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Energy Efficient B-Leach Routing Protocol

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Abstract— In wireless sensor networks LEACH was the first most Routing Protocol based on clustering concept. In LEACH nodes are deployed randomly due to this clusters size varies dynamically, Cluster heads are selected according to their distances only, transmission residual energy is an unconsidered factor which effect the cluster heads performance in the network. Therefore to overcome this limitation an Energy Efficient B-Leach Routing Protocol proposed which uses the forward/backward multi-hop path approaches to improve the energy consumption of wireless sensor network and prolong its system lifetime. Cluster heads transmits their data information to the base station by using multi-hop path

Keywords— Hybrid, Leach, BCO, BS, WSN

I. INTRODUCTION

In the field of wireless communications and miniature electronics have allowed the development of low-power, low-cost, multifunctional and tiny sensor nodes. These nodes are composed of equipment's that are responsible for sensing, data-processing and communicating. A collection of such sensor nodes, when scattered in one area, gathers data from their proximate environments and coordinate it to execute a certain task. Thus, this collection of sensor nodes can be referred to as a wireless sensor network (WSN) [1] [2]. The basic goals of a WSN are:

- To determine the values of physical variables at a given location like temperature of storage room.
- To detect the occurrence of events like how many time temperature drops below 30 degree.
- To estimate parameters of the detected event or events what's the current temperature
- To classify a detected object
- To track an object.

Sensor nodes are used in a wide variety of applications which requires constant surveillance of particular events. Smart sensor nodes can be built into daily use appliances such as ovens, microwaves, refrigerators which enable them to interact with each and be remote controlled. This type of WSN application proved us a smart environment in which adapt according to the user preferences. Military applications include 24 hours surveillance, guidance system for missiles and provide security assistance from mass destruction. A patient can be monitored remotely by a doctor using WSN. This is more convenient for the patient, it allows the doctor to have better understanding about the patient's current condition. Sensor networks can also be used for detecting foreign chemical agents in the air and the water. They help in identifying the type of object, concentration and location of pollutants. The wireless sensor networks will provide the end user with intelligence and a better understanding of the environment [1].

A. Routing Protocols for WSNs

Wireless sensor networks, is a self-establishing multi-hop wireless network, which works as a decentralized system and it does not pose fixed infrastructures. Conventional routing protocols do not compatible with at present WSN requirements: Sensors have low battery power, limited memory, the routing tables raise up with the network size and don't support diffusion communication. This is the main reasons to build more an energy efficient routing protocol for WSNs. [3] [4]

The accountabilities of a routing protocols includes exchange the route information, finding the feasible path to the destination based up on hop length, minimum energy required, and lifespan of the wireless link, gathering information about path failure, mending the broken paths, consuming minimum processing power, bandwidth and exploiting minimum bandwidth.

Classification of Routing Protocols: WSNs might be have network structure based or the protocol operation based routing protocol. Routing protocols in WSNs may varies according to the application of network.

- Location based Protocols: In this case sensor nodes are addressed by their own locations. The distance between two nodes can be estimated depending upon the incoming signal strengths from the source nodes.
- Hierarchical Protocols: The nodes having higher energy are used for processing and sending the information while the other nodes with low energy are used for performing the sensing activity near the target.

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- Flat-based Protocols: Each node plays the same type role and number of sensor nodes collaborate to carry the task of sensing.
- Data centric Protocols: The local data processing on the nodes can be differentiate between the coherent (minimum processing) and the non-coherent (full processing) routing protocols.
- Multipath based Protocols: It uses multiple paths rather than single path for enhancing the network performance. For instance the fault tolerance can be increased by maintaining multiple paths between the source and sink.
- Negotiation-based routing: The negotiation based routing is done for eliminating the redundant data transmission. In this the communication decisions are made based on the sources available in the network scenario.
- Query based protocols: The destination nodes propagates the query for data from a node through the network.
- QoS-based protocols: When process of data in ongoing with the help of this routing, it balances the network in between energy consumption and data quality through certain QoS metrics such as delay time, energy used or the bandwidth.

II. REVIEW OF LITERATURE

In clustering, sensor nodes organized into clusters, each cluster operate by cluster head. The nodes in each cluster exchange their message with respective to their cluster-heads and these heads send messages to a base station by using two hops count distance. BS acts an access point connected to a wired network.

A. LEACH

LEACH Protocol is the first most protocol of hierarchical routing that has proposed data fusion, it has milestone significance in the clustering routing protocols. Many hierarchical routing protocols are improved based on LEACH protocol [8]. It is self-adaptive as well as self-organized. LEACH protocol use its round as unit, each round is made up of two stages (cluster set-up stage and steady stage), for the purpose of reducing unnecessary energy costs, the steady stage must be much longer than the set-up stage

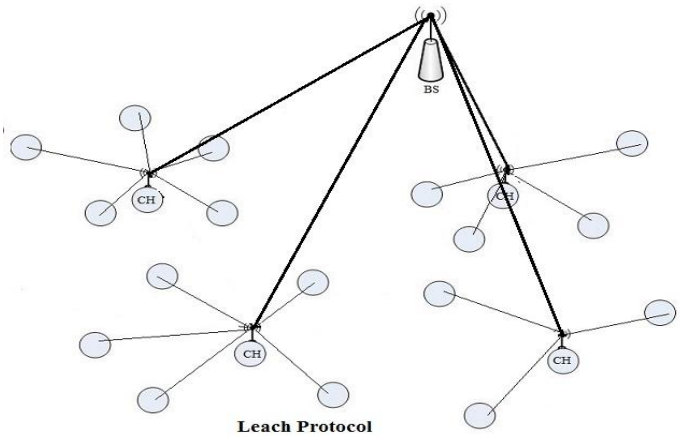

Fig 1 Leach Protocol

Advantages: It provides the best feature of scalability in the network by means of limiting most of the communication inside the different clusters of the network. Single-hop routing is possible from sensor node to cluster head and by this we are able to save the energy of the network. Distributiveness property within the cluster, where it distributes the role of CH to the other cluster members within the clusters. It does not require the information of the location of the sensor nodes in the net-work to create new clusters. It provides the dynamic clustering approaches. It is well-suited for the applications that needs constant monitoring of the environmental.

Disadvantages: It significantly relies on cluster heads rather than the cluster members of the cluster for having communication with the sink. It incurs additional overheads due to the process of cluster head changes in each iteration of the communication of information. There is no inter-cluster communication in the networks because the CHs can directly communicate with the sink. This process requires high range of the transmission power in the network. In LEACH CHs are not at all uniformly distributed within the cluster that means the CHs can be located at the edges of the clusters. In LEACH, CH selection is a random process, which does not take into considerations the energy consumption of the different nodes within the cluster along with the CH into account and this leads to the reselection of CH as the same node in many simultaneous iteration of data processing in the network. It does not work well with the applications that requires large area of coverage along with the multi-hop inter-cluster communication.

B. Bee Colony Optimization

BCO algorithm is consider as family of Swarm Intelligence approach, where the agents take the artificial behaviour of honey bees and communicate by mechanism called "Waggle Dance" and exchange information regarding rich food source's location. A typical hive may have 2,000 to 10,000 individual bees. 20 to 40 days old mature bee become foragers.

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Food source: Before selecting a food source, forager bee evaluates its several properties like its distance, quality, nectar taste etc.

Forger are of three types:

- *Active forgers:* Travel to a food source, examine neighbour food sources, gather food and return to the hive. An active foraging bee continually gathering food from a particular food source until that food source is exhausted, this time active bee becomes an inactive forage.
- *Scout forgers*: Investigate the area surrounding of the hive and looking for attractive new food sources. Roughly 10 percent of foraging bees in a hive are employed as scouts.
- *Inactive forgers*: After some time forger become inactive and wait near the hive entrance. When active foragers and scouts return to the hive, according to the quality of the food source they have just visited, they may perform a waggle dance to the waiting inactive bees. This waggle dance conveys information to the inactive bees about the new location and quality of the food source. After receive this food source information inactive foragers may become active foragers.

Basic Principle of Artificial Bee colony

Initialize Population

Repeat

- Place the active bees on their food sources
- Place the inactive bees on the food sources depending on their nectar amounts
- Send the scouts to the search area for discovering new food sources
- Memorize the best food source found so far until
  Requirements are met

Scout bees chooses a food source depending on the probability value associated with that food source

$$\mathrm{pi} = \frac{\mathrm{fit_i}}{\sum_{n=1}^{SN} \mathrm{fit_n}} \qquad (2)$$

SN is the food source which is equal to the number of active bees and fit_i is the fitness value of solution i which is proportional to the nectar amount of the food source in the position i.

Normalization value of pi [0, 1].

In order to calculate the fitness values of solutions we use the following equation. *Fi* is the fitness function which can be modified according to application.

$$fit_i = \begin{cases} \dfrac{1}{1+fi}, & fi \geq 0, \\ 1 + abs(fi), & fi \leq 0 \end{cases} \qquad (3)$$

III. METHODOLOGY

Our proposed Methodology is divided in three parts setup phase and route searching, steady phase. BS is a base station, CH is cluster head.

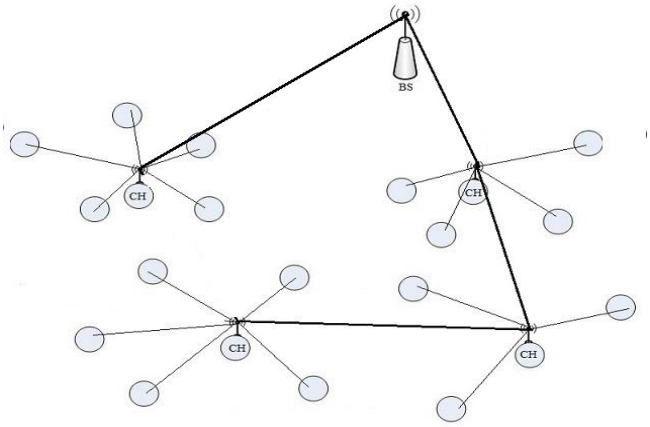

Figure 2 Proposed model wireless sensor network

Setup phase

- Sensor nodes and base station are deployed in the sensor field.
- Invitational parameters are provided to sensor nodes so that they can start working.
- Cluster head is selected with the help of equation (1) and sends the information about clusters to the base station. The information from base station is sent back to all nodes so that they can select their cluster heads.

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- After step up phase complication we establish a cluster head link with base station and base station also have information about all node id's and their respective cluster heads

Route searching

- Cluster heads distributed in three different groups active, scout, and inactive forger.
- Multi-hop forward and backward path is computed between cluster heads and BS with equation (2), (3) and by modifying fitness function as follow:

$$fi = \sqrt[2]{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

x and y are the position co-ordinates of the sensor nodes.

Steady Phase

Time division multi access (TDMA) approach principle is used. In a particular time slot non-cluster head sensor nodes send their data to the respective cluster heads. Due to non-uniform distribution of nodes some cluster heads either nearby or far away from the base station. A multi-hop path is followed by cluster heads to transmit aggregate data to the base station. As a result, energy consumption by cluster heads gradually reduced and increased network life time.

Results and Performance Evaluation

In our simulation we have used java programing. Experiments are performed on simulations with different numbers of sensor nodes uniformly distributed in a 100 m×100 m. Base station is located at position [75,100] with similar parameter used in [1].

We use four performance metrics to evaluate the performance of proposed algorithm. Simulation is run on different number of nodes to check the network performance with increase in network load.

Average throughput: It is the ratio of total packets received at BS to total packet generated by nodes. Fig 3 represents the average throughput of the Bee-Leach and Leach protocol graph hence with increased in network life time the average throughput also increased.

Energy efficiency: It is the total energy consumed in delivering 1000 bits of data to the base station (j/Kbits). Fig 4.represents the Energy efficiency graph proposed algorithm consumed less energy as compare to Leach protocol.

Network Life time: **T**he total number of nodes which are alive at end of all cycles of the algorithm. Fig.5 shows that at different node value proposed approach always runs more cycles as compare to leach protocol

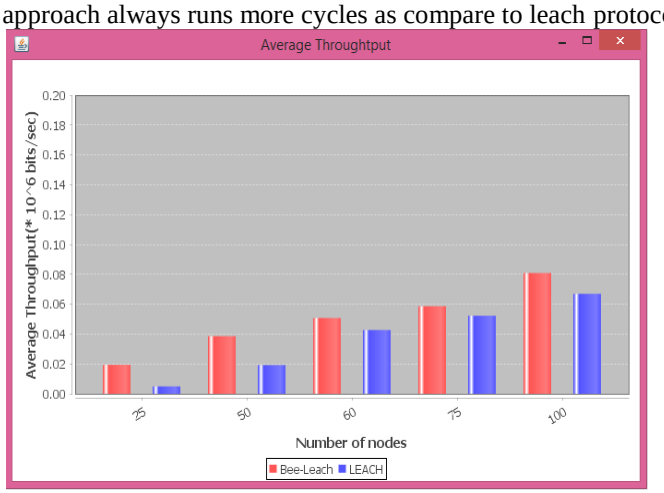

Fig 3 Average Throughput**.**

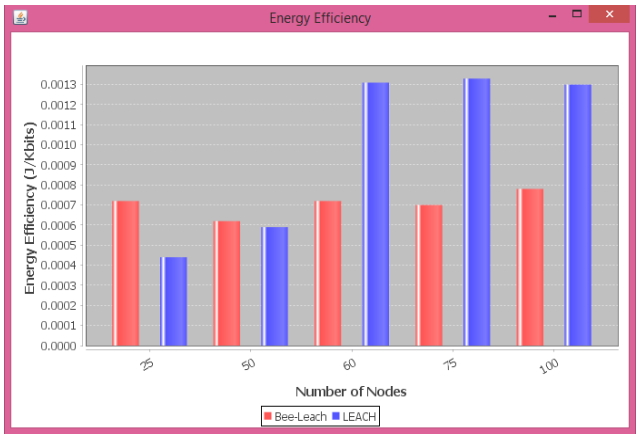

Fig 4 Energy efficiency

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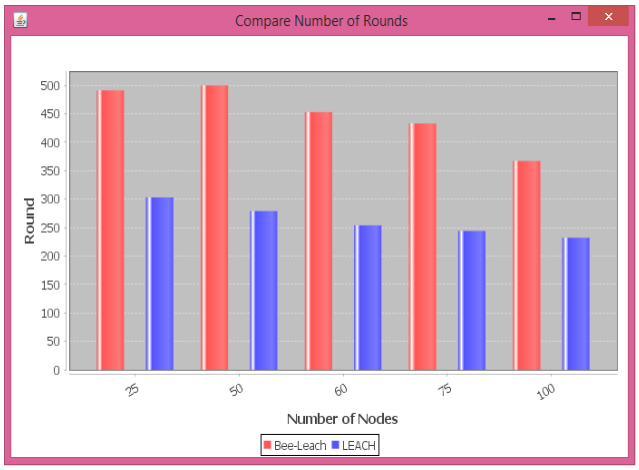

Fig 5 Network Life Cycle

IV. CONCLUSION

The LEACH protocol had some limitations like energy consumption, network life time, network delay etc. These type of limitations reduced the LEACH performance. To improve them a new Energy Efficient Routing Protocol is proposed. As a result optimized routing path reduce the energy consumption by using multi-hop routing among clusters heads. An average throughput of network, average energy consumption and network durability improvement is the main concern of the study with the help of research methodology that is proposed in this paper. In future work we try to balance load among cluster heads and compare proposed algorithm with other swarm approaches.

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