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# Enhanced Routing Using BBO to Improve Energy Efficiency in WSN

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**ABSTRACT**
Wireless Sensor Networks are networks which are designed of large quantity of tiny and battery dependent sensor nodes. These sensor nodes comprised of limited on-board storage, processing and radio capabilities. Nodes gather or sense the information from the environment surrounding them and then pass it to the central node which is known as Base Station. In view of the fact that the nodes require lots of energy for the handling of data, the architectural protocols and algorithms should be conscientious in order to provide an efficient routing mechanism. Because of efficient routing, the lifetime of a network can be prolonged. In general, the actual life purposes are mainly depending upon the concept of heterogeneity rather than homogeneity so as to provide the routing which should be efficient in nature. Hence, in this paper, an efficient routing protocol is proposed which works upon the implementation of heterogeneous sensors and works on the concept of chain routing. The heterogeneity lies in the terms of energy assigned to different nodes so that the lifetime of network can be prolonged. Simulation results are accomplished to examine the efficacious behaviour of Bio-geography based optimization (BBO) algorithm to crack the energy efficiency coverage problem in comparison to Polination Based Optimization (PBO) algorithm and Ant Scheduling Algorithm (ACA).
**Keywords:** Wireless Sensor Networks (WSNs), Base Station (BS), Cluster Heat (CH), Low Energy Adaptive Clustering Hierarchy (LEACH), Power Efficient Gathering in Sensor Information System (PEGASIS).

## 1. INTRODUCTION

A WSN typically made up of large quantity of sensor nodes which are arranged densely over a certain observable area. These sensors demand little power for their work and also inexpensive in nature [1]. These nodes or devices are integrated with embedded microprocessors, radio receivers and power control mechanism for the sensing, gathering and transmission of data. These nodes sense the environment from the surroundings around them, gather the sensed data and then pass this data to the main or central node which is known as BS. BS then makes link with the client node also called end user. The user then access or collect the data from the BS. This processing and sensing of data is carried out with the technique named as routing. This process provides an efficient path to the nodes. On the basis of routing mechanism, an efficient and secure data can be sent [2].

In order to design efficient protocols for WSNs, it becomes mandatory to comprehend the relevant parameters of sensor applications. As, there are numerous ways in which the properties of a sensor network protocol can be appraised, we employs the following metrics [1].

**i. Effortlessness of Operation**
Sensor networks are formed of few hundreds to thousands of nodes, and require to be arranged in remote or unsafe environments. This allows users to get information in ways that are impossible to achieve in another way. This demands that nodes should be able to make contact with each other even when the network is not recognized by infrastructure or by predetermined node locations [3].

**ii. Configuration Lifetime**
WSNs should do operation for as long as probable. It may be complicated or unfeasible to revive node batteries. Therefore, all individuality of the node, from the design to the protocols, must be anticipated to be extremely energy efficient.

**iii. Latency**
Information from WSNs are typically time responsive, so it is momentous to receive the data in a suitable mode [1].

**iv. Dominance**
The concept of "Dominance" in WSMs is an extraordinary than in traditional wireless networks. In sensor networks, the client node does not requires all the data in the network because of the reason
1) The information from neighbouring nodes are exceptionally connected, making the data surplus to the requirements and,
2) The end user doubts concerning a higher-level enlightenment of actions occurring in the surroundings being ensured. The authority of the network is, therefore, depends upon the fineness of the shared data, so that the protocols should be proposed to optimize for the outstanding and application-specific eminence of a sensor network [1].

There are numerous routing techniques offered for the sensing of data including flat, hierarchical, location based and chain routing. There are devoted protocols which have been realized for routing. These protocols convey the information or data from one node to BS, so that the routing should be efficient. In case of flat routing, each node plays the indistinguishable responsibility and sensor nodes effort together to bring out sensing task. This matter led to the routing which is data centric in nature. In this data centric routing, the BS transmits explorations to confident areas and waits for the acknowledgement from the sensors positioned in the favoured areas [5].

On the other hand, hierarchical routing is one of proficient technique to execute energy-efficient routing. The routing mechanism is separated into two tiers of nodes i.e. higher node and lower node. The higher nodes or devices are intended for the processing and transmission of data whereas the lower nodes are used to check the closeness of an objective. This concept of routing is based upon the two-layered mechanism of routing in which one layer is implemented for the selection of CHs and second layer is used for routing. An imperative example of protocol used in this routing is LEACH which based upon the formation of CHs inside a cluster and broadcast of information to other CHs. These CHs will make a link with the central node or BS [5], [6].

But, due to the formation of CH within a cluster the routing technique requires a large amount of energy. Therefore, the battery gets drained off as within a short time. Hence, to provide more stability, in this paper, PEGASIS protocol is used which is an efficient example of chain routing technique. In this routing, PEGASIS builds a chain in between the nearest neighbouring nodes in order to transmit the data to the end user via BS. PEGASIS protocol is a protocol which depends on the concept of data-gathering in which the establishment of energy savings takes place. The protocol offers the scheme under the condition that when the nodes construct a chain from the first node or from the source node to destination or sink node, then only one node in any particular transmission time-frame will broadcast data to the central node or base station [5].

The integration of information will take place at each and every node within the sensor network. This permits for all noteworthy information to permeate across the network. In addition to this, the standard transmission range requisite by a node to spread information can be much less as compared to LEACH which results in an improvement of energy [7].

## 2. LITERATURE SURVEY

In this part, the brief introduction of the existing work associated with the work is being presented. Numerous routing protocols have been recommended in various reputed works. They can be categorised into many classes like flat routing, hierarchical routing, location based routing and chain routing protocols [6]. One of the most general and efficient paradigm of hierarchical routing protocol is Low Energy Adaptive Clustering Hierarchy (LEACH) protocol [7] which depends upon the implementation of hierarchical routing scheme. The data is transmitted from one node to another by the formation of hierarchy's and Cluster Head (CHs). But, this method was not as efficient as required because of the overhead on nodes which restricts the efficiency of nodes at one level [15].

In the year 2001, Threshold Sensitive Energy Efficient Sensor Network (TEEN) protocol [8] is being proposed. In this protocol, the nodes which are nearer to cluster within a CH have to transmit the gathered data to upper layer. For the formation of clusters, the CHs broadcast two values of threshold. Hard threshold and Soft threshold. The transmission of an event is done by hard threshold whereas the soft threshold prevents the transmission of redundant data. But, this protocol is only suitable for applications related to time-critical application.

Adaptive Threshold Sensitive Energy Efficient Sensor Network (APTEEN) [9] protocol was proposed in 2002 which acts as an extension to TEEN protocol. The main aim of this protocol was to capture time-critical as well as periodic data collections. The architecture of APTEEN protocol is same as that of TEEN protocol. For the formation of clusters, the CHs broadcast the features and the values along with schedule of transmission among all nodes. APTEEN protocol shows better results as compared to LEACH protocol but because of the overhead, this protocol was unable to prove itself as efficient as required.

S. Lindsey and C. Raghvendra in the year 2002 introduced Power Efficient Gathering in Sensor Information Systems (PEGASIS) protocol. This protocol is considered as one of an efficient extension to LEACH protocol. Despite the formation of cluster heads within a cluster, the data is sent to another node by the use of only single node in PEGASIS protocol. Each node in PEGASIS protocol senses the data from the environment around it and transmits the data to another node named as sink node by its compression. The concept of multi hop transmission and the selection of only one node for the transmission of data to BS is one of the major advantages of PEGASIS protocol. The overhead has also been minimized up to a certain extent by reducing the dynamic topology arrangement [10], [11].

## 3. PEGASIS PROTOCOL AND CHAIN ROUTING

PEGASIS stands for Power efficient gathering in Sensor Information Systems. It is considered to be an addition to LEACH protocol. In this protocol the idea of chaining approaches into consideration. The sensor nodes which are located nearest to each other will be considered to build a chain and this chain is responsible for making the connection between the nodes and to communicate with the BS. Only one node will be put into practice from this chain for the transmission to the BS despite multiple nodes. Each node fuses its own data or information with the information of the nearest neighboring node and hence, forming a single packet i.e. the compression of data takes place. This compressed and single packet will be of the same size and convey the fused information to the next sensor node. By default, Greedy approach is implemented in forming the chain. In PEGASIS, signal strength is considered to measure the distance to all the neighboring nodes [12], [13]. This signal strength is accustomed in a way so that only one node can only be heard at a time [16]. A new chain is built using the same procedure when a sensor node dies in a chain because of restricted battery storage [17-19].

## 4. BIO-GEOGRAPHY BASED PROTOCOL

Bio-geography based optimization (BBO) is an evolutionary algorithm which is used to optimize a function by improving candidate solutions. This can be done only with the consideration of a measurement of excellence or fitness function. BBO is based on the concept of population and acts as global optimization algorithm. The algorithm is expanded on the basis of the nature of biogeography. The study of the distribution of animals and plants are mainly done in the concept of BBO among diverse surroundings with time. The results carried out by BBO by many of the researchers are superior as compared to other optimization algorithms include Ant Colony Optimization and Particle Swarm Optimization [21].

BBO is classically implemented to optimize multidimensional functions which are real-valued in nature, but avoids the use the gradient of the task. This means that it does not need the function to be differentiable as essential by classic optimization techniques like gradient descent and quasi-newtons techniques. Hence, BBO can be used on discrete. In the beginning, biogeography was implemented by Alfred Wallace and Charles Darwin [24] chiefly as significant study. On the contrary, in 1967, the work approved out by MacArthur [22] and Wilson changed this point of observation and anticipated a mathematical demonstration for geography. This concept made it reasonable to envisage the quantity of species in a habitat.Mathematical models of biogeography explain speciation (the evolution of fresh species), the migration of species (like animals, insects , birds, or fish) between islands, and the extinction of species. Islands which are pleasant to life are considered to attain a high habitat suitability index (HSI). Features that associate with HSI comprise rainfall, topographic diversity, land area, temperature, vegetative diversity, and many more. The features that conclude are called suitability index variables (SIVs). In terms of habitability, SIVs are the self-regulating variables and HSI is the dependent variable [23].

Islands consisting of high HSI can maintain numerous species and islands consisting of low HSI can bear only a little species. Islands consisting of high HSI have many species which emigrate to close by habitats. This is because of the huge populations and the large statistics of species that they swarm.

The main idea to be put into consideration is that the emigration from an island having high HSI does not happen because species desire to depart their native place. After all, their home island is a beautiful place to live. Emigration arises because of the gathering of random effects on a great number of species with huge populations. Emigration takes place as animals ride swim, fly or ride the wind to the islands neighbouring them. This does not indicate that the species entirely disappears from its original island, when a species emigrates from an island. Only a few numbers of representatives emigrate [16].

Moreover, in BBO it is understood that emigration from an island outcomes in extermination from that island. This supposition is essential in BBO because species signify the independent variables of a function. Each island characterizes a candidate solution to a function optimization issue.

Islands consisting of high HSI not only attain a high rate of emigration, but they also get a low immigration rate because they already have supported numerous species. Species which migrate to such islands will be prone to die soon. This is because of the fact that there is enough competition for the resources from further species. Islands having low HSI consist of high immigration rate because of low populations. This is not possible because of the reason that the species wish to immigrate to such islands because these islands are detrimental places to exist. The reason behind this is that the immigration happens because there exist a lot of space for additional species [25].

## 5. PROPOSED METHODOLOGY

In proposed work, the reduction in energy consumption by sensor nodes from the battery is being focused. By curtailing the energy consumption by the battery, the lifetime of WSNs can be increased. Hence, a scenario has been made in which the nodes look for the shortest path between them, in order to transfer the data from one to another node. This can only be done by the use of PEGASIS Protocol in which the concept of chain routing is used for the construction of chain between nodes.

As, PEGASIS works on the concept of reducing the battery power by nodes with the use of chain method, the nodes then look for the shortest path. Then, PEGASIS is put forward along with Biogeography-based optimization (BBO) algorithm which is used to optimize a function by improving candidate solutions. The flow of work is discussed in Figure 1 which is as follows.

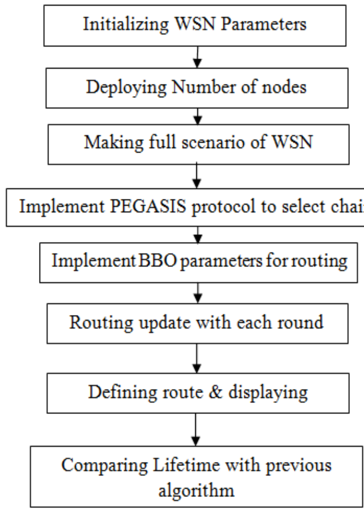


Figure1. Flow of Work

The first step in figure 1 gives the idea regarding the initialization of WSN nodes parameters on which the working of whole of the network depends. The second phase of the proposed work is to deploy the number of nodes in a manner so as to process, gather or transmission of data. The third stage is the making of whole of the scenario of WSN after the deployment of nodes. After this step, an important part of network is put into practice in fourth level when the implementation of PEGASIS protocol is done for the construction of chain by the nodes between the nearest neighbouring nodes. The fifth phase is the implementation of optimization algorithm named as BBO algorithm which gives the idea concerning the emigration of nodes within the network. The sixth and seventh step is the updating of routing as the rounds go on in order to find a highly efficient path.
The results and outcomes are carried out at the step seventh where the comparative analysis of BBO algorithm is carried out among Ant Scheduling Algorithm (ACA) and Polination by Optimization Algorithm (PBO).

## 6. SIMULATION RESULTS AND DISCUSSION

The simulation results have been carried out by using PEGASIS protocol along with BBO algorithm. The work is done on a system having core i5 processor having 4GB of RAM. The simulator used for this purpose is NS2. The parameters of the proposed work are shown in Table 1 as follows.

**Table-1 Parameters of Proposed Work**

| Parameter Name | Value |
|---|---|
| Channel | Wireless channel |
| Propagation | Radio-propagation |
| Number of Nodes | 50 |
| Mobility Model | Random-motion |
| Antenna | Omni antenna |
| Layer | LL Layer |
| Mac version | 802.11 |
| Simulation Time | 150 |
| Routing protocol | PEGASIS |
| Area | 1000*900 |
| Topology | Flat grid |
| Packet Size | 500 |
| Packet Interval | 0.005 |
| Queue | Drop Trail |
| Hello Interval | 2s |
| Traffic Rate(packets/s) | 10s |
| Network Interface | Physical |
| Delay | 25us |
| Minimum Delay | 50us |
| Traffic | CBR |
| Energy | 5j |
| Energy Transmission | 0.0012j |
| Energy receiving | 0.00020j |

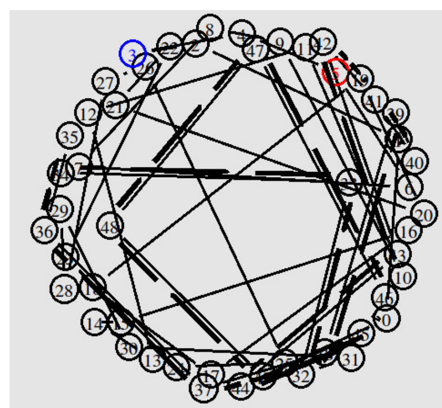

Figure 2. Data Transference from Source to Destination Node

Figure 2 shows the transference of data from the source node to destination node. The node which is red in colour represents the alive node and blue node demonstrates dead node. The node which has residual energy for the transference of information is called alive node which is able to send the data again. On the other hand, the node which become unable to send data again and which has lost its energy. That node is known to say dead node which is represented in red colour.

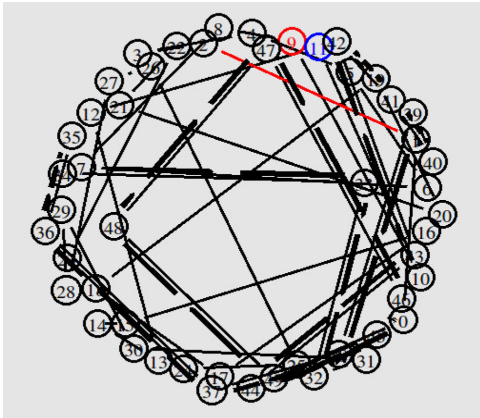

Figure 3. Energy of Nodes

Figure 3 reveals the energy of the nodes. The loss of energy has been denoted by this figure i.e. the amount of energy lost by the nodes while the transference of data from one node to another.

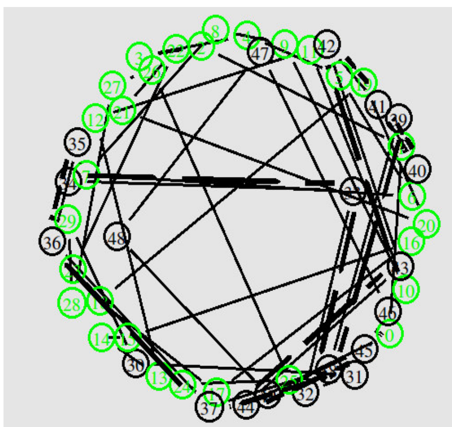

Figure 4. Alive Nodes

Figure 4. Shows that the green nodes are the alive nodes.

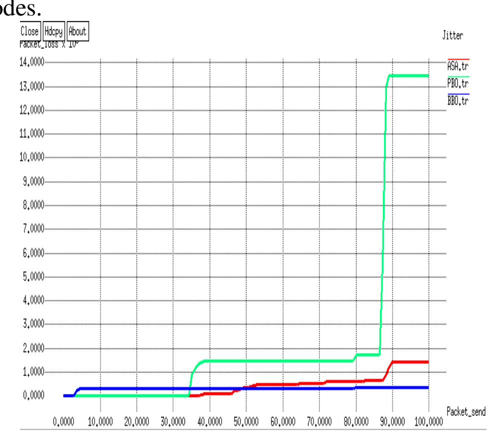


Figure 5. Average Efficiency of System

Figure 5 represents the average efficiency of the system. It shows that with the increase in packet count, the value of packet loss is decreasing. As much the lower value of the jitter more will be the efficiency provided by the system.

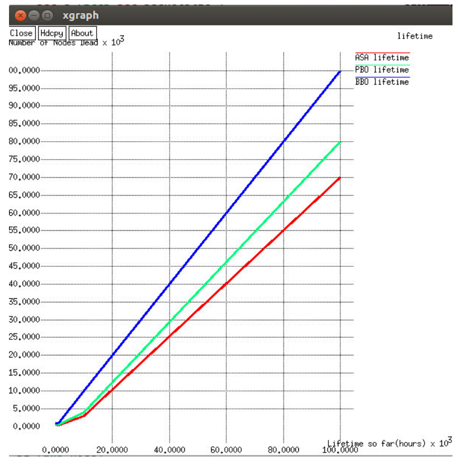


Figure 6. Lifetime of the System

Figure 6 shows the lifetime of the system from the starting node to the dead node by losing its energy in the packet receiving and transmission. The nodes lose some of their energy while the transference of messages from one node to another. The graphical representation shows that BBO algorithm shows the better lifetime of nodes as compared to ASA algorithm and PBO algorithm.

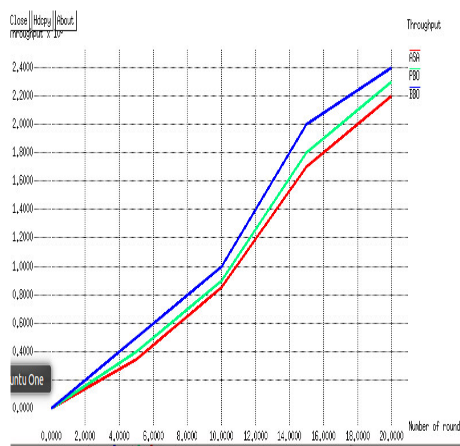


Figure 7. Performance Evaluation of the System

Figure 7 indicates the performance evaluation of the system. It shows the number of packets delivered in a particular time. As no. Of rounds increases, throughput also gets increases. Therefore, by doing this the delivery of packets from one to another node increases.

## 7. CONCLUSION & FUTURE WORK

The implementation of PEGASIS protocol with BBO algorithm in this paper ensures that the PEGASIS which is purely a chain routing protocol can show better results when modelled with BBO algorithm. As, BBO algorithm is optimized the lifetime of network because it works efficiently on real-valued functions and it is multidimensional in nature. This increases the lifetime of network by reducing the consumption of battery. The simulation results show that PEGASIS is continuously building the chain between the nearest neighbouring nodes for the transference of messages or information .The increases the lifetime of a network. This is because of the fact that in PEGASIS the energy of main node or central node i.e. BS is kept larger than that of other nodes. Therefore, the routing becomes optimized with the use of BBO algorithm and hence, the lifetime of a network is prolonged.

The future works will include the analyzation of the performance of network by taking into consideration the loss of signal.Also to minimize the overhead formation by the use of hierarchical PEGASIS.

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