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A GA-BFO Swarm Based CH Selection Approach For Enhancing Efficiency In Clustering Protocols

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***Abstract*— Wireless Sensor Networks, the networks that communicate through nodes. These do not have any particular controller at the center. It is data transmission from the nodes to the base station. Since, wireless technology is in trend these days, so the demand for wireless communication mediums is going up. Many scholars and researchers are working on energy efficient protocols in WSNs. These are those protocols that set a certain criteria for communication in WSNs. Node deployment, clustering, formation of cluster heads is done on the basis of applied protocol [5]. The conventional energy efficient protocols are LEACH, HEED, DEEC, PEGASIS etc. Each new protocol was designed as an improvement in the former or to overcome the disadvantages of the conventional protocol. The approaches for clustering were varied, new methods are developed to choose a cluster head among nodes. The prime objective of each protocol was to improve the efficiency of wireless sensor network so that its lifetime could be improved and that network can work for longer time. The performance parameters are calculated that depict the performance of the wireless network after employing the designed protocol. In this paper a new protocol for improving energy efficiency in wireless networks is developed that is advancing in QLEACH [1]. The proposed protocol is a hybrid approach that uses QLEACH with optimization algorithm, i.e. Genetic Algorithm and BFO to take decisions for selecting the cluster head. The employment of optimization algorithm for generating results produces efficient results and it is observed that the network lifetime improves significantly using the proposed approach. The results are shown in MATLAB.**

Keywords*— *MATLAB, Quadrature LEACH, Wireless sensor Networks, Clustering, Genetic Algorithm, Network Lifetime, Bacterial Foraging Optimization.

1. Introduction

Wireless sensor Networks are gaining popularity because of their easy and convenient use. These offer communications at distant places without the use of wires which reduces complexity of the system and also decreases the system cost [5]. And to add to it, these networks have made communication possible in places where it was impossible to reach using wires. The only need of the networks is reliability, security and improved energy efficiency. These wireless networks to find applications in various areas like military, health sciences [8] etc. and these application areas are increasing day-by-day. The communication in wireless networks is done through the deployment of nodes and these nodes transmit data from source to destination reliably. Energy efficient protocols have been designed to improve the energy efficiency of the network to improve the lifetime of the network [5].

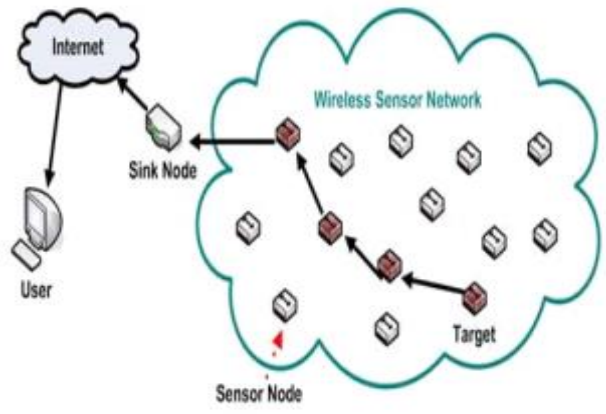

Figure 1. Wireless Sensor Networks

2. Routing in WSNs

Routing is a process of finding a path to transmit data from source to destination. In wireless sensor networks, routing is done among nodes and the nodes are selected for data transmission. Routing in Wireless networks is different from conventional routing because in these networks the data has to be transferred to the sink or base station and the same path cannot be followed every time, which means that any universal scheme cannot be applied in these networks for routing [5]. The routing protocols for WSNs are designed such that they can calculate energy dissipation of nodes and can also find out which node is unable to transmit data further or which sensor nodes have chances of failure and these protocols also need to save copies of transmitted data [5].

3. Protocols for Routing IN WSNs

The protocols for routing in wireless networks can be either structure based or operation based [6]. These two types are classified according to the network architecture of the network or its application. The two types of routing protocols in WSNs further have some sub types that are mentioned below:

i. Multipath Based routing: the concept of this protocol is using multiple paths for transmitting data in a single network. The network performance will be improved by introducing multiple paths in a network as it will improve the fault tolerance of the system. But at the same time this will increase traffic as well as the cost of the system [7].
ii. Query-based routing: In this routing protocol a query is initiated by the node that serves as a destination, and the node that matches the query that was initiated by the

destination node will send data to that destination node [7] [6].

iii. QOS-based routing: In this protocol some Quality of service parameters are considered while transmission of data to the destination node. These parameters can be delayed, the energy of the node or the bandwidth. The energy consumption of the network is balanced by this protocol during the transmission process [7].

iv. Negotiation-based routing: This protocol takes decisions on the basis of the current scenario of the wireless network. The advantage of using this protocol is that it reduces or diminishes the redundancy caused during transmission of data [7].

v. Flat-based Routing: This is one of the structures based routing protocol and on this protocol the sensor nodes work collaboratively. A single task is performed by all the sensor nodes and all these nodes play the same role in the network [7].

vi. Location-based routing: In this protocol the location of the nodes is the factor that decides path for transmitting data to the destination. The distance between the neighboring nodes is taken into consideration and the strength of the signal received from the sink purely depends on the distance between the sink and the sensor node. This protocol considers the nearest sensor nodes for sending data and this way it will reach the destination [6] [7].

vii. Hierarchical-based Routing: This protocol considers the energy value of the nodes for transmitting data. The sensor nodes having higher energy value are only considered for transmitting information and the nodes having lower energy value will be used least. The concept of clustering, introducing cluster heads in the network and then communication of cluster head and sink etc. is introduced by these protocols. These protocols were designed to improve the lifetime and scalability of the network significantly and also increase the energy efficiency of the WSNs [6] [7].

4. LEACH Protocol

LEACH is Low Energy Adaptive Cluster Hierarchy Protocol that comes under the category of Hierarchical-based Routing. LEACH protocol was designed by Wendi B. Heinzelman, Anantha P. Chandrakasan and HariBalakrishnan [6]. The LEACH works by isolating the system into various group of sensors. Those sensors are made by coordination and figure out how to lessen the amount of information that are transmitted to the sink furthermore make directing and information appropriation more adaptable and enthusiastic. LEACH manages this Trouble by randomized rotating movement of bunch head to spare the battery of every last hug. By this LEACH make best utilization of system hubs furthermore diminish the vitality liberality by pressing the information before transmitting to the leader of the bunch in LEACH convention [5]. This protocol works in two phases, namely the set-up phase and the steady phase. This was an efficient protocol that had few drawbacks like it was single-hop network and the selection of cluster head was random. So, various protocols were developed by advancing the LEACH protocol to overcome its disadvantages and improve the efficiency of the network [7].

The protocols that were developed as advanced versions of LEACH are [5]:

i. LEACH-C: It introduces a creative calculation of grouping arrangement, where finest node is picked and the cluster head is selected having least transmission energy. The best cluster is then chosen on the basis of energy value amongst all selected cluster heads and the normal sensor nodes.

ii. E-LEACH: E-LEACH has least traversed tree from where the cluster head having the highest energy is chosen as the root node.

iii. M-LEACH: This protocol allows multi-hopping in the network and in this way improves the energy efficiency of the network.

iv. QLEACH: This protocol divides the network into four quadrants and then the clustering in the network is done accordingly. The concept of relay or some rechargeable nodes can be introduced in the network to further improve the efficiency of the network.

5. Genetic Algorithm

The genetic algorithm is an optimization algorithm for solving problems using the natural selection process. Genetic Algorithm has a place with the bigger class of developmental calculations (EA), which create answers for advancement issues utilizing strategies roused by regular development, for example, inheritance, mutation, selection and crossover. This algorithm helps in bringing out the optimized solution for the problem by applying crossover and mutation on the process. A fitness value is considered that is used for calculating the results for the given population. First of all, the initial results are calculated without applying GA and those are saved for future use. Then, crossover is applied to the initial population using fitness value. In this a new population is created by interchanging the bits of the selected population and then the results are calculated. Then, mutation is applied to the initial population in which swapping of bits is done to create a new population. The results of the new population after applying mutation are calculated. These all results are compared and the best ones are saved. In this way applying GA can help obtain the best possible results for any problem.

In wireless sensor networks, GA can be applied to obtain an optimized path for routing that will further improve the network efficiency and lifetime.

6. Block Diagram & Methodology

QLEACH is a quad- Low Energy Adaptive Cluster Hierarchy. Its methodology is described as:

1. As for the QLEACH system the energy parameters are most important to be known. So, the first step in this process is the initialization of the energy and physical parameter. These both parameters will be initialized in the beginning.
2. The next step to be done is the round processing and hence, it will be done after the initialization of the energy parameters.

3. The third process to be done is the checking of energy residual after initialization of energy parameters and the round processing.
4. Now, the three processes, i.e. the initialization of parameters, round processing and checking of energy residual is done, then the value of energy will be checked, whether it is positive or negative. The value of energy will decide the next process to be applied.
5. If the value of energy is negative, i.e. it is lesser than zero the nodes energy has drained. This means the node is dead. Hence, the node will be declared dead.
6. The dead node's NCH energy will be calculated.
7. The CHs selection optimization using GA algorithm and BFO algorithm.
8. The final result will then be calculated, i.e. the performance parameters of the system will now be calculated like the network's lifetime, node lifetime, etc.
9. Now, if the value of the energy of the node comes out to be positive, i.e. it is greater than zero then it will move on to the next round. Then again the energy residual will be checked. This process continues until the node energy does not come out to be zero or negative.
10. When checking the intermediate node, the iterations of the intermediate nodes will be increased and the energy of the intermediate nodes will also be calculated and checked. The condition is similar to the energy values of intermediate node as that of a normal node, i.e. the energy value will be checked if negative or positive. If the value comes out to be greater than 0 i.e. positive, then the step 9 will be repeated and if the energy comes out to be lesser than 0 i.e. negative than the steps 7 and 8 will be repeated.

7. Problem formulation

As we know in WSN when sensor are deployed in unstructured environment sensor nodes are typically powered by irreplaceable batteries with a limited amount of energy supply then we generally want the sensor network to work as long as possible. So to achieve this we have to perform transmission with less power or energy consumption. As per previous work many algorithms for routing has been proposed as LEACH, HEED, PEGASIS, SEP, etc. but all these algorithm are single hop routing protocols. In conventional technique the cluster heads selected are arbitrary in size. In this cluster heads are selected by determining the number of each node as 0 or 1. As per this selection some cluster heads are located far away from the sink, this farther located nodes suffers high energy drainage and thus, the network performance degrades. The sensor nodes are located far from the sink and are also immobile. These all problems need to be diminished to improve the system performance and for the effective working of the system. There needs to be introduced a solution so that the problems faced by the conventional techniques could be overcome. The clustering process needs to be improved and the stability period is required to be increased. A system should be designed such that the network lifetime for the good performance of WSNs could be improved

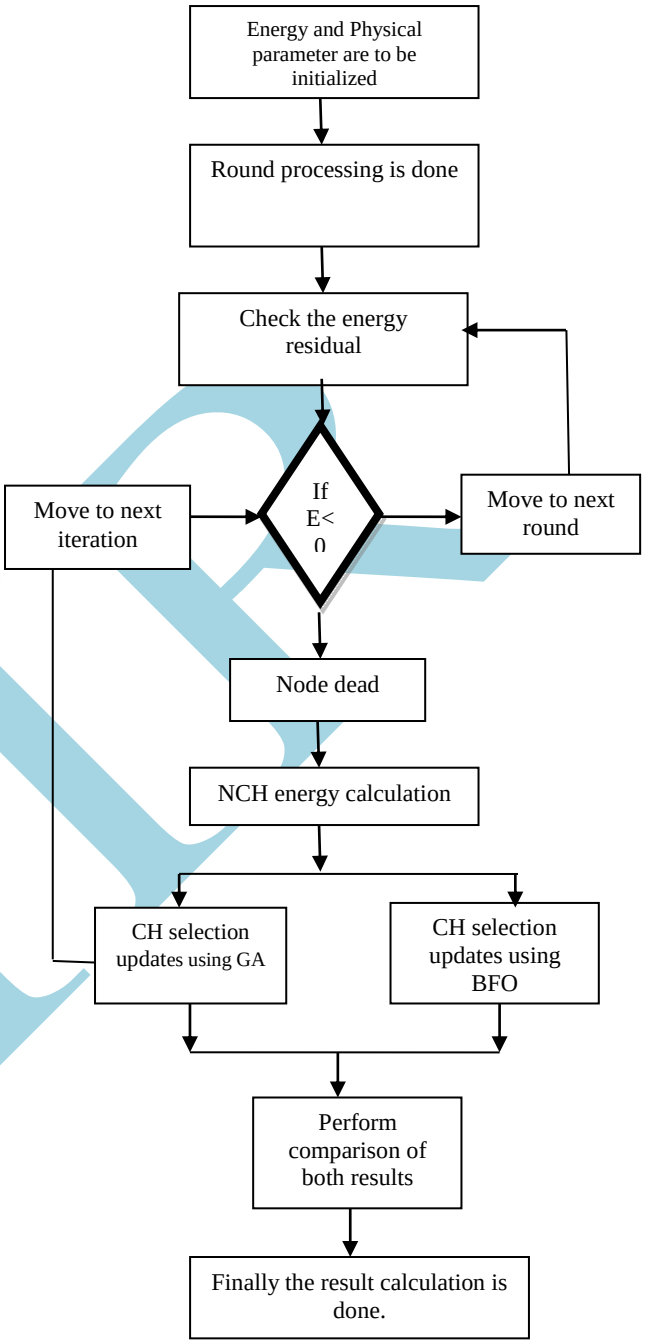

Figure 2 Block diagram of proposed work

8. Proposed Work

In the traditional approaches if we talk about LEACH, SEP, etc. they are single hop communication system and along with that the CH selection approach was dependent on the probability equation, but that approach is so old and can be further enhanced using some innovative approaches on which the performance of the system depends.

So in this thesis the fitness function will be dependent on below written conditions that are

1. Checking that the node has enough energy to become the cluster head and also checked the physical parameter name as bandwidth.

2. The node must have small distance between all the nodes that will involve a single cluster that is the mean distance between all the nodes and Ch must be as small as small
3. The thirdly and the main dependency is the node which will be chosen as Ch must have less distance with the BS and high bandwidth.
4. The implementation of GA and BFO for CH selection.

This objective must be achieved by using genetic algorithm and along with this in proposed work the concept of multi-hopping is there to introduce a relay node between the Ch and the BS.

9. Results & Discussions

The proposed technique in the paper improves efficiency of wireless networks by using optimization technique called as GA i.e. Genetic Algorithm and BFO i.e. Bacterial Foraging Optimization. Implementation of this algorithm optimizes the final results and hence generates efficient results.

The figure below represents the comparison graph between proposed GA and BFO algorithm. The comparison is performed on the basis of number of packets deliver to the base station. The graph shows that the GA transfers a large amount of packets to the base station as compared to BFO, but the stability of BFO is much more than the GA. Because in GA the network is alive till the 4000 rounds, but in BFO the network remains alive even after 4000 rounds.

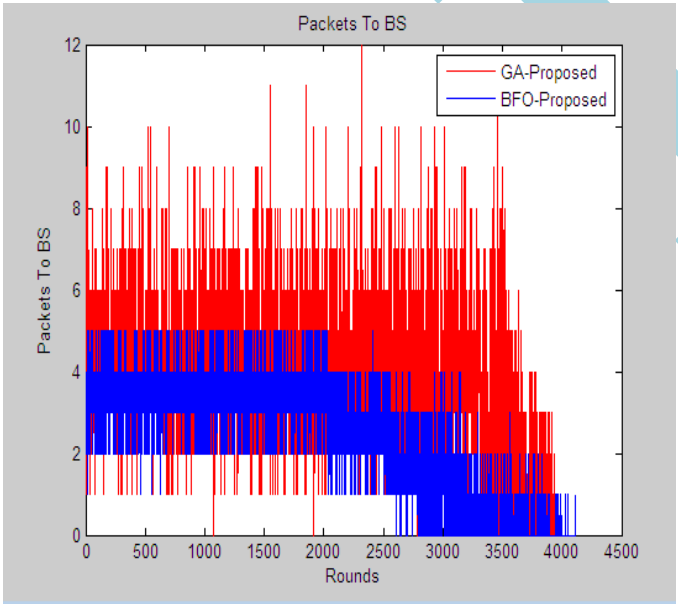

Figure 3 Graph showing comparison of data delivery to base station after each round using GA-Proposed and BFO-Proposed

The figure below represents the comparison graph between proposed GA and BFO algorithm. The comparison is performed on the basis of number of alive nodes in the network. The graph shows that in GA the amount of alive nodes started dropping after 35000 rounds, whereas in BFO the ratio is dropped after 2000 rounds, but in GA after 4000 rounds the network gets halted because there was no alive node left in the network but in BFO the network is in working condition till 4500 rounds.

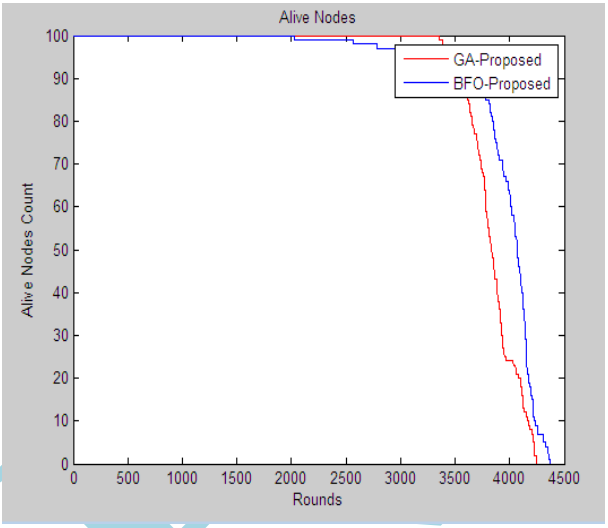

Figure 6.8 Graph showing comparison of alive nodes after each round using GA-Proposed and BFO-Proposed

The figure below represents the comparison graph between proposed GA and BFO algorithm. The comparison is performed on the basis of the number of dead nodes in the network. The graph shows that in GA the first node was found dead between 3000 and 3500 rounds and after 4000 rounds all the nodes were dead. In BFO the first node was found dead after 2000 rounds and after 4500 rounds all the nodes were dead. Hence it shows that the BFO is much more stable as compared to GA.

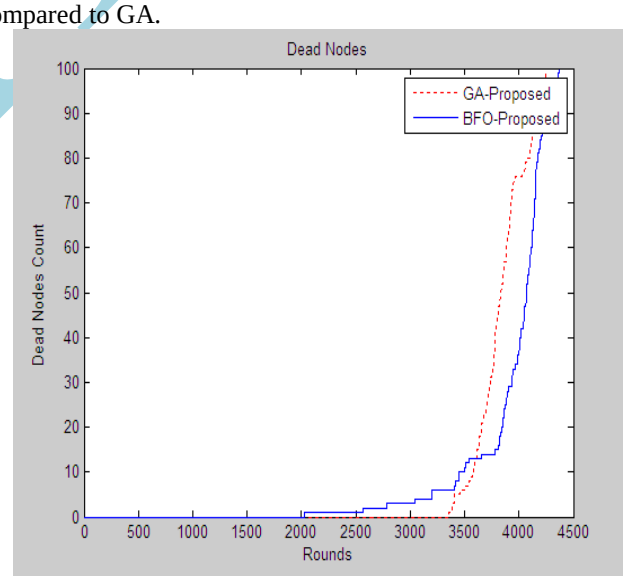

Figure 6.9. Graph showing comparison of dead nodes after each round using GA-Proposed and BFO-Proposed

10. Conclusion

The proposed technique using the QLEACH protocol with optimization technique, i.e. Genetic Algorithm and BFOhas proved to be efficient in terms of energy efficiency and has also improved network lifetime significantly. It can be easily

demonstrated from the results that the proposed technique is better than the conventional technique. When working with QLEACH, all the nodes of the network become dead at around round number 4000 whereas the nodes became dead after 5000 rounds when proposed technique is applied. It can be concluded that the proposed technique works better in terms of increasing the lifetime of the wireless network and in improving the energy efficiency of the network.

In future various parameters rather than energy can be used for selecting the cluster heads such as throughput, delay, packet lost, etc. Various techniques can also be introduced to enhance the work.

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