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Swarm Intelligence based QoS optimized Routing in WSN

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Abstract:
WSNs have been experiencing a rapid rise in usage that gives it high responsibility while it is a resource constraint network in terms of memory, processing and lifetime. So finding a desired output for a long duration is not easy in it due to the its limitations. So, in each functionality optimization has an important role. Due to the importance of optimization, it attracts researchers to further development in all the directions, including aggregation, localization, deployment strategy, routing and QoS. For optimization bee colony problem has gotten popularity since last few years. In this paper, authors providing a routing methodology with QoS optimization for wireless sensor network. For over ten years, bio-inspired solutions have progressively gained the researchers' attention due to their effectiveness in solving numerous optimization problems in a larger domain. The enhancement of the RZLEACH protocol by selecting the routing path using bio-inspired solutions play a significant role in this research paper. This paper aims to enhance the network lifetime, stability, and packet transmission ratio. Therefore, a hybrid technique known as ABC-RZLEACH that combines the functionalities of ABC and RZLEACH has been proposed.

Keywords: QoS, RZLEACH, WSN, Routing, Swarm Intellegence.

1. INTRODUCTION

Electronic The wireless sensor network is becoming the most popular and necessary method of delivering standardized computing environments for different applications with characteristics like inexpensiveness, compactness, reduced energy consumption and also has the capability of performing multiple functions [1]. WSNs are based on tiny sensors arranged by wireless network. These sensors are powered by battery that provides power to send data to monitoring station using through base station (BS), apart from this, data transmissions are only performed with routing that is a continuous process of finding better route. The routing exhausts most of the lifetime of node that may lead to the failure of network. That is why, optimized routing having importance to increase lifespan of network. Therefore, Artificial Bee Colony algorithm proposed here to find a path between the sender and receiver. Since this technique is population-based, the placement of a food source denotes a conceivable solution for optimizing, whereas the quantity denotes the fitness of the respective solution. The amount of bees present in the swarm represents perspective solutions that can be utilized in the population. Initially, a population created that distributed randomly. This population represents the position of the food sources. Then, it allocated to all three types of search procedures. Once a bee is employed, it identifies the food source and modifies the position in the memory. After this, it identifies another food source, and this loop goes on. If the nectar value of the source is more than the existing, the new memory is stored; otherwise, the current location is not removed from the memory [2].This cycle continues until all the bees are employed. Once, all the bees complete the search steps, the position data of the food sources given to the onlooker bees. When the onlooker bee obtains this information, it picks a location depending on the amount of nectar in the source. They create an alteration in the memory of the source position and calculate the nectar sum. Since nectar in the new location will be more than the previous position, this will be retained in the memory. The scout bees resolve the relinquished sources by randomly creating new sources. With this estimation technique, it could handle multi-target advancement issues.

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Furthermore, a robust approach to enhance the performance and simulation of enhanced energy-efficient routing protocol for WSN has been developed. In this Clustering is an important way to enhance network lifetime by grouping sensors to different cluster [3]. In these clusters, data transmission performed with the help of the cluster head while in a cluster, choosing a cluster head (CH) is a research trend. This is performed by utilizing the neighbor search technique, thereby discarding unnecessary solutions. Note that few terms used frequently are RZLEACH, ABCRZLEACH, Mobile sink(MS), Cluster Setup(CS), Rendezvous Points (RPs), Rendezvous node (RNs), normal node (NN), LEACH, TDMA considered from [15] that is published recently.

2. Related work

A wireless sensor network (WSN) ordinarily contains many sensor nodes and a sink situated in a testing domain. Sensor nodes transmit their information to the sink, which processes the required information. The sink can send directions to the sensor nodes if necessary. Every sensor node can transmit data to the sink with the help of a single hop by long-distance transmission. Long distance transmission isn't ideal as far as energy utilization, thus, diminishing the separation can expand energy effectiveness and prolong the system lifetime. A guaranteed technique is utilizing a multi-hop situation. In this strategy, every node courses its information through different nodes and those nodes send the information to the sink. It diminishes the transmission distance and all-out energy utilization when different nodes go about as routers.

In the present examination, the node structure has been made by utilizing an improved LEACH algorithm and normal node (NN) information is moved to the CH, which totals the information. In the event that the CH has appropriate separation from an MS, the CH will straightforwardly transmit the information to the MS. In the event that the separation is more prominent than a predefined limit value, the information will be moved to the closest living RN which will move it to an MS in an appropriate time. The present investigation looked to safeguard the advantages of the LEACH calculation, (for example, self-association) and improve CH choice to join them with the utilization of RP and MS. The proposed technique diminishes energy utilization in WSNs more distant than in customary LEACH, especially when the system is enormous.

2.1 Cluster head selection

A survey was performed by [5] says Selection of cluster head for rotation affects the energy efficiency of the network. In the selection of cluster head Fuzzy MADM approach was used by [3] using criteria of residual energy, number of neighbors, and the distance from the base station of the nodes. [4] Improved Minimum Separation Distance(IMSD) proposed by [4 B]. This IMSD was an extended version of MSD clustering. After these, an analytical network process (ANP) for cluster head selection uses five distinct parameters including distance from nodes), residual energy level, distance from the centroid, number of times the node has been selected as cluster head and merged node in [6]. The main contribution of this work is to check the applicability of the ANP model for cluster head selection in WSN. To remove the problems created by random process selection [7] has proposed the method for cluster head selection to solve the problem of failure of some cluster heads in LEACH versions. LEACH based modified cluster-head selection algorithm was proposed by [16]. In which authors taken distributed address assignment mechanism (DAAM) of ZigBee, both residual energy and network address of nodes to optimize cluster-head threshold equation. When a node chooses to wind up a CH, at that point, its determination should be possible based on three factors; the current CHs percentage(i.e. Somewhere in the range of 5% to 10%), the frequency of a node being elected as CH and the power that is consumed by the sensor nodes [8]. On the off chance that the nodes energy level is more noteworthy or equivalent to the normal energy of all nodes, then the nodes naturally take an interest in the cluster head determination and if not then they will cause a postponement of 1/p rounds. The nodes create a random number in the range of 0 and 1. When the value is lesser than the threshold value T(n), that particular node will be selected as a cluster head in this particular round and then CH labeling will append to it which is shown in equation 1 below:-

$$T(n) = \begin{cases} \dfrac{p}{1 - p * (r \bmod 1/p)} & if n \in G \\ 0 & \end{cases} \quad (1)$$

Where, p is the number of cluster nodes in percentage.
r is the existing round
G is sets of nodes that are not allotted as CH for the last 1/p round.

The nodes, which are not selected as a CH will be designated as an ordinary operational node in the WSN network. Once the RNs and CHs are selected,

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each of these nodes imparts progress information to the Normal nodes (NNs). These nodes should maintain their beneficiaries ON in the midst of this period of setup stage for hearing adverts from each of the RHs and CHs. These utilize CSMA traditions and send their adverts by utilizing comparative transmitting essentials. Each of the nodes decides which aggregate it has to place and which RN is closer. This is decided by considering the difference between the NNs and the other nodes. When they are switched off, the region of the nodes is identified using GPS[9,10].The signal quality of the advert messages identifies which node will be nearer to the NN. The one, which is closer, sends a signal. In this phase, each CH creates a schedule using Time Division Multiple Access (TDMA) protocol. During this phase, the schedule is transmitted to every sensor node regardless of where they can send data. The nodes maintain the radio in 'ON' mode only during their allotted slot of time, which decreases the power consumed by the sensor nodes as every node know the transmission time for data transmission [11].

Cluster head selection Phase

Begin
Initialise the new 1/p round
The first Node computes the threshold value T(i) of the prevailing round
The first Node generates and selects a value randomly between 0 and 1.
If (rand(i) < T(i))
Then node i is chosen as a CH node in the present round and transmits its status.
Else
Node i is non-CH node, waits for data come from CHs and choose the nearest one to join it.
Endif
Node i complete the clustering setup and attains a steady state where it transfers the data
End

3.2 Data transmission

Cluster head collects data within the cluster after its formation and transmits it to the MS or nearest RN.

ABC Procedures for Routing Optimization: A virtual onlooker honey bee selects a food source on the basis of the possible value which is linked with that food source, px , where fxtx denotes the fitness value for the solution that is relational to the quantity of the nectar at the source in the current location. x and SN denote the quantity of the food source that is comparable to the amount of employee honeybees [12].When all onlookers bees have chosen a nourishment source, every one of them decides a sustenance source present in the area of its chose nourishment source and figures the fitness estimation of this recently decided source of food. After this, the execution of the source in the area (new candidate) is contrasted and the execution of the old one. A technique known as greedy selection technique is utilized as the determination activity between the new and the old. If the newer source of food has equivalent or preferred nectar over the older source, it is supplanted with the older one in the memory. The food sources that are found are the answers for the issue and the amount of sustenance gathered depict the magnificence or wellness of the related arrangement.

4. Simulation and evaluation

The assumption to this model is that the network domain is square with a definite amount of sensors and also the entire group of sensors has been deployed in random in the environment and mobile sink (MS) is placed on the y-axis and position of mobile sink is changed with every round. The energy of the sink is assumed to be unlimited. In consideration, that position of nodes as well as a sink can be determined after each round. The rendezvous nodes are used as a storage point for the receiver. The selection of cluster head and rendezvous node is done initially followed by the formation of clusters made in setup-stage and transfer of information from the sending nodes to the receiver is done in the steady-state phase thereby improvising the network lifetime. The MS is located initially on x=0 and $y=\frac{Ym}{2}$. Matlab was used for the simulations and the area scalability also checked for the randomized network.

Simulation Environment: The boundaries utilised for performing the implementation are outlined in Table 2.

Table2:- Simulation Parameters

Parameters	Value
Area (x,y)	250 ×250 m^2
Position of BS(x,y)	Moving along Y-axis
No. of nodes	100
The probability of cluster head creation	0.1
Initial Energy	0.5J
Tx Energy	50 nJ/bit
Rx Energy	50nJ/bit
Free space Energy(amplifier)	1.0nJ/bit/m^2
Multipath Energy	0.0013nJ/bit/m^2
Message Size	1800 bits

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Simulation time	3000 seconds

In biological terms Bee indicates Nodes, Source of foods like hello message, nectar as a power, nectar table as a routing table, elite state as a cluster head wile hive a a sink or base station(BS. Bees show the number of nodes that are available in the network for communication as 100 nodes are used for performing network routing. Food source represents the beacon or landmarks or anchor nodes which contains information regarding the position of nodes. In network-routing hello message is broadcast towards the nodes. Nectar is the amount of energy or power given to the nodes as 0.5 Joule during the network routing process. Patch table represents the routing table in which all parameters are defined related to network routing as outlined in table 1. Elite site act as a CH that collects the information from the nodes hive represents a sink or base station where it receives all the information from cluster head.

Evaluation of ABC-RZLEACH in 250×250m2:

The performance of ABC-RZLEACH is also evaluated by increasing the network area from 150×150m2 to 250×250 m2 on the metrics like quantity of dead nodes, the quantity of alive nodes and packets transmitted to BS.

Dead Nodes:- The performance of the ABC based RZLEACH technique is also determined by enhancing the size of the network from 150×150m^2 to 250×250m^{2}network. Figure 6 shows that ABC-RZLEACH saves maximum nodes available in the network i.e., fewer nodes are dead in ABC-RZLEACH as compared to RZLEACH. In 1000 rounds, ABC-RZLEACH has 79 dead nodes, which is lesser than RZLEACH protocol. As the number of rounds increase, the ABC-RZLEACH has the least number of nodes as compared to RZLEACH. At 2000 rounds, the ABC-RZLEACH has 96 dead nodes but in case of RZLEACH, the network is fully dead. Table 7 represents the numeric values that correspond to the dead nodes.

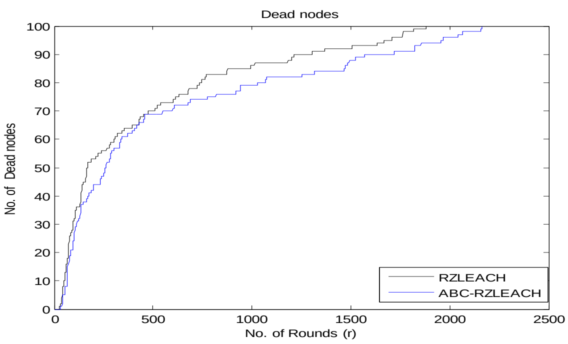

Figure 6. Dead nodes Vs Rounds

Table7:-Amount of Dead nodes Vs Rounds for 100 nodes in 250×250 m^2 network

Number of Rounds	Number of dead nodes	
	RZLEACH	ABC-RZLEACH
500	70	69
1000	86	79
1500	92	88
2000	__	96

Alive nodes:-
Results are also evaluated on the performance of alive nodes in the case of 250×250m^2 networks. Figure 7 shows that the number of alive nodes are present with ABC-RZLEACH when compared to RZLEACH algorithm for repeated rounds and this enhances the life of the network. In 1000 rounds, ABC-RZLEACH has 21 alive nodes and it is more than RZLEACH protocol. As the number of rounds increase, the number of alive nodes in ABC-RZLEACH is higher when compared to RZLEACH. At 2000 rounds, the ABC-RZLEACH has 44 alive nodes but in case of RZLEACH, the network is fully dead. Table 8 represents the numeric values corresponding to the alive nodes.

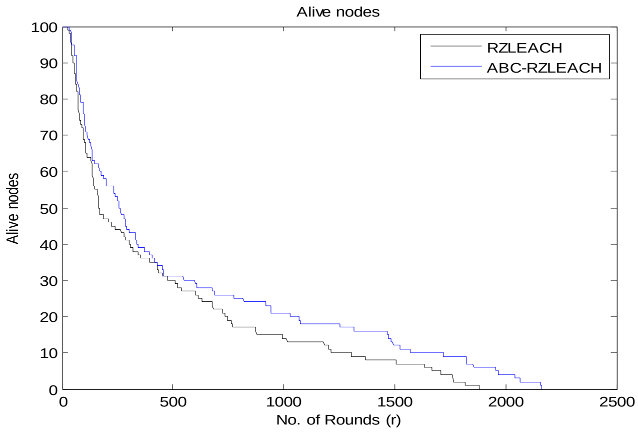

Figure 7. Alive nodes Vs Rounds

Table8:-Amount of alive nodes Vs Rounds for 100 nodes in 250×250 m^2 network

Number of Rounds	Number of alive nodes	
	RZLEACH	ABC-RZLEACH
500	30	31
1000	14	21
1500	8	12
2000	__	4

Packets Send to the base station:-
The PDR is the ratio of the amount of packets that reaches the receiver node from the sending node. Figure 8 demonstrates the examination of PDR of the

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two techniques. When there are 2000rounds, the network is dead in case of RZLEACH and the aggregate amount of packets transmitted to the BS is 1769 because of ABC-RZLEACH, which clearly states that ABC-RZLEACH has prolonged the network lifetime. Table 9 represents the numeric values corresponding to the packets sent to the base station.

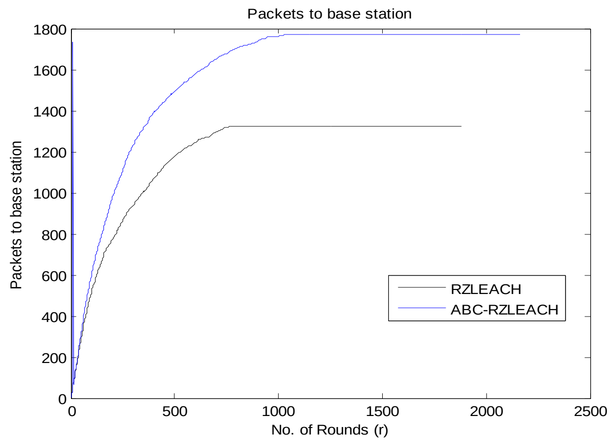

Figure 8. Packets sent to the BS Vs Rounds

Table9:-Number of Packet sent to the BS Vs Rounds for 100 nodes in the 250×250m^2 networks

Number of Rounds	Packets sent to the base station	
	RZLEACH	ABC-RZLEACH
500	1176	1494
1000	1326	1763
1500	1326	1769
2000	__	1769

5. Conclusion and future scope

Current work forwards our last studies [13,14, and 15] and this works specifying the study performed in [15]. Work performed in [10] just provided ABC optimization by considering the stability and lifetime of the network with the help of swarm characteristics of optimization.

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