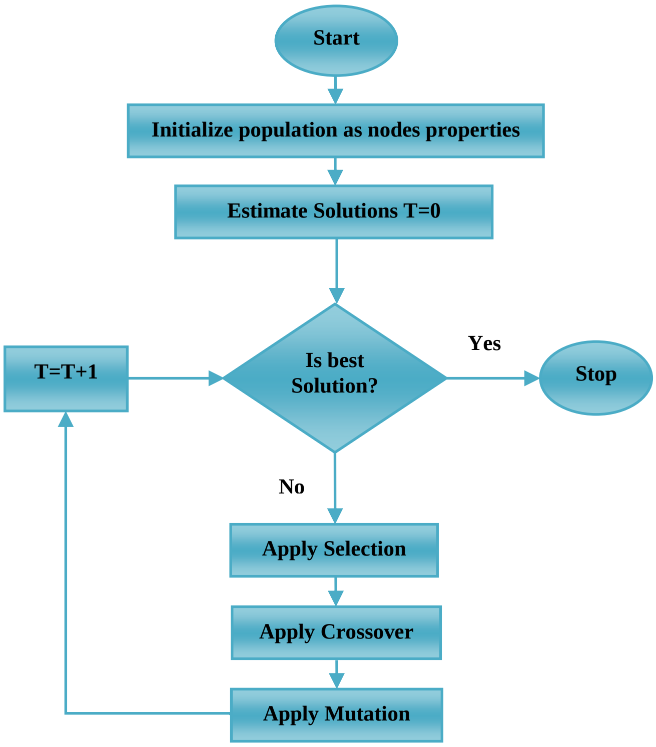

Fig. 2: Flow diagram of GA[15],[16]

GA mainly performs several functions which are described as below.

A. ***Initialize population:*** The initial step in GA is to define the population size which represents the basic properties of communicating nodes.

B. ***Fitness function:*** The fitness function consider the applicant resolution to the difficulty as input and provide the consequential output to identify the best properties of communicating nodes. The value of fitness is changes until the best solution is obtained and an optimized solution is provided by the GA.

C. ***Crossover:*** This function is analogous for reproduction process in GA. In this, number of parents is selected to develop a number of Childs based on the fitness function.

D. ***Mutation:*** It is used to obtain a new solution by doing small random adjustment in the chromosome. It is utilized to sustain the multiplicity of genetic populations and is generally functional with low probability.

Artificial neural network (ANN): ANN is a learning algorithm which helps in decision making, and it is capable to classify the multiclass data [17]. The ANN comprises of simple elements of parallel operations. The artificial neural network is basically used with weight. When an ANN initially presents a pattern, it produces a random 'guess' for it. After that it checks how far it is with the target value and then make suitable adjustments to its connection weights. The artificial neural network can be trained for performing particular functions by adjusting the weights between the elements. The artificial network function is determined by the connection between elements. This function is used to generate related outputs from weighted and input. The output is compared with the target; if the output produced is compatible with actual output then the input is correct otherwise that output will be adjusted according to the weight. In ANN, Sigmoid Function is used and this function is real-valued and differentiable, a non-negative or non-positive first derivative, one local minima and one local maxima.

$$\mathrm{sig}(t) = \frac{1}{1+e^{-t}} \qquad \ldots\ldots\ldots\ldots (1)$$

In the proposed work, sigmoid function [17] has been used as activation functions to produce output in terms of normal communicating nodes.

This paper presents an optimized artificial intelligence approach based Spectrum-Aware Energy Efficient Routing (SAEER) for D2D IoT communication and their comparison with existing trends. Specifically, in section II, we present the background survey of existing work for device-to-device IoT communication using different routing protocols. Problem formulation is discussed in section III. The architecture of proposed solution is explained in section IV. The research methodology is explained in section V. The simulation results are covered in section VI and we have concluded with discussions on current challenges and future trends in section VII.

II. BACKGROUND SURVEY

In this section, we discussed the survey of existing work based on the device-to-device IoT communication using different routing protocols and others techniques.

Saptarshi Debroy et al. [1] discussed about challenges of Dynamic Spectrum Access based secondary routing in a D2D IoT network. They proposed SpEED-IoT, a spectrum aware, energy efficient routing technique with multiple channels and multiple hops for IoT devices using a spectrum map creation process by ESC sensors. A selective flooding technique is is also proposed in this work which is based on transmission power control for spreading request for route in the network that doesn't cause transmission overhead. They examined the connectivity conditions among IoT devices using these techniques. Furthermore, they may study the performance of their proposed work experimentally and theoretically for various IoT networks in terms of primary transmission characteristics, operational spectrum, spectrum characteristics and heterogeneous secondary IoT device communication abilities. But they don't work on security mechanism and transmission time.

Pan et al. [2] in 2017 presented a light weight, distributed geography based multicast routing protocol for IoT environment. Their aim is reduction in the count of transmission links and shortening path length in the constructed multicast paths. This proposed method includes 3 phases: request phase, reversed update phase and modification phase. Request phase involves finding the least number of next hops locally for reaching target nodes. After that, in reverse update phase and modification phase, multicast paths can be trimmed further and merged by the designed system. The experimental and simulated outcomes indicates that this work can efficiently decrease the count of communication delays and communication links but, they can be modify their scheme to support node mobility and their security.

Huang, Jun, et al.[4] in 2017 presented a model to handle the difficult issue of multicast steering for sight and sound correspondence in the IoT, in this paper, they have proposed two calculations with K > 2 limitations. They have exhibited hypothetical examination on the intricacy and estimate of the proposed calculations, and directed broad recreations to assess execution of the calculation. Both expository and test results have exhibited that one of the proposed calculations is better than a delegate multi-obliged multicast directing calculation as far as both speed and precision. There are disadvantages that they have utilized set number of asset.

Mohammed Zaki, and Fadi Al-Turjman [5] in 2017 exhibited a bio-propelled molecule multi-swarm Optimization (PMSO) technique to develop, recuperate and selects k-disjoint multi path courses. To position data as far as close to home worldwide position and the best position are presented as speed update to upgrade the execution of steering calculation. To approve this procedure, they have surveyed target work which thinks about the normal vitality utilization and normal in-organize delay. Their outcomes demonstrate that the methodology utilizing the qualities of all close to home best data is a legitimate procedure for the reasons for improving the PMSO execution. Additionally, the proposed calculation has likewise been contrasted and comparative calculations, which enhance the vitality utilization and normal deferral over the investigated ways.

Khan et al. [6] in 2017 they have inferred that the plan of steering and MAC conventions for CR-based SG systems is generally an unexplored territory. Existing exploration built up some underlying novel MAC convention structures for the CR-based SG, while steering convention has been constrained to alterations of RPL.
Expanding the quantity of collectors to guarantee an adequately huge next-jump recipient set may not be a reasonable financially savvy arrangement. With the PRMA-based MAC approach, a gadget itself does not have range detecting capacities. Rather, a gateway detects the range. This methodology can decrease energy utilization, however delay-touchy applications may endure and they could create and approve a typical act assessment structure for MAC and directing conventions in CR-based SG frameworks.

Otermat et al. [7] in 2015 exhibited an examination of FM radio range of Melbourne or Palm Bay FL urban territory inferred that the range is 76% under-utilized. Besides, due to the sharp utilization of the empty range by low-control short-extend IoT gadgets, the under-utilized range can possibly yield information rates upto 60.8 Mega bits per second. So as to accomplish such information rates, appropriate power and impedance executives plans must be used. These broad examinations will decide how the empty FM radio range can be utilized by means of CR to advance the throughput of low-control short-go IoT frameworks. Whilst limiting impedance to the FM radio-stations (essential clients). Deciding the ideal figure of IoT gadgets that can reuse empty FM radio range in a given region will be vital to boosting the IoT gadget throughput and limiting impedance to the FM radio stations as well as for existing together IoT gadgets.

Feng, Zhiyong, et al. [8] in 2015 presented another need-based Dynamic Spectrum Management (DSM) strategy for Smart Grid (SG). Assets are assigned thinking about the QoS and needs of SG applications. Further, empty Digital Tv (DTv) recurrence groups are powerfully used for advanced support for such applications. Reenactment results were exhibited that validates the proposed DSM procedure. It was demonstrated that this can give solid correspondences to basic SG functions and great execution for different applications, while alleviating the obstruction to the DTV framework.

Ishino et al. [9] in 2014 exhibited a lightweight and disseminated geography based multicast steering convention for IoT application. They proposed the adaptable steering engineering utilizing Bloom Filters for the IoT devices, and after that have cleared up the viability of our directing design. Thus, they have demonstrated that their steering engineering can decrease the extent of filters to roughly when required bundle conveyance rates are around 0.9. Furthermore, they want to address the examination questions like how to stifle overheads to refresh steering data.

III. PROBLEM FORMULATION

IoT is the network of interconnected devices that are usually of short range, low energy, and wireless devices with their own predefined set of operations. Moreover, these devices are not compatible to existing routing protocol due to which a new set of routing protocols are developed to cater the requirements of the IoT. Some of the most widely used protocols in IoT are SpEED: Spectrum aware Energy Efficient Routing for device-to-device, CoAP: Constrained Application Protocol, MQTT: Message Queuing Telemetry Transport etc. They facilitate energy conservation making devices operate for a longer duration of time. Several recent IoT devices are not capable of using current authentication techniques because of heterogeneity. For designing or improving a safe and light-weight structure for flexible trust management, authentication and identity management for safe and compatible communication amongst IoT devices. These types of problems are always faced by the researcher in the field of IoT and to solve out these problems better option is SAEER protocol with the route optimization mechanism for D2D communication using genetic algorithm with artificial neural network. Based on the survey we conclude some important points which helps to sort out existing problems. Our contributions in this paper to solve above mentioned problems are presented in three folds:

Firstly, we introduced a completely automated hybrid scheme for detection of malicious/fail nodes using genetic algorithm with artificial neural network as an artificial intelligence technique. To the best of our awareness, our proposed work is among the first few attempts to use the concept of hybridization of genetic algorithm along with artificial neural network to tackle this challenging problem.

Secondly, we designed an appropriate routing protocol to solve out the energy efficient routing problems which is known as SAEER protocol. Our experimental results show that SAEER protocol can further improve the routing performance by removing the unauthorized nodes over the region then consider in the routing table.

At the end, we comprehensively evaluated efficiency, effectiveness and the generalization ability of the proposed scheme with another author research work. This model can be smoothly generalized to other challenging routing protocol problems and also improve the energy consumption rate of proposed model.

IV. PROPOSED SOLUTION

The step-by-step procedure of proposed optimized artificial intelligence approach based SAEER protocol for D2D IoT communication work is defined as follows:

1) Firstly design a framework using the concept of GUI for simulation of proposed SAEER protocol for D2D IoT communication. The area of proposed work is defined by using given formula;

$$\boldsymbol{Area\ of\ Network = Height\ X\ Width} \quad \ldots\ldots (2)$$

Where, Height and Width is considered as 1000m so the total area of network is 1000m^2. The designed frame work is show in Fig. 4.

2) Deploy N number of nodes within the simulator and defined Source and Destination node. The network deployment algorithm is given as:

Algorithm 1: Network Deployment

Input: Number of Vehicles, Height and Width
Output: Created Network
Define height = 1000
Define width = 1000
Define number of region R
Define N number of nodes for the simulation of network
1. for r→ 1 to R
2. **for i → 1 to N**
3. X (i) = Area X random
4. Y (i) = Area X random
5. Plot_node (i) = coordinate(X, Y)
6. Define node name = N (i)
7. S_Node = random (N)
8. D_Node = random (N)
9. **If S_Node == D_Node**

10. S_Node = random (N)
11. D_Node = random (N)
12. **Else**
13. S_ Node = S_ Node
14. D_ Node = D_ Node
15. **End**
16. Deploy nodes in network
17. Define S_node as source
18. Define D_node as destination
19. **End**
20. End
21. Return: Created Network
22. End

3) Define the coverage area for each node which helps to establish the route from source node to Target node using inter and intra communication process. The algorithm of coverage area calculation is given as:

Algorithm 2: Coverage Area Creation

Input: Number of nodes (N), Coverage Limit and Height/Width
Output: Coverage List of Nodes
1. Define coverage set using equation (3)

$$Coverage\_Limit = (20 * Area)/100 \ldots (3)$$

2. for I → 1 to N
3. **for j → 1 to N**
4. Calculate distances from one node to other nodes using equation (4)

$$Dist = \sqrt{\left((X_j - X_i)^2 + (Y_j - Y_i)^2\right)} \ldots (4)$$

5. **If Dist<Coverage_Limit**
6. Cov_set (i) = Coverage_set (N)
7. Cov_list (N, i) = Cov_set (i)
8. **End**
9. **End**
10. Return: Cov_list as a coverage list of nodes
11. End

4) Discover Route from Source to Destination using SAEER routing protocol for the D2D IoT communication and calculate QoS parameters of network. The SAEER protocol algorithm is given as:

Algorithm 3: SAEER Protocol

Input: Source Node (SN), Destination Node (DN) and Coverage List of Nodes
Output: Route from SN to DN
1. Initialize Route as empty
2. Set Destination Found Flag (DFF) = 0
3. While DFF = 0
4. Route (1) ← SN
5. Route (2) ← Region nearest node which have maximum energy using algorithm 2
6. Route (3) = Middleware of network
7. Repeat till DFF = 1
8. Route Next Node = Coverage (Route (3))
9. If Route Next Node = DN
10. DFF←1
11. Route (last) = Next Node
12. Else
13. Repeat Again
14. End
15. Return: Route from SN to DN
16. End

5) If performance of network is degraded, then ANN with Genetic algorithm is used to detect the fail/dead node in network. The combined algorithm of ANN with GA is given as:

Algorithm 4: ANN with GA

Input: Number of nodes (N), Route and Nodes Properties
Output: Optimized Route from SN to DN
1. Initialize GA in simulator
2. Define population size, selection function, mutation function, crossover function etc (Default).
3. Data = Network Node Properties
4. F_s = Selected value from the Data
5. F_t = Threshold value from the Data (Average of Data)
6. Define fitness function of GA using given equation (5).

$$Fitness\ Function = \begin{cases} fs & if\ fs \geq ft \\ ft & else \end{cases} \ldots (5)$$

7. No. of variables = 1
8. for i →1 to Node within Route
9. Affected_Node (i) = GA (Fitness_function, Initialize GA, No. of variables)
10. End
11. Save the affected node list in the table of Affected_Node
12. for i → 1 to N
13. Initialize ANN with parameters
– Epochs (E)
– Neurons (N)
– Performance parameters: MSE, Gradient, Mutation and Validation Points
– Training Techniques: Levenberg Marquardt (Trainlm)
– Data Division: Random
14. for each set of T
15. Group = Categories of Training Data
16. End
17. Initialized the ANN using Training data and Group
18. Net = Newff (T, G, N)
19. Set the training parameters according to the requirements and train the system
20. Net = Train (Training Data, Group, Neurons) Classify the attackers
21. End
22. If properties of Attackers Node == true
23. Node not consider in the route
24. Else
25. Create an optimized route
26. End
27. Calculate QOS parameters
28. Return: Optimized route with improved Qos
29. End

6) Identify nodes in discovered route and detect the fail node which is not able to communicate with another node and consume more energy within the route using the ANN based on the GA fitness function.
7) At last of simulation, the QoS parameters of proposed work are calculated and compared with existing work in terms of Routing Capacity, End to End Data Rate, Packet Power Conservation and Average number of hop.

We made a comparison of the performance of our proposed SAEER protocol with SpEED protocol based on the following QoS performance metrics:

A) Route Capacity: In IoT environment, route capacity can be defined as the intricate measurement of the highest amount of packet data that can be transferred among source-node to destination-node over a secure route. Due to the amount of tangled measurement variables, actual network route capacity is hardly ever accurate.

B) End to End Data Rate: It is the value of received packet over sent packet in the IoT network for D2D communication. To calculate the E2E Data Rate of proposed work given equation is used.

$$\text{End to End Data Rate} = \frac{\sum_{i=1}^{node}(P_{Delivrd})}{P_{Sent}} \quad \ldots..\ (6)$$

C) Energy/Power Consumption: This parameter evaluates the energy efficiency of our proposed SAEER protocol. It is calculated as the total energy consumed in a network per data packet successfully delivered to destination node. The formula of energy/power consumption is given as:

$$P_{Con} = \sum_{i=1}^{node} T_{power} + R_{power} + W_{power} \quad \ldots.\ (7)$$

Where, T_{power} is the total power consumed by node during the packet transmission, R_{power} is the total power consumed by node during the packet receiving by receiver node and $W_{power}$is the waiting power consumption rate which consumed by node.

D) Number of hop count: Total number of hop count is an estimated measurement of route distance from source to destination. At each hop, messages are processed and forwarded. It results in further delay. More hop count means more delay.

E) Time Delay: The delay value of proposed work is the summation of all types of time consumption during packet data transmission from source to target node via region head. To calculate the delay value of proposed work given equation is used.

$$Delay = \sum_{i=1}^{node} T_{time} + R_{time} + W_{time} \quad \ldots..\ (8)$$

Where, T_{time} is the packet transmission time, R_{time} is the packet receiving time and W_{time} is the waiting time. The exact time consumption of proposed work with F-LEACH routing protocol is given in tabular form in table 4 with delay of existing work.

F) Execution Time: It can be defined as the time taken by the network to execute that entire simulator with successfully data transmission, including the time spent executing run-time or system services on its behalf.

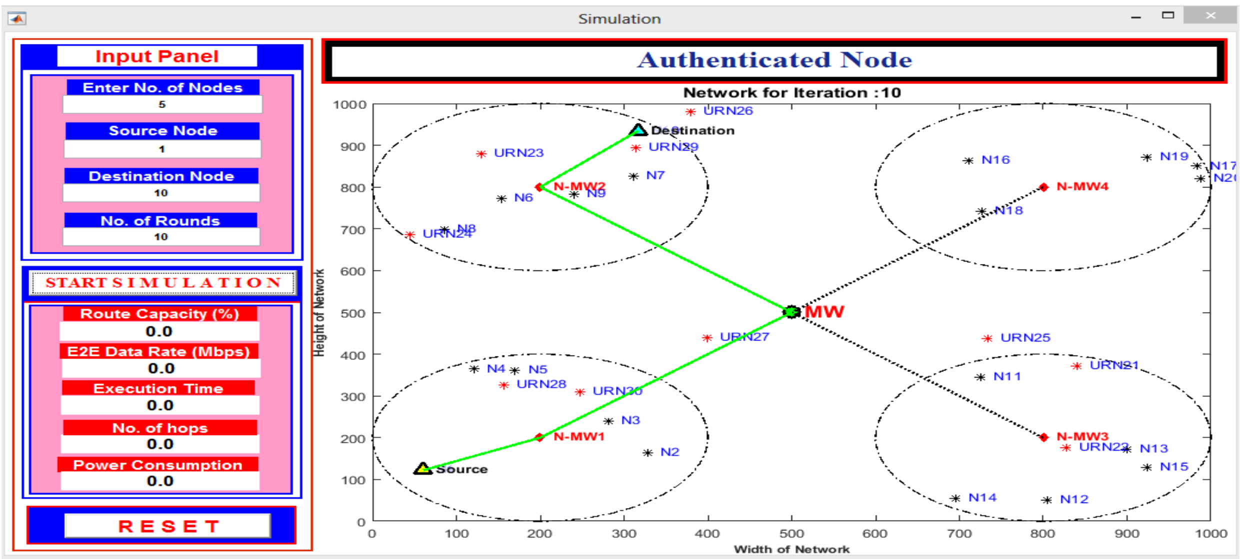

Fig. 3: Proposed Framework

The above figure represents the simulator with height and width (1000×1000). In the figure, there are two sections first is “Input Panel” and second is the “Simulator part”. In the “Input Panel” we provide the required input data to simulate the designed network and in “Simulator part” we check the performance parameters of proposed work.

V. RESEARCH METHODOLOGY

The flow chart of the proposed work is shown in Fig. 4.

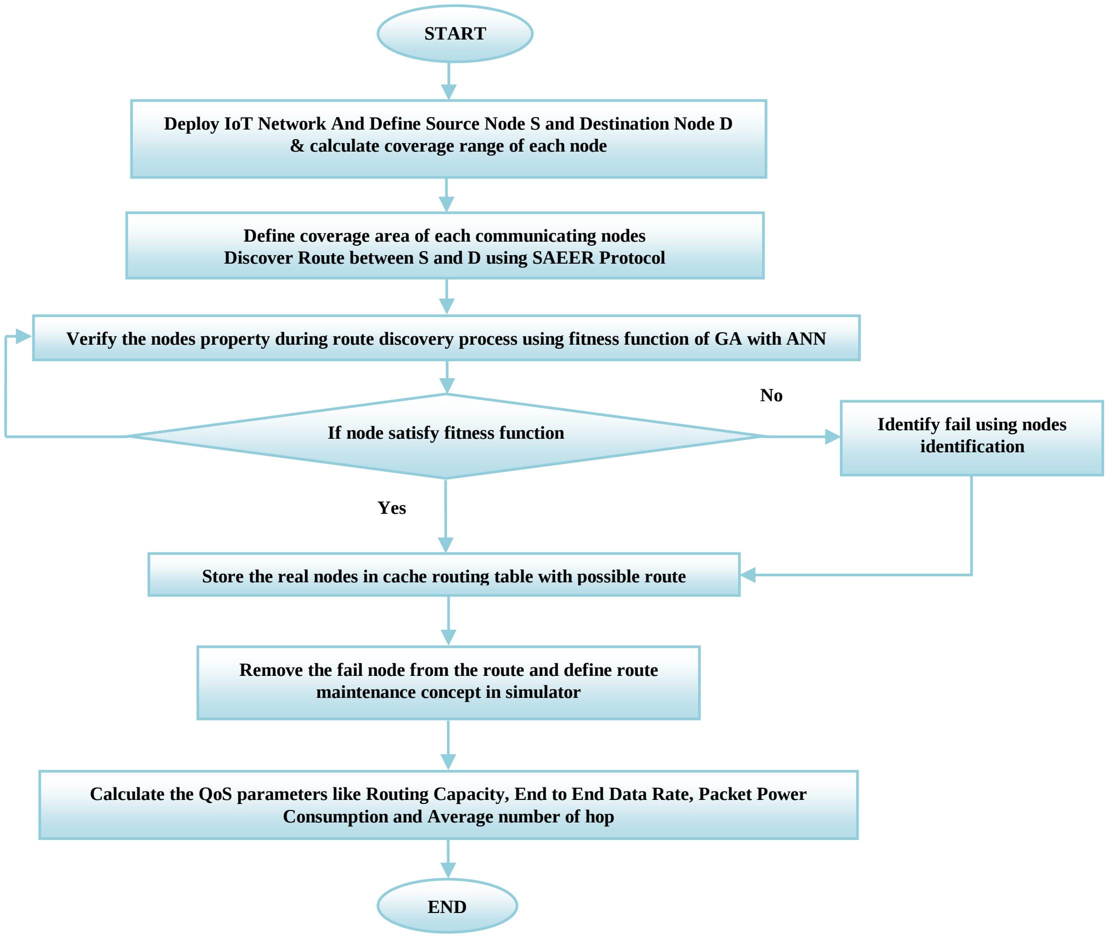

Fig. 4: Flowchart of proposed work

VI. RESULTS AND DISCUSSIONS

In this part, the simulation outcomes of proposed optimized artificial intelligence approach based SAEER protocol for D2D IoT communications is discussed and the efficiency of proposed scheme is compared with existing work [1].

The simulation environment of the proposed work is shown in table 1 and the simulation results are described in the below section.

Table 1: IoT Network Requirements

Number of Nodes	50-100
Area	1000m^2
Simulation Tool	MATLAB
Sub Region	4
Routing Protocol	SAEER
Optimizer	Genetic Algorithm (GA)
Classifier	Artificial Neural Network (ANN)
Authentication Parameter	Power Consumption
Evaluation Parameter	Routing Capacity, End to End Data Rate, Packet Power Consumption and Average number of hop

On the basis of the above mentioned scenario, the simulation results of proposed work with existing work [1] are given as:

Table 2: Route Capacity of IoT Network

NO. OF ROUNDS	EXISTING WORK [1]	PROPOSED WORK
1	17.8	23.5
2	14.1	22.7
3	11.9	21.3
4	9.2	21.1
5	9.1	19.8
6	9.0	18.3
7	8.9	17.5
8	8.9	16.3
9	8.8	16.3
10	8.8	16.2

The route capacity of the designed IoT network is shown in Fig. 5 with the comparison table 2 between proposed and existing work [1].

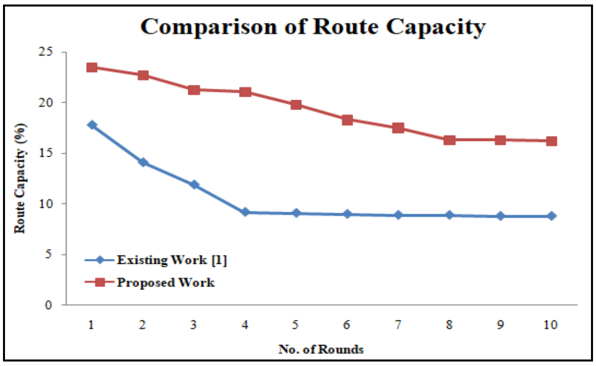

Fig. 5: Comparison of route capacity

In the figure, x-axis defines the number of rounds and Y-axis defines the route capacity values measured for improved SAEER protocol. Red line represents the route capacity value measured of proposed work and blue line defines the route capacity value measured for existing work. From the above graph it is clear that the route capacity value measured for the IoT network with improved SAEER protocol is higher than existing technique.

Table 3: E2E Data Rate of IoT Network

No. of Rounds	Existing Work [1]	Proposed Work
1	5.7	8.8
2	5.4	8.2
3	5.3	7.3
4	5.3	7.1
5	5.2	6.9
6	5.1	6.2
7	5.1	5.2
8	5.1	5.2
9	4.9	5.1
10	4.7	5.1

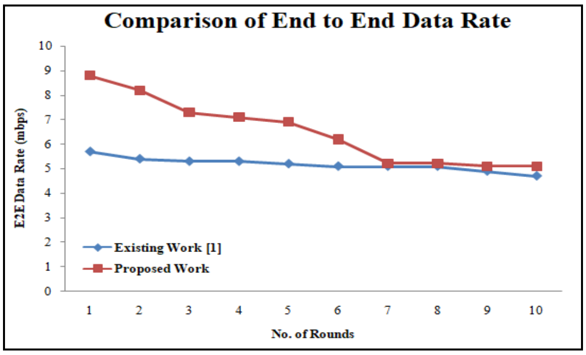

Fig. 6: Comparison of E2E Data Rate

The number of E2E data packet transmission rate of the proposed work is shown in Fig. 6 with comparison table 3 between proposed and existing work [1]. Blue and red line defines the number of packet transmitted value measured for existing and improved SAEER routing protocol. The packets delivering rate by using improved SAEER with the combination GA and ANN is more than of existing routing protocol.

Table 4: Number of hop count of IoT Network

No. of Rounds	Existing Work [1]	Proposed Work
1	3	3
2	3	2
3	2	2
4	2	2
5	2	2
6	3	3
7	1	1
8	1	1
9	3	1
10	2	1

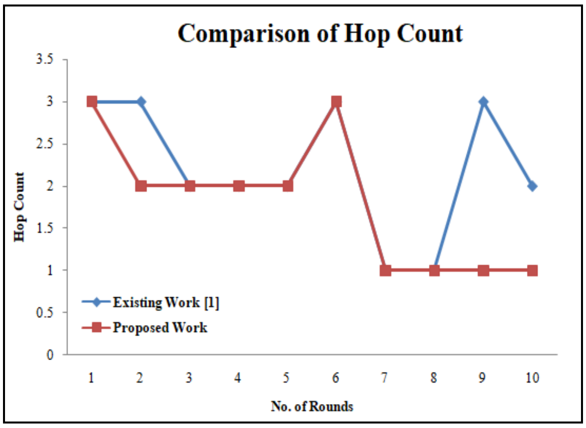

Fig. 7: Comparison of Hop Count

The hop count value of the proposed work is shown in Fig. 7 with comparison table 4 between proposed and existing work [1]. Blue and red line defines the hop count value measured for existing work and improved SAEER protocol using the combination of GA and ANN. The hop count by using proposed algorithm is less than use of existing routing protocol.

Table 5: Power Consumption of IoT Network

No. of Rounds	Existing Work [1]	Proposed Work
1	5600	5470
2	5200	4900
3	4300	4210
4	3020	2810
5	2800	2450
6	1300	1100
7	870	500
8	600	460
9	530	380
10	440	350

Figure 8 represents the power consumption rate by the sensor nodes during the transmission of data from source to destination node with comparison table 5 between proposed and existing work [1].

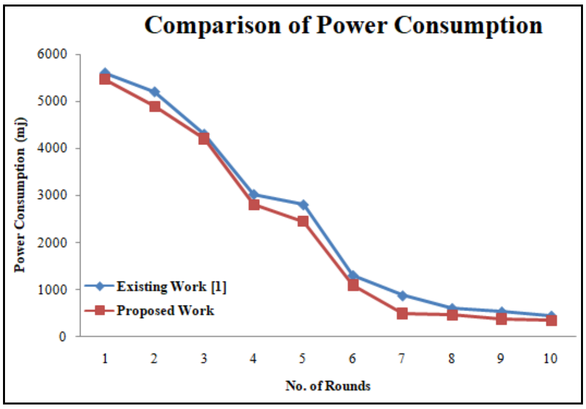

Fig. 8: Comparison of power consumption

From the above figure, it is clear that the power consumption with improved SAEER protocol using the hybridization of GA and ANN is less as compared to the existing routing protocol. From the analysis it is clear that the power consumption is reduced by 8.23%.

VII. CONCLUSION AND FUTURE WORK

In this paper, an optimized artificial intelligence approach based SAEER protocol for D2D IoT communication is proposed. SAEER protocol is analyzed on different parameters and compared with SpEED routing protocol in IoT network. We focus on efficient region based data dissemination issues and proposed an optimized SAEER protocol using GA and ANN with the help of a novel fitness functions. Illustrative results point towards the proposed device relaying scheme that effectively improves the system performance in terms of QoS parameters. In addition, the proposed routing protocol helps to transmit data packets with secure and trusted route which achieves significant improvements in spectrum and energy efficiency. On the basis of observations of results, we can conclude that power consumption of SAEER is 8.23% less than SpEED routing protocol [1] which is best among existing work in the survey section. In future work, the concept of deep learning can be used as a classifier to train IoT system based on hybridization with soft computing based optimization algorithms which may be applicable for fast mobility behavior of nodes within the IoT network for D2D communication.

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