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Data Collection from Clusters in Wireless Sensor Network with Help of Mobile Nodes

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Abstract: ***In a wireless sensor networks, there are large numbers of sensor that are used to collect data from the network whenever any event occurs. These sensor nodes are placed at large distance from the base station. Genetic algorithm (GA), artificial bee Colony (ABC) algorithm or Particle Swarm Optimization (PSO) algorithm can be used to form clusters. The data transmission range of sensor node is limited, so the clusters of sensor nodes are formed with the help of any optimizing algorithm. The multiple mobile nodes are going to collect the data from those cluster heads. The ABC-MMN algorithm is used to minimize the energy consumed by the cluster heads. Also, multiple mobile nodes would be used to reduce the traveling cost. The pre-computed path is being used for data collection on the basis of the clusters formed by optimizing algorithm.***

Keywords: Multiple Mobile nodes, Clustering, Data Collection, ABC-MMN algorithm, Wireless sensor Network.

1. Introduction

In a Wireless sensor network, recent research works have proved that dynamic mobile nodes are playing a vital role instead of static sensor nodes for data collection. In static network, it is considered that the sensor nodes are highly populated. The communication between those nodes is possible through multiple hops because of highly populated network [1]. The data is transferred from one node to another till it reaches the sink node.

Instead of considering the high population of sensor nodes, let us assume that those nodes are not able to communicate with each other. In such scenario, a mobile sensor node could be used to collect the data from static sensor nodes [2]. The problem with usage of single mobile node is time consuming. The energy of static sensor node is dependent on a small battery supply which has limited energy. The transmission of data done by each static sensor node consumes energy of each node. So clustering of static sensor node is done in order to prevent the energy consumption of static sensor node for transmission of data. Also, multiple mobile nodes move around the wireless sensor network to collect the data from the heads of the cluster. In this paper, the survey is done on clustering of nodes on a regional basis and multiple mobile nodes collecting the data from cluster heads.

The rest of the paper is organized as follows. Section 2 provides a brief overview of the literature. Section 3 gives the architecture of multiple mobile nodes. Section 4 introduces the Artificial Bee Colony Multiple Mobile Nodes Algorithm. Section 5 shows the performance and the result of our proposed algorithm. Section 6 gives the applications of multiple mobile nodes in wireless sensor networks. Finally, Section 7 concludes our work.

2. Literature Survey

Traditionally, the nodes in wireless sensor networks were considered as denser networks. Due to denser networks the nodes were able to communicate with each other [1]. Thus, in many research the wireless sensor nodes are assumed to be static. If any event occurs in sensor node, the data is transmitted from one sensor node to another till it reaches to sink node. Thus to transmit data of a single node, many of the nodes have to transmit the data. Unfortunately the energy is consumed of many nodes. The problem with static sensor nodes is that they have a limited energy in the form of battery supply.

To improve the network lifetime, it is necessary to store the energy of sensor nodes. This could be achieved by clustering the static nodes with the help of optimizing algorithms. A very popular clustering algorithm which proposes a two-phase operation based on single-tier network using clusters is called LEACH [09]. The cluster heads are created randomly and also it performs the data aggregation process in the clusters.

Ant colony optimization (ACO) algorithm follows Ants behavior of finding food sources [10]. In event based applications, it is a candidate method for multi-path routing using a swarm based algorithm to maximize network lifetime. ACO is not suitable for monitoring applications where we require continuous data transfer. PSO algorithm [11] could be used for clustering purpose and to define the cluster heads. It gives us the desired results. But then we also require the best clustering algorithm which maximizes the network lifetime. This artificial bee colony (ABC) algorithm proposed by Dervis Karaboga[12] which is a new optimizing technique could be used for clustering of wireless sensor nodes.

The data collection in WSN could be done with the help of mobile nodes. Instead of using sensor nodes to send the event occurred data to sink node, we could use mobile node to send

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the data [1]. The mobile node collects the data from predefined path. A single mobile node is used to collect the data from all sensor nodes. The ABC based TSPN algorithm [2] gives the shortest path for a mobile node to collect the data from sensor nodes. TSPN is the travelling salesman problem for finding the shortest path from given all travelling paths. ABC with TSPN gives the shortest path for a single mobile node to collect the data from all sensor nodes. This literature gives the idea about cluster formation with the help of ABC algorithm and moving multiple mobile nodes with the help of TSPN to gather data to the sink node.

3. Architecture of Multiple Mobile Nodes

The assumptions of traditional wireless sensor nodes, the sensor nodes were densely populated. Due to denser nodes, they were able to communicate with each other. If any event occurs in sensor node, the data was traveled through node by node to sink node. Thus, it consumes the energy of many nodes. In this paper, we assume that the nodes are associated at larger distances. Due to the large distances between two nodes, the communication is not possible between those nodes. It implies that for communication, the nodes are not in range of each other. In such scenario, we propose a method of data collection from such nodes when any event occurs. Clusters are formed by grouping those nodes. Each cluster is having its cluster head, which is going to deliver the data to the mobile node. Instead of single mobile node we have used multiple mobile nodes to collect the data from clusters.

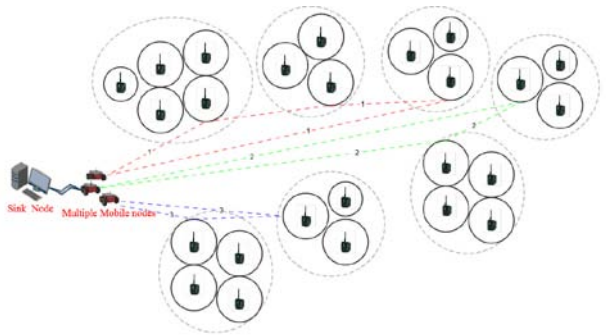


Figure 1: Multiple Mobile node Architecture for 25 sensor node

The architecture of 25 sensor nodes is shown in figure 1. Here 25 sensor nodes are divided into 7 different clusters with the help of efficient clustering algorithm i.e. ABC algorithm [3]. The cluster heads Ch are calculated on the basis of energy backup of sensor nodes in each cluster. After each journey of mobile nodes, the cluster heads are changed to increase the network lifetime. Mobile nodes Mn are calculated depending upon the number of clusters. The equation (1) gives the total number of mobile nodes to be imposed depending on total number of cluster heads.

$$M_n = C_{h-1}/2 \quad (1)$$

In figure 1, three mobile nodes collect the data from 7 different clusters. The paths of the mobile nodes are decided by ABC-MMN algorithm proposed in this paper. After collecting the data from cluster heads, all mobile nodes transfers the data to sink node. The use of multiple mobile nodes improves the time consumed by single mobile node to collect the data from sensor nodes. Thus, it improves the network lifetime.

There are many problems in using single mobile node for data collection in wireless sensor node [2]. If any failure occurs in mobile node, then the whole network may go down. This problem has been overcome in this paper by using multiple mobile nodes. Even if any failure occurs in mobile node, other mobile nodes could be used to collect the data from the clusters defined for the failed mobile node.

4. Artificial Bee Colony Multiple Nodes Algorithm(ABC-MMN)

In this paper, Artificial Bee colony multiple mobile nodes (ABC-MMN) is proposed to collect the data from clusters more efficiently. Artificial Bee colony algorithm has proved the most efficient data collection in wireless sensor networks by single mobile node [2]. In this section we impose the ABC algorithm on multiple mobile nodes to collect the data from cluster heads. Algorithm 1 gives our ABC-MMN algorithm.

Algorithm 1:

1. N ← Initialize the number of nodes.
2. Evaluate the nodes in three groups, i.e. Employed, Onlooker, Scout Nodes.
3. Loop← 0, MLC←Max Loop Count
4. Do
   a. For all employed nodes
      i. Calculate the distance of neighbor nodes D_{ij}= d_{ik} - d_{kj}
      ii. Follow the greedy selection process to form the clusters depending on D_{ij}
   b. For all onlooker nodes
      i. Calculate the fitness of all nodes in clusters (F_i).
      ii. Follow the greedy selection process to choose cluster heads (C_h) depending upon the fitness value in each cluster (F_{best}).
   c. Memorize the best solution for cluster heads.
   d. Loop ← Loop +1
5. While Loop <= MLC
6. No of Mobile nodes (M_n)=(Cluster Heads (C_h)-1)/2
7. Calculate the distance between cluster heads D_{ch} = D_{ic}- $D_{jc.}$
8. Divide the clusters equals to number of mobile nodes.
9. For Each mobile node M_i
   a. Array of Cluster heads A_n←{C_{h1},C_{h2},…C_{hn}}
   b. For i ←1 to C_n do
      i. If A_i != visited
      ii. A_i ← visited
      iii. d_i ← data of C_{hi}
      iv. End For
   c. End For

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Table 1: Notations

Sr. No.	*Notation*	*Description*
1	N	Total Number of Nodes
2	MLC	Maximum Loop Count
3	D_{ij}	Distance between two nodes
4	F_i	Fitness of node i
5	C_h	Total no of cluster heads
6	F_{best}	Best Fitness Value
7	M_n	Total number of mobile nodes
8	D_{ch}	Distance between the clusters

As per the principles of the Artificial bee colony algorithm, our algorithm has three phases for clustering purpose. The employed phase, onlooker phase and scout phase. After the each loop of all these phases a new best solution for cluster head is reported. The flowchart for ABC-MMN is as follows:

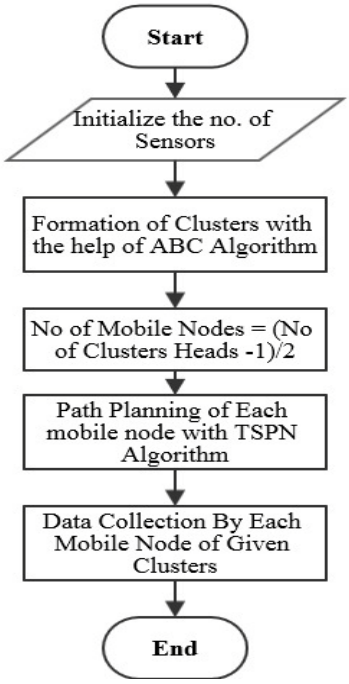


Figure 2: Flowchart of Artificial Bee Colony Multiple Mobile Node (ABC-MMN) algorithm

5. Results

We vary the number of sensors from {25, 50, 100, 150, 200…500} and for each instance the energy conserved is recorded for three algorithms i.e. for Leach, PSO and ABC-

MMN. Figure 3 shows the energy conserved by all of three algorithms. The results have proven that the ABC-MMN algorithm could be used to preserve the energy of sensor nodes.

The time consumed by the single mobile node without clustering is calculated and single mobile node with clustering is calculated. It is compared with Artificial bee Colony multiple mobile node algorithm. Figure 4 shows the time consumed by single mobile node to collect the data in the wireless sensor network. The time consumed to load the data on sink node is lowered by multiple mobile nodes. Thus, it helps in increasing the network lifetime.

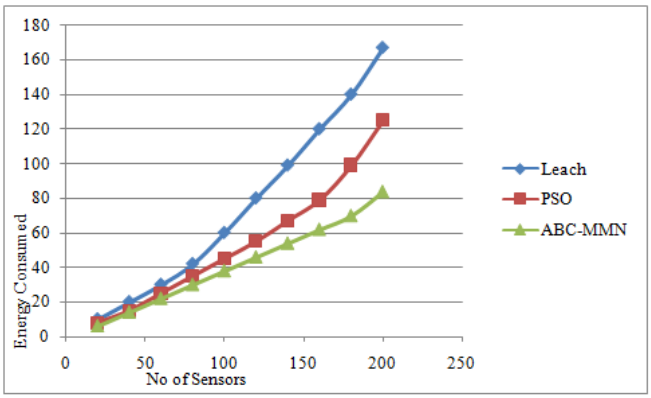


Figure 3: A comparison of the energy consumption

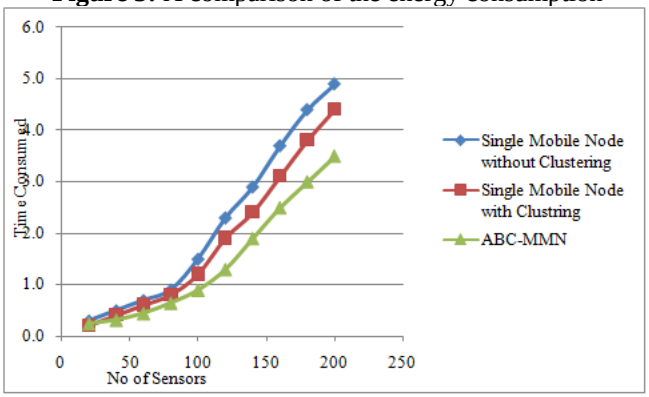


Figure 4: A comparison of the time elapsed for data collection

6. Applications

The advantages of allowing multiple mobile nodes to collect the data increase the number of applications in static WSN fields. The sensors could be attached to peoples for health monitoring i.e. heartbeats, blood pressure, and temperature. Military fields could also use this for detecting the positions and movements of military. Depending on which commander can give signals and could make decisions for attacking on enemies.

7. Conclusion and Future Work

In this paper, we presented that data could be collected efficiently in wireless sensor networks with the help of an Artificial Bee colony multiple mobile node algorithm. The clustering of nodes and data collection was done successfully with the help of ABC-MMN algorithm. Through high extensive simulations done on this system, we got validated with the high efficiency of our proposal. In the future, we will replace the static sensor nodes by dynamic sensor nodes. So that sensor nodes could be planted to the heart patients and data could be collected by multiple mobile nodes for providing them necessary remedies in time.

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