RESEARCH ARTICLE

Choose the Appropriate Cluster Head for Decrease Energy Consume in Wireless Sensor Networks Based on Gravitational Emulation Local Search Algorithm

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Abstract: New Wireless Sensor Networks (WSN), is the new generation of real-time embedded systems with limited computation, energy and storage which have variety usage, especially when that is not possible using traditional networks. Given that, in this networks energy problem is important major challenge, using Clustering model can be considered as a solution to overcome this problem. In this instruction, sensor nodes grouped in a set of cluster and pick out a central node for Cluster Head (CH) node. Choose the appropriate cluster, reduce energy consumption in these networks, as a result increase networks lifetime. Hence, in this study, unlike previous studies, used Gravitational Emulation Local Search Algorithm (GELS), for clustering and select appropriate CH. This method is based on three descriptors of energy, dispersion and centrality of nodes, and simulations indicate, where the CH only selected based on local data set, significantly increase network lifetime.

Keywords: Wireless sensor networks (WSN), Clustering, Cluster head, Lifetime, GELS algorithm

1. Introduction

Wireless Sensor Networks (WSN) are consisting by hundreds or thousands nodes which randomly distributed in faraway or dangerous places. The main responsibility of these nodes is collect data from environment in which they are placed. In fact these nodes have ability to collect data from region that is not possible to get this information from other ways. Every sensor node includes a sensor unit, computing unit, memory unit and wireless communication unit with limited connection bandwidth unit [1, 21-35].

These networks have much benefit for military, medical, and living environment and etc. Changing power resource of these nodes is very difficult or often impossible, when the powers of these nodes are finished. Therefore, the main problem in designing WSN is decrease energy consumption to have longer network lifetime [2, 3]. The main responsibility of WSN is collecting data from environment their placed. Direct data transferring from resources to central node, is expensive and often impossible, because central node always far from resources, and sensor nodes have limited energy power. Hence, use multistep route for routing. Furthermore, there are nodes in route which always busy in data transferring. In other word, havoc and energy discharge and failure in nodes towards to increases. To overcome to this problem, use clustering method. In this structure sensor nodes grouped in some cluster and a central node pick out as Cluster Head (CH) node. Often CH node have energy more than normal nodes and task work of these nodes is collect data from other nodes and then send collected data to central station. If for any reason this node fails, such as increasing time, another CH should be selected [4].

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All activities that have been conducted in this regard separated in two group: Frist group are only attention to energy parameter in order to choosing CH [5-8] which is not fine to use them in complex network, because, it might be possible a node with the high power placed in corner of area, and in this case, other nodes have to use more energy power for data transmit. In second group there are nodes that mention more parameters such as distance and movement[36-49]. In this study every node in order to network lifetime optimization knows these elements:

The energy status

Situation which is located.

Centrality of every node to it neighborhood.

Then due to use this information and based of gravitational force algorithm CH will be determined. The results indicate that propose method coin comparison to other algorithms, significantly increase networks lifetime [50-53].

The rest of the paper is organized as follows. Section 2 reviews related works on the subject covered in this paper. The GELS algorithm is introduced in Section 3. The evaluation of the proposed method and simulation results are presented in Section 4 and Section 5 respectively; and finally Section 6 concludes the paper.

2. Related Work

Due to being sensor networks useful, many studies in this case has been accomplished and as a result many clustering algorithms and CH selection has been developed, which can mentioned the following:

LEACH algorithm, which has been introduced in 2000. LEACH is a centrality protocol and self-organizing with dynamic grouping, which is use for randomly energy consumption balancing between nodes. In this case, nodes organized their self into local group and in these groups, one of nodes make responsibility of local station or cluster head. LEACH algorithm, until a specific nodes energy discharged, uses random principle rotation between powerful nodes. In this algorithm, every node, select a random number between 0-1 in every cycle, if random number be lower than standard limitation level, mentioned node choose for this cycle CH [7]. Standard limitation level (1) computed according to:

$$T(n) - \begin{cases} \dfrac{p}{1 - p * \left(r \bmod \dfrac{1}{p}\right)} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases} \qquad (1)$$

P is the possibility of being cluster head, r is current round number, and G is all nodes that weren't CH in 1/p. because, this algorithm only uses local data, have some problem as followed:

Due to the CH number in every cycle in not determined, it may number of CH in every cycle be different. CH possible placed in corner of area, therefore, other nodes should use more energy for communicate with this CH. Every node in every cycle, have to compute a random number and standard limit generation. LEACH-C algorithm is also a study in this case [6]. In this algorithm, also focus of work has been done. In intensive method all nodes send information to one node, and this node select CH according to collection data which this work causes more energy consumption.

AHP algorithm is one of other related studies [7]. In this algorithm, energy, movement and distance of one node to CH parameters has been mentioned. Work done as intensive and central station that, the node which makes final decision about cluster head.

3. The GELS Algorithm

In 1997, Guided Local Search Algorithm (GLS) algorithm was proposed by Voudouris and Tesang [9] to search and solve complex problems for the first time. In 2004, Webster [10] called this method GELS and was used as a powerful local search algorithm for solving complex problems. The main idea of GELS is based on gravitational force, which causes to attract objects with each other such a way that heavy object has higher gravitational force and attract low weigh objects. The attraction force between two objects depends on the distance between them.

In GELS algorithm, possible solutions in search space are divided to several categories according to their fitness's. Each of these categories named a dimension of the solution and there is initial velocity for them. Equation (2) computes the gravitational force between Current Solution (CU) and Candidate Solution (CA). This force (F) is added to velocity vector in the path of current motion. If velocity exceeds the maximum value (threshold), maximum velocity becomes the current velocity, and if the velocity becomes negative due to this force, the velocity is considered zero [11-14].

$$F = \frac{G(Cu - CA)}{R^2} \quad (2)$$

4. Proposed Method

In previous study, CH were distributed selected, therefore energy consumption in great, or selected intensive, because of a node make decision for the entire network, nodes traffic will be increase. Also if this node failed all of network failed by problem one. In this study, we have some step for reduce computation and networks lifetime.

- One value determined for minimum being CH energy which any nodes have lower energy not selected in selection for CH candidate.
- The node that has the blind spot or a very small number of neighbors that are not candidates for cluster heads, even if you have a lot of energy.
- Every node compute chance parameters for itself and this value determined how every node have chance for being CH. Because of increase network lifetime, if two nodes have equal chance and be located in same neighborhood, one of them turned off for increase network lifetime.

In every cycle, every node has standard level for selection, run this algorithm and found a chance value for every selected node. In proposed algorithm, the work method in followed by this way, which, every node know its chance and also know neighborhoods chance value. Every node compares his chance with this information. If being bigger than all, selected for CH, anything else, try being member of CH which have lower distance. The node which be selected for CH, introduced itself to others, so, other nodes try membered cluster which have lower distance to CH. Due to this theory, performance of this algorithm is decentralized and every node makes decision for itself.

In our method, CH selection as decentralized and run based on force gravity. There is many parameters which can used for CH selection, but should know, as the parameters is greater, In this respect, the table rules and therefore increases and this increases the computation time and energy consumption is increased.

In each round, each node has its own gravitational force and risk parameters describe the three main energy distributions and its centrality to bring their neighbors, then, all nodes in the CH choose the nodes of their position with the company and each of its neighboring nodes that are to be compared. And if the case is better than its neighbors as the cluster heads is introduced. Simulated compared parameters show in Table1.

Primary Energy	0.1j
Eelect	50 nJ/bit
Efs	10 pJ/bit/m^2
Dco	87 m
Eda	5 nJ/bit/signal
Packet Size	4000 bits
Calculation Energy	50 nJ/bit
Send_near Energy	Packet_Size ∗ (Elect + Eda) + Packet_Size ∗ Efs ∗ dis^2
Send_far Energy	Packet_Size ∗ (Elect + Eda) + Packet_Size ∗ Emp ∗ dis^4
Receive Energy	(Packet_Size ∗ (Elect + Eda) ∗ 0.05)
Combination &Compacting	(Packet_Size ∗ (Elect + Eda) ∗ 0.05) ∗ 0.05

Table 1. The Value simulation parameters

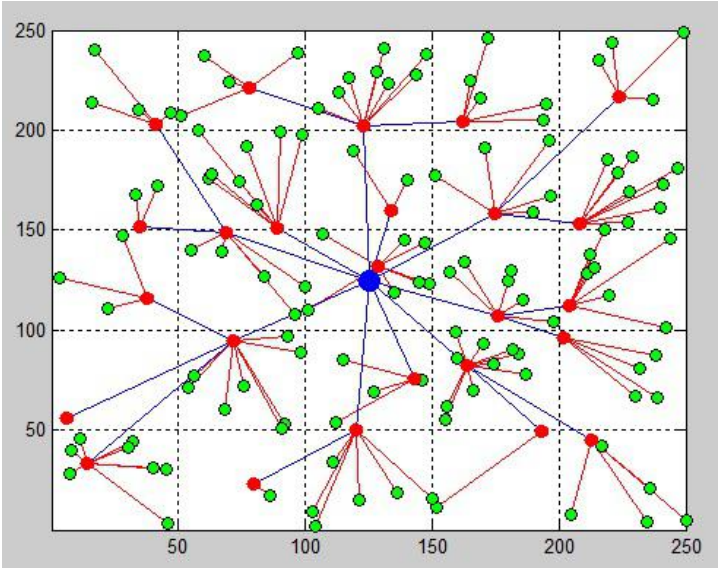

Figure1. A sample of proposed algorithm answer in a 250*250 environment

5. Simulation Result

Simulation conclusion for below problem shows in this section. Implementation in this section is based on C# and programs run with 2.4 GHz-IV and 2GB RAM. For network lifetimes measurements use FND (first node dies) [15] method. In the other word, first node which finish up energy, removed from network.

Also said, this algorithm explored if one node, inform of one parameters have good situation, it maybe not good selection for CH, but also as a whole and with respect to all aspects of CH is a good option. So far as has been stated, the goal is to integrate all the parameters and we find that the nodal position, the best position is. It maybe some node have more energy than neighborhoods, But the place is in a position to send their data to the other nodes of the node energy consumption are incurred. So, this makes the probability of the node is reduced. It should be noted that the proposed algorithm reduces the energy consumption and longevity can be seen in the simulation, the execution time of each round algorithm, the algorithm is simple and low overhead in comparison with the other algorithms that simulate have been much less and is very substantial. Table 2 compares the death of first node in the proposed algorithm (GELS_CWSN) compared with LEACH [16], FSCA [17], GSAGA [18, 19] and CFGA [20] shows. Improve the performance of the algorithm increases the network lifetime compared to other methods is shown in Table 2. As can be seen the death of first node in the proposed algorithm compared with other methods has increased.

Network parameters	Type of Algorithms				
	Leach [16]	FSCA [17]	GSAGA [18, 19]	CFGA [20]	GELS_CWSN
150 node with network size 250*250	117	92	118	150	166
175 node with network size 300*300	62	59	90	120	131
200 node with network size 400*400	27	17	42	95	97

Table 2. Compare the death of the first node in rounds during the period for algorithms

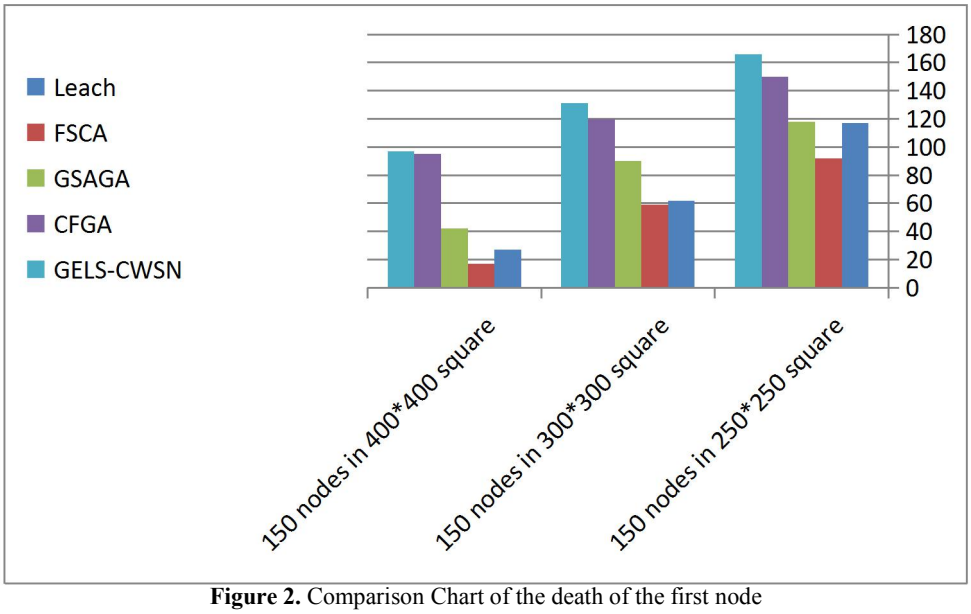

Figure 2. Comparison Chart of the death of the first node

6. Conclusion

In this paper, the local search algorithm to simulate gravity for reduced energy consumption problem in WSN, by selecting a suitable CH have been used. A new method for calculating competence and evaluate solutions for solving the optimal sensor selection for clustering in WSN is presented. The advantages of this algorithm speed, low implementation time, increase the lifetime of network and reduce energy consumption and optimize the network efficiency is also increased. A new method for calculating competence and evaluate solutions for solving the optimal sensor selection for clustering WSN is presented. The results show the improvement and superiority of the proposed algorithm is compared to the algorithms, the improvement is more evident in larger systems.

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