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Enhanced Distributed Energy Efficient Clustering Scheme Using Artificial Bee Colony Algorithm for Heterogeneous WSNs

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Abstract:
Wireless Sensor Network (WSN) consists of several distributed sensor nodes. It is used for several military applications, environmental applications and health related applications. The main problem in WSN is the lifetime of network. The lifespan of sensor network depends on battery unit. To support scalability, nodes are often grouped in clusters having a leader, often referred as Cluster Head (CH). Artificial Bee Colony (ABC) algorithm which increases both lifetime and throughput of network. ABC algorithm that involves inspiration from foraging principle of honey bees, has been effectively utilized in our technique. Keeping multiple food source, a characteristics of ABC, is incorporated to enhance network lifetime and reliability of our scheme. Waggle dance, for multiple interaction and information sharing, is utilized to optimize the CH selection. A CH is responsible for not only sending data to base station but also assist the general nodes to send sensed data to target nodes. The energy consumption of CH is greater than general nodes. Therefore CH selection will affect the lifetime of WSN. In this paper, an approach is introduced for the selection of cluster head by using swarm intelligence.
This proposed approach is based on Energy Distributed Clustering (EDC) algorithm. This approach helps in reducing the energy consumption. This proposed technique works in three stages: Cluster sends data to CH, CH sends data directly to Leader and leader sends data to BS.

Keywords: Artificial Bee Colony, Cluster Head, Energy Distributed Clustering, Waggle dance, Wireless Sensor Network

I. INTRODUCTION

Wireless Sensor Network (WSN) consists of large numbers of sensor nodes which are deployed in harsh and inaccessible terrains. WSN is very popular for monitoring the remote environments .These sensor nodes monitors the parameters like temperature, humidity, vibration, etc. After monitoring these parameters it processes these data and transmits it to the base station or main location. Data is transfer to the main station in multi-hop routing

Limited memory and battery power are main constraints in WSN. So, it transmits data to Cluster-Head (CH) of the cluster instead of direct transmission to base station. Fig1 represents the Clustering Model. Transmitting data to CH is more energy efficient than direct transmission. The main idea of clustering is to use Cluster-Head to collect data from other nodes and send it to base station. It reduces the energy dissipation of other nodes. Some of the advantages of clustering are: Size of routing table stored at individual nodes is reduced. Battery life of individual sensor and whole network is extended. Data aggregation is performed by CH in its cluster which decreases the number of redundant packets. Scheduling the activities in CH can reduce energy rate.

The power consumption between two nodes is based on transmission distance. As the distance increase more power will be consumed. Since the hierarchical architecture provides more flexibility to handle data routing problem, it is applied extensively to WSNs. To preserve the energy consumption in WSN there are numbers of relevant energy saving techniques, which increase the network lifetime.

In this paper, we are going increase the network lifetime by using Energy Distributed Clustering protocol with Honey Bee Optimization technique (EDC-HBO). With these algorithms we will select the high energy cluster head which will devote less energy while transmitting aggregated data to base station.

Swarm Intelligence SI is a computational approach, that depends on study of collective behavior of social insects in decentralized, self- organized systems. Ant Colony Optimization and Bee Colony Optimization are widely studied among the other Swarm Intelligence techniques utilized for networks.

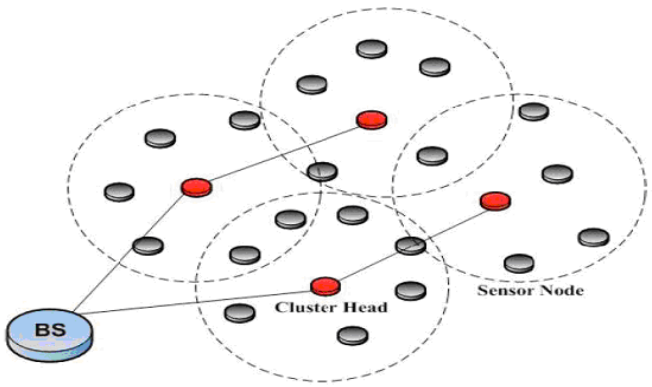

Fig 1. Clustering Model

II. RELATED WORK

In this section we have presented several existing methods in the literature for energy efficient cluster head selection in wireless sensor network.

A. Low Energy Adaptive Clustering Hierarchy [1]

Low Energy Adaptive Clustering Hierarchy (LEACH) is a cluster based protocol. It organizes nodes into clusters with one node from each cluster serving as a cluster-head (CH). LEACH randomly selects some predetermined number of nodes as cluster heads. CHs then advertise CH claim packets and other normal nodes join one of those cluster heads whose signal they found strongest. In this way a cluster is formed. The CH then makes a Time Class Multiple Access (TDMA) schedule for the nodes under its cluster. The communication between different clusters is done through CHs in a Code Division Multiple Access (CDMA) manner. The CHs collect the data from normal nodes of their clusters and aggregate it before sending it to the other CHs or base station (BS). After some predetermined time lapse, the cluster formation step is repeated so that different nodes are given a chance to become CHs and energy consumption is uniformly distributed.

B. PEGASIS: Power-Efficient Gathering in Sensor Information System [2]

By this author proposed algorithm PEGASIS that is a chain based protocol provide improvement over LEACH algorithms. In PEGASIS, each node communicates only with a close neighbor and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. Using greedy algorithm, the nodes will be organized to form a chain, after that BS can compute this chain and broadcast it to all the sensor nodes.

The main idea in PEGASIS is for each node to receive from and transmit to close neighbors and take sums being the leader for transmission to the BS. This approach distributes the energy load evenly among the sensor nodes in the network.

C. EECS: Energy Efficient Clustering Schemes [3]

In EECS, cluster formation is different from LEACH protocol. In LEACH protocol cluster formation takes place on the basis of a minimum distance of nodes to their corresponding cluster head. In EECS, dynamic sizing of clusters takes place which is based on cluster distance from the base station. The results are an algorithm that addresses the problem that clusters at a greater distance from the sink requires more energy for transmission than those that are closer. EECS is a LEACH-like clustering scheme, where the network is partitioned into a set of clusters with one cluster head in each cluster. Communication between the cluster head and BS is direct (single-hop). Each node can compute its approximate distance to the BS based on the received signal strength. This helps nodes to select the proper power level when they communicate with the BS.

D. Hybrid Energy-Efficient Distributed Clustering[4]

HEED considers a hybrid of energy and communication cost when selecting CHs. Unlike LEACH, it does not select cluster head randomly. Only sensors nodes that have a high residual energy can become cell-head nodes.

HEED has three main characteristics:

1) The probability that two nodes within each others transmission range becoming CHs is small. Unlike LEACH, this means that CHs are well distributed in the network.

2) Energy consumption is not assumed to be uniform for all the nodes.

3) For a given sensors transmission range, the probability of CH selection can be adjusted to ensure inter-CH connectivity.

E. Energy Efficient Chain Based Routing [5]

The proposed protocol organizes sensor nodes as a set of horizontal chains and a vertical chain. In each chain, a node is selected as chain head. For selecting the chain heads in horizontal chains, EECBR considers residual energy of nodes and distance of nodes from the header of upper level. In each horizontal chain, sensor nodes transmit their data to their own chain head based on chain routing mechanism. EECBR also adopts a chain based data transmission mechanism for sending data packets from the chain heads to the base station.

III. PROPOSED SYSTEM

Using honey bee algorithm in WSN, each node calculate its best fitness value to elect as cluster head. Initially, honey bee optimization is explained and then proposed EDC-HBO algorithm is described.

A. Honey bee optimization

In ABC[6], search procedure is carried out by three groups of bees as employee, onlooker and scout bees. Employed bees search food sources within the neighborhood of the initial food sources in their memory and they share new food sources information with onlooker bees. These onlooker bees then search a new food source according to the received Information, i.e., finding out a new one from the neighborhood of existing food sources. Scout bees search a new food source randomly when an employed bee abandons a food source.

The quality of a food source, i.e., the amount of nectar, is evaluated by its fitness value. Then, the algorithm calculates all the food sources' selection probabilities by their fitness values. The onlooker bees select the food source with the largest probability value and produce a modification on the position of the food source. The fitness value of the new food source is calculated and compared with the fitness value of the old one. Then, the food source with the larger fitness value is recorded as the temporarily best solution. The best food source is iteratively updated for certain iterations.

$$fit_{i=1/1+f_i} \quad (1)$$

Where f_i is the cost function of clustering problem and fit_i is fitness of solution in eq. (1)

Food source chosen by onlooker bee depend on the probability value associated with that food source p_i. It is calculated by:

$$p_i = fit_i / \Sigma^{SN}_{n=1} * fit_n$$

Where SN is the number of food sources equal to number of employed bees.

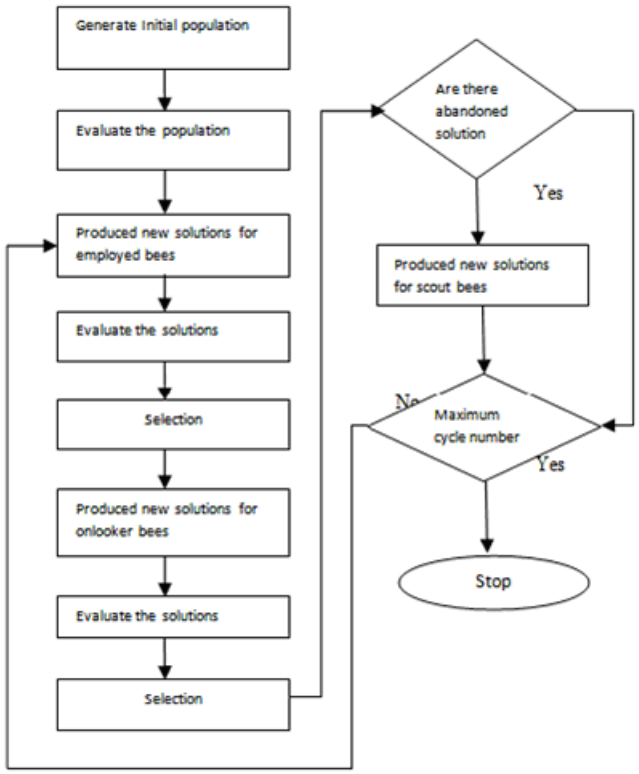

Figure 2. Shows the flow chart for Artificial Bee Colony Algorithm

Figure 2. Shows the flow chart for Artificial Bee Colony Algorithm. the first half of the colony consists of employed bees and the second half consists of onlooker bees.

B. Description Of EDC-HBO

Proposed clustering algorithm is divided into three phase: initialization, set up phase and steady phase.
These are explained below.

A. Initialization Phase

Sensor nodes are deployed over flat area with different energies randomly. Random deployment is achieved by choosing random locations in coordinate system.

B. Setup Phase

The setup phase consist of cluster formation. The flat area is divided into equal parts, nodes belong to same part form cluster. Cluster head having highest energy is nominated as leader cluster head its responsibility is to communicate with all sensor nodes within that cluster, gather the data and sends to base station.

C. Steady Phase

In this phase, once the leader among the cluster heads is identified, it takes the ownership of the communication. Sensor nodes communicate with the leader cluster head based on TDMA schedule and in turn it communicates with sink. After each round of communication based on the energy levels of cluster heads leadership is rotated. Rotation of the leadership allows balancing of the energy consumption among the cluster heads and prolongs life of cluster thereby sensor network.

D. Algorithm

- Form the cluster based on x, y location of grid.
- Select high energy node as a cluster head within in cluster as leader.
- Leader sends join request message to all sensor nodes within the given cluster.
- Leader CH is selected as highest energy node.
- Sensor node within the cluster communicates the sensed data to CH in allocated time using TDMA schedule.
- CH collect data from all nodes in its cluster.
- CH transmits data to sink node.

IV. CONCLUSION

In clustering hierarchy, the cluster head selection is a major challenge. If network is taken as a whole, them the power consumption can be optimized by the rotation of this cluster head inside the individual clusters. Energy conservation is a significant concern in the WSNs. This paper proposes EDC-HBO a cluster head selection algorithm for effective cluster head selection. The mail goal of EDC-HBO is to enhance the network lifetime as well as to improve the power consumption of network by considering the energy and distance factor as parameter to improve cluster head selection.

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