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Simulation of ABC optimization on RZLEACH in WSN

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Abstract— This paper elaborates the artificial bee colony optimization technique based on the swarm intelligence. In ABC, the situation of a food source speaks to a conceivable answer for the issue and the nectar measure of a food source relates to the quality (fitness) of the related arrangement. The quantity of employed bees is equivalent to the quantity of food sources (solution) since each employed honey bee is related with one and just a single food source. With these steps, the performance of algorithm enhanced in terms of dead nodes, alive nodes, network lifetime and remaining energy.

Keywords—ABC (Artificial Bee Colony Optimization),dead nodes, alive nodes, network lifetime, remaining energy.

I. INTRODUCTION

The Sensors are mainly used to sense the environment and to gather the data to a centralized location. Advent of processing devices and networks makes it as "Wireless Sensor Network" [1]. Development in Semi-conductor technology and Networking methods has stimulated the use of sensor networks for observing and information collection. In Wireless sensor network, information collected by sensors is gathered at a distant location for analyzing and computation purpose via wireless links. Some applications of wireless sensor network include medical, environmental, transportation, military, entertainment, homeland, defense, and crisis management etc. Alike to other communication systems, wireless sensor network systems development has a diversity of origins. The history of development can be briefly alienated into four phases [3]:

Phase 1: During the cold war period, there was a need to monitor and detect the positions of enemies which gave birth to number of projects such as Sound Surveillance System and radar networks developed by United States.

Phase 2: DARPA (Defense Advanced Research Projects Agency) of United States Department of Defense initiated the research programs in the early 1980s that were basically focused on advance developments on new technologies and protocols of wireless sensor networks.

Phase 3: Projects undertaken by DARPA laid the foundation for military applications developments based on wireless sensor networks. Huge amount of money spent on newer technologies made the development faster in early 1990s.

Phase 4: Recent advancements in semi-conductor technologies and networking techniques directed an innovative stage in the growth of sensor network technology. In 2000's IEEE released the first version of IEEE Standard i.e. 802.15.4 standard "Low Rate Wireless Personal Area Networks" which is the base for recently introduced standards such ZIGBEE [3].

Wireless sensor network contains battery functioned small nodes which are positioned over a wide geographical area to monitor the events and to accumulate the collected data to a distant centralized location called as base station. Nodes are deployed in such a way that the entire area is in the coverage of wireless nodes. The deployed nodes sense the data from its neighborhood and transmit the collected data for further processing. The main distinction between ad hoc networks and Wireless Sensor Networks is their applications area. Ad-hoc networks primarily focus on communications aspects whereas wireless area networks focus more on monitoring and information collection. Wireless nodes are bound by several resource restrictions such as the memory availability, battery power, bandwidth requirement and the data rate [4]. These tiny nodes may work for a longer duration of time from few months to many years depending upon the application requirements, so the battery power needs to be employed proficiently so as to extend the network life time. Sleep Mode operation of nodes is efficient way to increase the life time [4]. Nodes wakes-up only when there is a need to sense the environment. In order to save the maximum battery life, the sensor node should communicate by using a special routing technique. Wireless sensor networks consist of two main components -1) Sensor node and 2) Sink Node. Normal nodes sense the environment and the sink node collects data from all cluster head coordinators and sensor nodes and thereby manages the entire network. Both normal and sink nodes have radio transceiver, processor, memory and one and more sensors as shown in Figure 1.2 [4]. The sensing unit consist of one or more sensors and an analog-to-digital converter (ADC). Sensor nodes collect the data from the surrounding and feed the data to analog to digital convertor

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for conversion into digital signals. This digital signal information is further sent to the processing unit. The sink node may possibly be cluster head (CH), which receives the data from the sensor node. Sink node removes the redundant information and transmits the aggregated data to a centralized location [4].

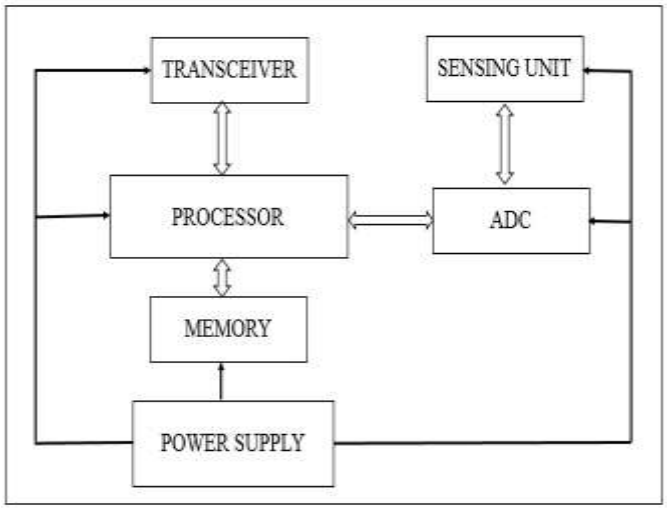

Figure 1. Sensor node structure

Communication unit consist of Processor and Transceiver circuitry for information processing and communication. Specialized microcontroller with low power consumptions are incorporated as the nodes have to work for a longer duration of time with smaller amount of battery power. Power supply unit supplies the power to each of the units of wireless sensor network. These batteries have limited capacity so the major concern for wireless sensor networks is to efficiently use the power source. Every node has some memory to store its current location, distance vector of neighboring nodes, associated cluster head and base station location. The wireless sensor network consists of battery-operated nodes and may work for a longer duration of time. Battery power must be effectively utilized to increase the network life time. Also, the wireless sensor network has been designed for different application and different data rates. The wireless sensor network can be classified as static or mobile depending upon the positions of the deployed nodes. If the position of the nodes remains unchanged or there is not the concept of mobility then the network is termed as "Static Wireless Sensor Network" whereas mobility of nodes makes the network as "Mobile Wireless Sensor Network". Static Network has Low energy consumption, simpler design but it creates network holes as the node dies. Mobile network overweighs these disadvantages by providing the coverage to the entire network area. In wireless sensor network the main function is data collection from individual nodes to a single distant centralized location. The path travelled by data to reach to that centralized location may be direct or via other intermediate nodes as shown in Figure 1.3. In single-hop networks, nodes directly transmit the data with the help of high-power radio transmitters whereas in multi-hop networks energy is utilized efficiently by transmitting the data via intermediate nodes. So, the energy requirement for multi-hop networks is lesser as compared with single-hop but it also results in early death of gateway nodes [4].

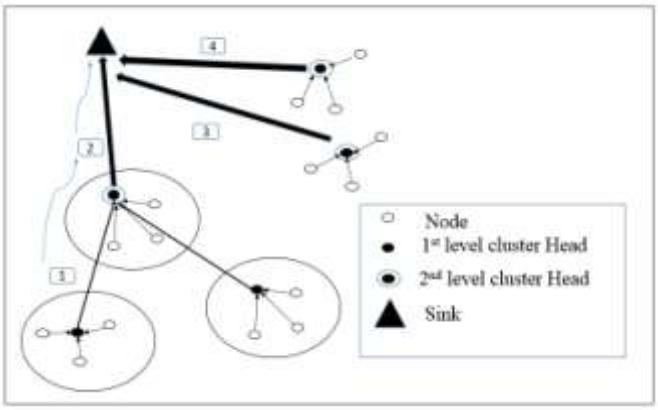

Figure 2. Single hop and multi-hop network

Homogeneous and Heterogeneous Wireless Sensor Network

The energy requirements for different wireless sensor networks may be different as per the application requirements. Wireless sensor network can be classified into homogenous and heterogeneous network based upon the competencies of the network [5]. In homogeneous network all the deployed nodes have the same energy level, whereas the heterogeneous network has different energy levels for the nodes in a network. This extra energy is provided in heterogeneous network for those nodes which are intend for more processing and communicating tasks. In flat wireless sensor network the function of sensing, processing and communication is performed by each sensor nodes as shown in Figure 1.4. Due to huge number of nodes it is not possible to identify each node by universal identifier. Data centric technique is used for collection of data from all the nodes and acknowledgement is retransmitted by sink nodes to all nodes.

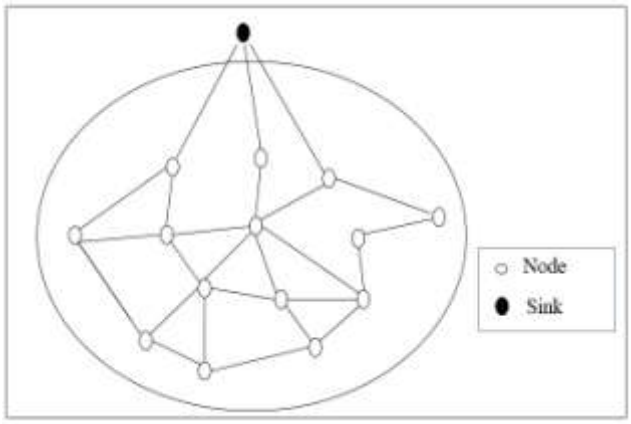

Figure 3. Flat Wireless Sensor

In hierarchical network architecture, the entire area is divided into number of small clusters as shown in Figure 1.4 [4]. Each cluster has higher energy Cluster-Head which is responsible

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for data collection from its associated nodes. Data aggregation is performed by cluster head before transmitting the data to the base station [4]. Hierarchical network architecture reduces the burden on sink node and it also more efficient as compared with flat network architecture.

II. LITERATURE REVIEW

Dervis Karaboga et al. (March 2012) - projected swarm intelligence based Artificial Bee Colony (ABC) algorithm and its application in their survey. ABC algorithm is basically motivated by the Bee behavior's for food finding. In ABC algorithm three types of bees are present: Onlooker, Employed and Scout bees. Each of the above bee symbolizes a search area in the sensor network. In ABC algorithm self-configuration feature of the bees is used to find the optimal solution of any problem.

Dervis Karaboga et al. (April 2012) - presented Artificial bee colony optimization algorithm to choose the cluster head in clustering-based routing mechanism to increase the network life time. In this method, bee's behavior for food search is utilized to choose optimum CH. This method not only increase network lifetime but also reduces the delay parameter.

Vidyasagar S.D et al. (2013) - presented a survey on various congestion control algorithms. Congestion is occurred due to excess data, low bandwidth, due to low speed processors, topology etc. this congestion results in delay, loss of packets in the networks. Various congestion control mechanism was discussed and a large variety of TCP variants are proposed for enhancing network throughput.

N.U.Ahmed et al. (2002) - proposed a dynamic model for Token bucket algorithm for network. Traffic regulating, multiplexing, and effective network usage polices are discussed. An algorithm consisting of feedback control mechanism is also discussed for enhancement of network quality.

III. LEACH ROUTING PROTOCOL

LEACH is an effective adaptive clustering protocol [1,6] and consists of two phases i.e. Set up phase and steady phase.
In the setup phase, the main issue is to make the cluster and formation of cluster head is also based on several parameters like energy, distance etc. On the other hand, in the steady phase, aggregate data from the normal node to the cluster head and then cluster head to the base station. Basically, the steady phase is longer than that of setup phase because data aggregation takes more time. The first phase of the leach is the set-up phase and it has three steps.
1) Cluster head advertisement
2) Set up of clusters
3) Creation of transmission schedule

In cluster head advertisement, the cluster head sends the information to all nodes that they become a cluster head on the basis of following formula,

$$Th(nd) = \begin{cases} \frac{pr}{1-pr*\left(rou \bmod \frac{1}{pr}\right)} & , nd \in Gr \\ 0 & otherwise \end{cases} \quad (1)$$

The node progresses toward becoming cluster head out toward that current round, if number is not as much as that of threshold value. In second step, nodes send joint demand to cluster head and tell they all are individuals from particular cluster head. In the third step, chose cluster head make a transmission plan for the node of their cluster. TDMA plan is made and every node must be send information in its constrained time. In steady phase, cluster head send their information to the base station.

IV. MOBILE SINK

Mobile Sink (MS) is a procedure which causes in to limit the vitality utilization. The development of MS [2,8,9] is inside or outside. It is of two sorts i.e. controlled way or uncontrolled way. On the off chance that the area of mobile sink is in inside territory called controlled development and on the off chance that versatile sink moves haphazardly in the region, it is called uncontrolled development. On the off chance that sink is nearer to the node, the separation is diminished which upgrades the vitality proficiency and system lifetime.

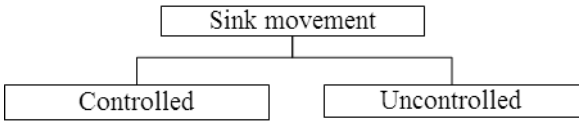

Fig.4. Movement of Sink

V. ARTIFICIAL BEE COLONY ALGORITHM

Artificial bee colony is same as the behavior of real honey bee. The way the honey bee working, searching, transferring food to the nest. This Processes is also called Honey bee algorithm. the main feature of this algorithm is that it has same intelligent behavior as honey bee in nature.
There are two main parts of the honey bee algorithm in real sense.

1 Food Source
2 Foragers

Food Source: The source is the way in which bees are searching food for themselves, is called Food Source (SN), it gives the direction, distance and timing from flower to the nest. Generally, it is food that are collected by bees for storing for further purposes or for use in winter, where food is not available.
Foragers: there are three types of bees working for searching and storing food source into the nest. These bees have their own responsibilities to searching, communicating and storing.
There are three types of bees working in this bee colony:

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- **Employed bees**
- **Onlooker bees**
- **Scout bees**

These Bee Has responsibility of "The employed bees search food around the food source in their memory; meanwhile they share the information of these food sources to the onlooker bees. The onlooker bees tend to select good food sources from those found by the employed bees. The food source that has higher quality (fitness) will have a large chance to be selected by the onlooker bees than the one of lower quality. The scout bees are translated from a few employed bees, which abandon their food sources and search new ones."

In ABC, the colony of artificial bees contains three gatherings of honey bees: employed honey bees related with explicit food sources, spectator honey bees watching the move of employed honey bees inside the hive to pick a food source, and scout honey bees scanning for food sources arbitrarily. The two onlooker and scouts are likewise called jobless honey bees. At first, all food source positions are found by scout honey bees. From that point, the nectar of food sources is misused by employed honey bees and passerby honey bees, and this persistent abuse will at last reason them to wind up depleted. At that point, the employed honey bee which was abusing the depleted food source turns into a scout honey bee looking for further food sources by and by. At the end of the day, the employed honey bee whose food source has been depleted turns into a scout honey bee.

In ABC algorithm the working bees are classified into three categories [38]:

a) Employed Bee Group: The number of bees which goes in the search of food, collect the food and gather the food in the hive are comes under Employed bee group. These are the main workforce for the artificial bee colony.
b) Scout Bee Group: When the food source of any employed bee is deserted, then the employed bee goes again in search of new food source and that employed bee comes under the category of Scout bee group. Scout bee does the arbitrary search for new food sources.
c) Onlooker Bee Group: These are those bees which on-looks i.e. waits on the hive area for employed bee for selecting the best food source according to the fitness function.

The food sources so found are the solutions for the problem and the quantity of food collected signifies the excellence or fitness of the related solution.

ABC algorithm consists of one half of total as employed bees and reaming as out-looker's bees in a network and the positions of associated food sources are spawned arbitrarily at start. At next phase new positions of food sources are selected by employed bees by using Equation 1.2 [36] as:

$$u_{xy} = a_{xy} + \emptyset_{xy}(a_{xy} - a_{ky}) \quad \text{…. (2)}$$

Here u_{xy} = applicant solution,
a_x = present solution
a_k = adjacent solution
ø = arbitrary number between -1 to 1

If the nectar amount of new-found position is more as compared to present food source, then employed bee selects that source otherwise it retains the previous one.

In next phase, employed bees give the information of all food sources with its associated nectar information to onlooker bees. Onlooker bee evaluates the nectar amount of food sources by using Equation 1.3 [7]as with a probability p_x :

$$p_x = \frac{f_x t_x}{\sum_{n=1}^{SN} f_x t_n} \quad \text{…_ (3)}$$

Here, $f_x t_x$ = fitness value of the solution x
SN = quantity of employed bees.

The fitness values of solution is calculated by Equation 1.4

$$f_x t_x = \begin{cases} \frac{1}{1+f_x} & if\ f_x \geq 0 \\ 1 + abs(f_x) & if\ f_x < 0 \end{cases} \quad \text{…_ (4)}$$

After the particular limit reached which is called as "limit parameter", food source for employed bee becomes absolute, then the scout bee again searches the new position arbitrarily as per the Equation 1.5 [7]:

$$a_x^y = a_{min}^y + rand(0,1)(a_{max}^y - a_{min}^y) \quad \text{… (5)}$$

Here deserted food source is denoted by a_x

PSEUDO CODE for Artificial Bee Colony Algorithm

Instate the number of populations in the solution, x_i (i=1, 2……SN) using Eq (1);
Cycle=1;
While cycle<=MCN do

1. Produce new method for solution v_{ij} for the employed bees using Eq (2) and evaluate them
2. Apply the greedy selection processes for the employed bees
3. Figure the probability esteem p_i for solution x_i using Eq (4)
4. Produce the new value v_{ij} for the onlookers for the selected solution x_i
   depending on pi and evaluate them
5. Apply the greedy selection processes for the onlooker
6. Decide the relinquished answer for the scout, if exists
   And replace with it new randomly produced solution x_i
   using Eq (5)
7. Memorize the best arrangement accomplished up

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until this point

8. Cycle =cycle+1
   End while

V. Simulation

In this simulation environment, the 100 sensor nodes are deployed in the area of (100,100). The MATLAB simulator is used for the given experiment. The parameters are listed below in the given table. The metrics used for the simulation are: -

- Number of dead nodes
- Number of alive nodes
- Number of packets send to base station
- Remaining Energy

Table1: - Simulation Parameters

Parameters	Value
Dimension (x, y)	150*150
Sink Position (x, y)	Moving
Nodes in Number	100
Probability to CH	0.1
Beginning Energy	0.5J
Transmitter Energy	50 nJ/bit
Recipient Energy	50nJ/bit
Free space Energy(amplifier)	1.0nJ/bit/m^2
Multipath Energy	0.0013nJ/bit/m^2
Rounds in Number	13,000
Message Size	4000bits

This is the simulation environment of wsn in which 100 nodes are deployed and position of sink is moving along y axis.

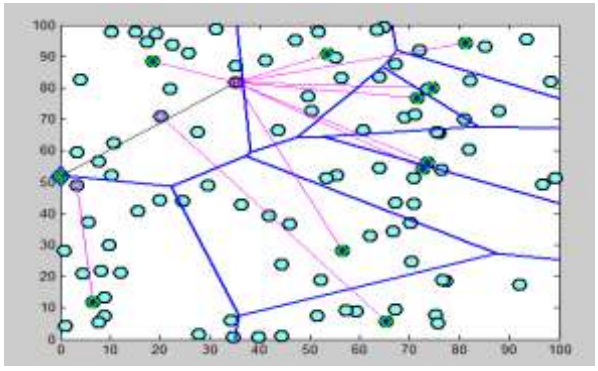

Fig.5. Square region of 150*150 having 100 nodes

Dead Nodes:- This is the graph of dead nodes in RZLEACH and ABC-RZLEACHprotocol.The network lifetime can be evaluated by using the number of dead nodes. It has been found that the number of nodes die earlier in RZLEACH protocol. Here, we can see from the graph that all the nodes are die at the round of 850 in case of RZLEACH and 1200 in case of ABC-RZLEACH.

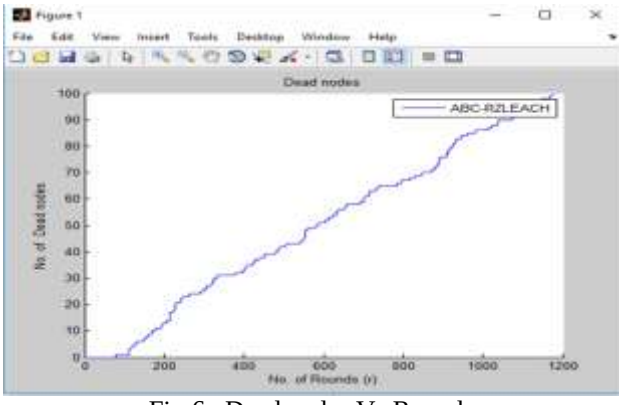

Fig 6. Dead nodes Vs Rounds

Alive Nodes:- This is the graph of alive nodes in RZLEACH and ABC- RZLEACH protocol. It has been found that the number of nodes alive much more in ABC-RZLEACHprotocol. Here, we can see from the graph that the nodes are alive at the round of 850 in case of RZLEACH and 1200 in case of ABC- RZLEACH.

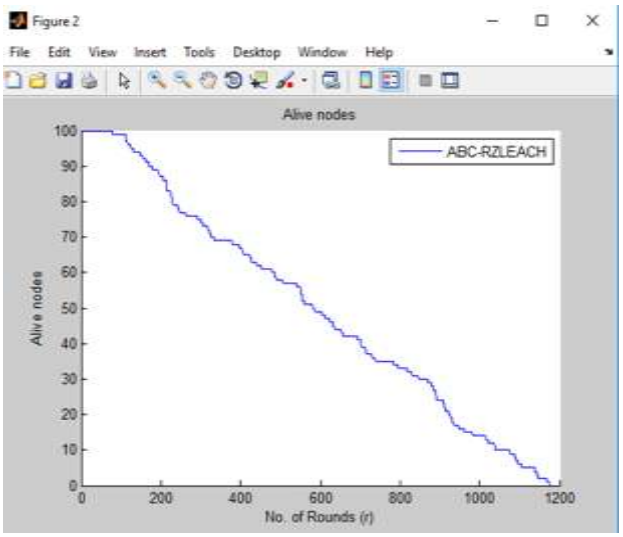

Fig 7. Alive nodes Vs Rounds

Packets Send to base station: -

This is the graph of Packet send to base station after simulation. This graph shows the total number of packets send to the base station by the sensor nodes. At the round of 850, the total number of packets send to base station is 3200 in the case of RZLEACH protocol and in case of ABC- RZLEACH ,the packets send to base station is 4200.

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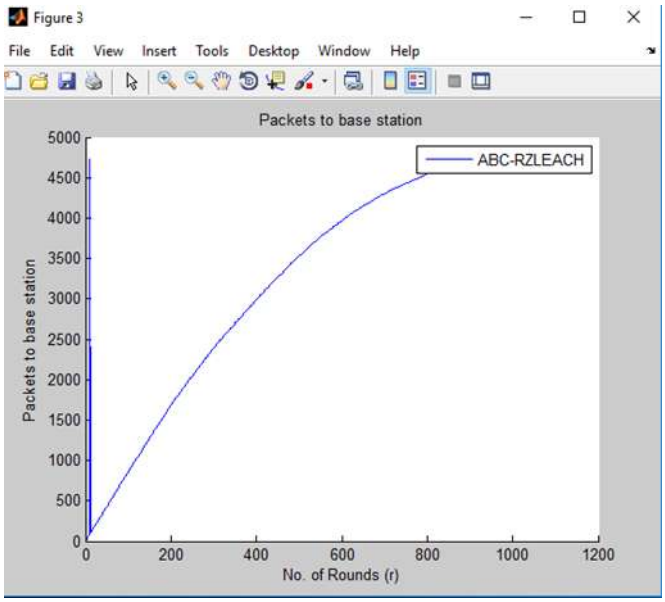

Fig 8. packet send to BS Vs Rounds

Remaining Energy: - This is the graph of remaining energy, how much energy is left with the rounds. From the graph, we can see the remaining energy with RZLEACH goes to 800 rounds, whereas in the case of ABC- RZLEACH the remaining energy goes to 1200 rounds means more work can be done with ABC- RZLEACH protocol.

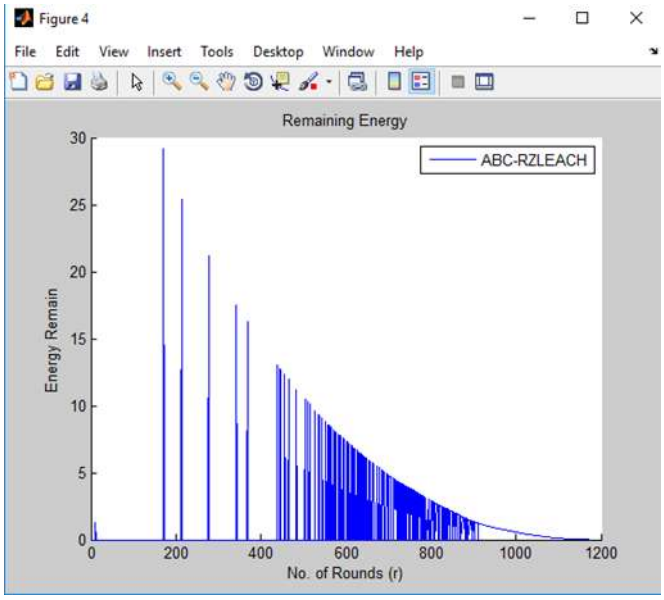

Fig 9. Remaining Energy Vs Rounds

The remaining energy is an important consideration for WSN, which is computed using

$$RemEng\,(re) = \sum_{N=1}^{n} E_{rr}\,(Nd) \qquad (3)$$

where E_{rr}(Nd) is the energy of Ndth node for rrth round.

VI. CONCLUSION

To limit the vitality utilization, we proposed an artificial bee colony province advancement method dependent on swarm knowledge. The employed honey bees seek sustenance around the food source in their memory; in the mean time they share the data of these food sources to the passerby honey bees. The onlooker honey bees will in general select great food sources from those found by the employed honey bees. The food source that has higher quality (fitness) will have an extensive opportunity to be chosen by the passerby honey bees than the one of lower quality. The scout honey bees are deciphered from a couple of employed honey bees, which forsake their food sources and inquiry new ones. The proposed convention demonstrates the better enhancement over existing convention. Be that as it may, this work has not considered the use of 3D WSNs, which are getting to be real zone of research in nowadays. In this manner, in not so distant future work we will expand the arranged procedure for 3D WSNs condition.

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