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# Electing a Cluster Head using Distance-Energy Clustering with BEE Optimization in WSN

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**Abstract**
*Wireless Sensor Network (WSN) is built of several sensor nodes with limited resources such as storage, battery usage and so on. These nodes may vary in size, topology and cost. The main issue in WSN is life time of the network. Energy consumption of Cluster Head (CH) is more when compared to other nodes. Hence the selection of CH affects the network lifetime. In this paper, distance and energy are the parameter that are used for selecting a CH. The proposed approach, Distance-Energy Clustering (DEC) with BEE optimization technique is used to maximize the network life time and also helps in reducing its energy consumption. Recent applications of wireless system are more beneficial than the legacy system.*

**Keywords**
*Wireless Sensor Network, Cluster Head, Base Station, Network lifetime, Distance Energy Clustering.*

## I. Introduction

WSN is a collection of multiple nodes that are well liked for their low price solutions to many here and now dare with limited resources such as battery, memory, computational power, storage and so on. WSN are spatially distributed sensors that are mainly used to monitor the state of environment with regard to its appearance. WSNs play a powerful part in the upcoming age group in order to sense the natural environment. This network has numerous attributes which are different from the common systems. Due to the needs of WSNs and its operating domain some of the issues including its topology, size, cost constraints and operation of nodes should be carefully considered.

In WSNs, a sensor node is the most important element and these nodes may vary in size, cost and topology. Effective communication can be achieved by Routing. Neighboring locations in this network are discovered by the sensor nodes and later on it conveys the discovered data to the base station (BS) or the sink by using Routing method. Besides sensor nodes, BS is another fundamental element that is found in WSNs and it is mainly used to interact with the end user. Routing method used in WSNs must ensure that the energy consumption is minimized and thus the duration of the network is improved. This states that, it not only concentrates on the effectiveness of energy but it also concentrates on the energy balance [3].

In WSN, Clustering and multipath are the most widely used routing methods. Multipath routing consists of multiple paths from source to destination. This helps in selecting a better path when the present path fails to reach the destination. Grouping a large number of objects is referred as Cluster or Clustering. Each cluster consists of one cluster head (CH) and several cluster members, where the CH acts as a leader. There are various clustering algorithms and they can be differentiated based on their cluster model. A best result for the clustering data is achieved by the bio-inspired algorithm [1]. Bio-inspired algorithm tries to solve different problems in WSNs by using various concepts.

## II. Related Work

To evolve a low power sensor application, several issues are related. That is nothing but using the current energy of the network in the well-organized way without affecting the performance. Here batteries acts as a power source with limited duration or lifetime. Hence the capability of energy management plays an important role in the design of WSN [2]. The main problem in the WSN is the network lifetime. The lifetime of the WSN can be improved via delivering a maximum data with minimum energy consumption. This can be referred as data collection. Its main aim is to collect data from various sensor nodes and pass the collected data to the CH and finally to the BS.

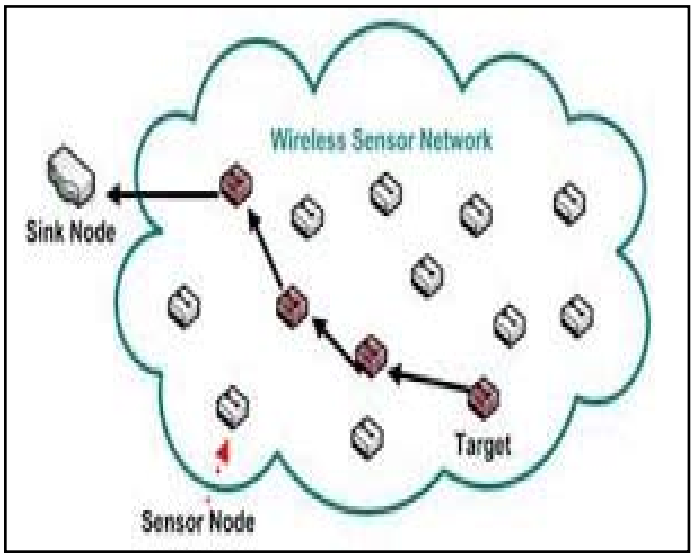


Fig.1 : Architecture of wireless sensor network

Clustering is the foremost method that is used to improve the network life time by consuming less energy.

Few advantages of Clustering:

- Reduces the routing table size stored at each nodes.
- Battery life of the whole network is improved.
- Number of redundant packets will be minimized by the data collection performed by the CH.

We now briefly present some of the well-known protocols for the cluster formation and cluster head selection.

An energy-efficient clustering protocol LEACH, employs a hierarchical clustering based on the data received by the BS. In such cases, BS periodically changes the cluster member and the CH in order to conserve energy. This periodic change of CH may result in reducing the duration of the network. LEACH protocol is self-adaptive and self-organized [7]. LEACH protocol is deliberated to balance the energy consumption of the network.

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Selection of CH using this LEACH protocol has some of the issues,

- At the same time, very big and small clusters may occur in the network.
- Neglects the residual energy and some other important aspects such as its location, distance and so on. This results in the failure of CH.
- Once the CH is dead, the members of that cluster lowers the energy.
- Unnecessary CH selection without the knowledge of its energy.
- Although LEACH is a simple protocol, it is not an energy efficient protocol because of its irregular CH distribution.

The power efficient clustering protocol PEACH is used to avoid the additional overheads in which the cluster formation is done by using various attributes of wireless communication [6]. PEACH supports adaptive multi-level clustering. In addition to this, PEACH can be used for both location-unaware and location-aware networks. This protocol is used for maximizing the lifetime of the wireless sensor networks. It operates on probabilistic energy-aware routing protocols

Karaca et al. [4] proposed Analytic Hierarchy Process (AHP) that is used for centralizing CH selection scheme. Based on the mobility and remaining energy of the sensor nodes CHs are selected in each cycle. It is reported that the AHP approach improves the network lifetime remarkably.

Distributed hierarchical agglomerative clustering (DHAC) [5], provides a bottom up clustering approach before electing a CH by grouping similar nodes together. DHAC can accommodate both quantitative and qualitative information types. DHAC avoids reclustering and also achieves uniform energy dissipation by automatic CH rescheduling and rotation.

Multiple criteria decision-making-based approach, trapezoidal fuzzy AHP (FAHP), and hierarchical fuzzy integral [8], have been investigated in clustering on WSNs. The selection of CH uses three criteria including the location, quality of service impact and energy. Based on these three criteria, individual node in a network calculates the composite value by using fuzzy integral. The network lifetime can also be increased by using various techniques.

Artificial Honey Bee algorithm [2] was invented by Karaboga for solving various WSN problems. It is a simple swam based technique used in WSN. Every individual node calculates its fitness value and CH is selected based on its best fitness value.

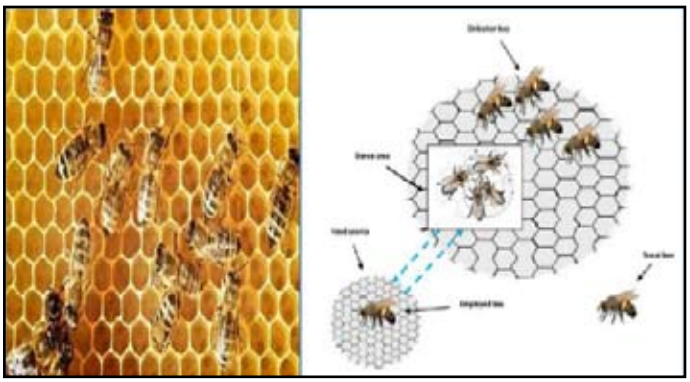

Fig. 2: Artificial Honey Bee

Artificial bee colony includes three types of bees: employed bees, onlooker bees and scout bees. Employed bees goes in search of food, whereas the onlooker bees wait on its dance floor for making decision to select a food source. Scout bees leave the hive in order to find new food source.

ABC includes three phases of operation:

#### 1) Initialization Phase

In the first stage, the sensor nodes are positioned with different energies over a flat area. This can be achieved by using random locations in the network.

#### 2) Structure Phase

This phase deals with the cluster formation. The flat area is grouped into several equal groups and the sensor nodes belonging to the same group forms a cluster. The CH is selected based on its highest residual energy and its main duty is to collect data from all the other nodes in that particular cluster, and forwards the data to the BS.

#### 3) Steady-State Phase

This is the final phase which includes the communication between the CH and the BS or sink node. Once the CH has been selected, every node in a cluster interacts with the CH using TDMA schedule, and then it communicates with BS. Balancing of the energy among the CH can be done by using different CH based on its rotation, which in turn improves the life of the cluster.

## III. Proposed Model

### A) Honey Bee Concept

Some of the insect's groups such as Honey bees have various beneficial characteristics in this network. These groups are created with easy and collective organisms that are mutually dependent for their survival. The enclosed structure in which some honey bee species live and raise their young ones is known as Hive. The population of bees is grouped into three: scout bees, employed bees and the onlooker bees. Onlooker and scout bees are unemployed bees. An employed bee explores numerous food sources and these provide the collected information to the onlooker bees. Based on the information received from the employed bees, onlooker bees select their food sources probabilistically. Scout bees are considered to be unemployed bees and these bees choose their food sources randomly not depending on any criteria.

### B) Network Model

We assume that WSN is a collection of several nodes, where the nodes can be a CH, sensor and the BS. Most often BS are thought as a central component that is mainly used to collect data from various distributed nodes. BS has high computational power and it handles traffic in the network. In this network model, BS acts as a HIVE. A cluster consists of several sensor nodes. Nodes can either be a sensor nodes or a CH. Senor nodes gathers sensory information and it communicates with the other nodes in the network. Each cluster consists of single CH whose responsibility is to collect the data from the remaining sensors and pass the collected data to the BS. Among several nodes one node will be elected as a CH based on its residual energy and distance factor. Fig 3: a simple cluster includes a possible cluster head (PCH), which is elected when the CHs energy is drained completely. The CH is selected among the PCH.

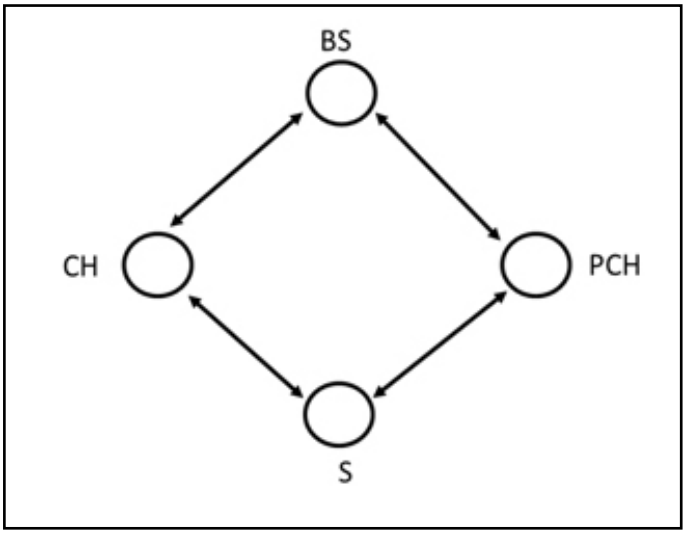


Fig. 3: Simple Cluster Formation

### C) Distance-Energy Clustering (DEC):

The main issue in WSN is life time of the network. DEC with BEE optimization technique is used to maximize the network lifetime. BS requests for the cluster formation. Upon receiving the cluster formation request, the neighboring nodes of the BS updates the request and forwards the updated request to the sensor. Senor acknowledges (ACK) to the cluster formation request. When the BS receives the ACK from the sensor, it requests for the data. As we are using Honey Bee Concept, request for data can be considered as a food source. Sensor sends the sensed data to the BS via CH. CH is elected based on its distance and energy factors.
CH is selected by using the formula

$$C_i = \left\{ \frac{1}{b_i + d_i} \right\} e_i$$

where,
bi is the distance between the sensor and the ith node,
di is the distance between the ith node and the BS,
$e_i$ represents the energy of the ith node.

### D) Close-Fisted Model

In case of multiple networks, the close-fisted model (CFM) is used. CFM considers only the next neighboring hopes for the selection of CH. A CFM is a method that follows the problem solving heuristic of making the locally optimal choice at each stage with the hope of finding a global optimum.

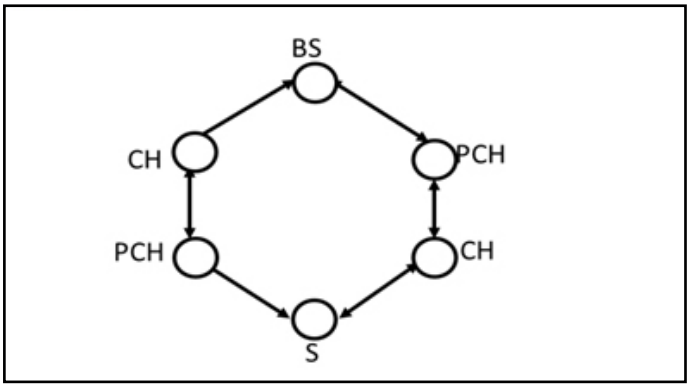


Fig 4: Cluster for CFM

In CFM, we can make any choice that seems perfect at that particular moment and later on solve the sub problem that arises. BS elects the CH among its next adjacent nodes in order to communicate with the sensor. Similarly second level nodes elects its CH among its adjacent nodes. CFM is used to find the optimal path. It makes one choice after another by reducing the problem into smaller one.

## IV. Conclusion

On the basis of Honey bee, this paper proposes DEC technique which is mainly used for selecting an efficient CH. DEC considers the distance and energy factors for enhancing the selection of CH within the cluster. The main goal of this technique is to improve the lifetime of the network as well as improves the overall network performance.

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