Energy Efficient WSN Clustering Using Cuckoo Search

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Abstract. A comprehensive range of applications exists for Wireless Sensor Networks (WSNs) have in today’s world. To name a few they are used in monitoring environmental parameters, condition of infrastructures, and related geophysical processes near to real-time, water quality monitoring, air pollution monitoring, etc. Wireless sensors can be placed in places that are difficult to human intervention for impossible to reach with a physical wired system. These WSNs, are low in power and computation so constructing an energy-effective data collecting protocol is a demanding issue. This is because all sensor nodes are usually provided with limited power sources. The development of an energy-efficient algorithm is the need of the hour as replacing the energy sources for the sensor nodes is a tedious task. Various clustering protocols have been proposed earlier but they suffer unbalanced energy problems and are not efficient enough to cater to the needs of these WSNs. To deal with this challenge, an improved algorithm using cuckoo-based search clustering protocol has been proposed in this research paper.

1. Introduction

With increase in the number of applications of WSNs, there is a vital demand to meet its energy requirements. Generally, the sensor nodes are deployed in areas which are hard to reach frequently physically [1][2]. These sensor nodes are inherited through restricted energy resource as well as their energy maintenance is a subject of constant research in order to yield practical ways to overcome this problem.

The concept of clustering in WSNs states that the sensor nodes are divided into groups geographically and each one of them transmits the data to a Cluster head. The received data is then by all the cluster heads is then sent to a sink and is reported to the base station for further analysis and record. Compilation of clustering-centered data collection methods is proven in numerous applications to ensure energy efficiency and accessible solutions [3][4].

The algorithm proposed in this research paper is designed with a motive to control this energy demand in the sensor nodes. In a WSN that uses clustering methodology, the cluster heads need to bear the maximum amount of traffic load and thus choosing the fittest node as the head of the cluster is an important step to ensure the smooth functioning of that particular WSN. The algorithm uses Cuckoo based search algorithm to choose the fittest node using a fitness function. After a set interval of time the fitness of each node is recalculated and then accordingly the new heads are assigned. In case a node is
drained out of energy, the algorithm finds out the next best head and an alternative path so that the data can be transferred efficiently.

The proposed algorithm has a wide range of scope. It can be used at all the remote areas thus eliminating the need of human presence for maintenance. Proper energy management will ensure that the nodes have a longer life duration and are thus cost effective.

2. Literature Review

The protocols belong to clustering are mainly divide up into 2 groups first is heuristic-based and another is nature-inspired computing-based clustering [3]. In the recent years a collection of heuristic-based protocols has been developed. One of the most famous ones is LEACH [4].

LEACH chooses the cluster head on the basis of some likelihood. Hence, the role of Cluster head moved to another nodes once a round is over. LEACH has a core drawback that sometimes the Cluster Head is chosen with less energy nodes sometimes and as a result that Cluster Head dies quickly. Some other protocols have been developed in with an intent to be more efficient. PEGASIS [3] is one such another example. It uses greedy approach to create an arranged list such that each node communicates with the neighboring node in the list.

HEED is another such attempt; to choose a Cluster Head, lasting energy of node is used as the main constrained [5]. Selection of energy efficient Cluster Head channels is the main focus of this protocol and hence, decrease of communication operating cost costs. This leads to an increase in the life of the network. In [6][7], a clustering arrangement called PSO-C has been proposed. It obtains a fitness function to find cluster heads, but it does not determine the cluster size that is essential for lowering the energy consumption [8].

In the paper [9] for cluster head selection, a PSO-based method, is discussed, named PSO-ECHS. PSO-ECHS has the principal constraint that it does not distribute Cluster Heads consistently, hence unstable energy use was monitored during its estimation.

In [10] E-OEERP is discussed which is a PSO-based protocol. This protocol uses PSO based scheme in order to select the cluster heads and focuses on the left-out nodes throughout clustering development. Also, this protocol faces the problem of unstable energy usage.

In [6] Cuckoo search based meta-heuristic algorithm which is based on WSN is discussed for diversity in clustering.

The previous approaches however suffer unbalanced energy consumption problem. Cuckoo based clustering protocol has already been proposed in previous literatures and through experiments it has been proved to be a better approach than previous mentioned protocols. The result of previous done experiments is depicted through the following figure 1 [11].
3. Proposed Protocol

Step 1. [Initialize]

N number of nodes have been taken to deployed over an area of size 100x100. Each with initial energy level as 120 Joules.

Step 2. [Determining the fittest node]

1. Arrange N nodes based on fitness function
2. Out of N nodes select 20% top nodes based on their fitness
3. Reset the Host Nest with n number of qualified Cluster Heads
4. Every Host Nest cost is to be calculated with finest quality of eggs (Cost_{best})
5. New Population generation
6. Cost Estimation of new population (Cost_{new})

Step 3. [Selecting the Cluster Head]

1. if (Cost_{new} > Cost_{best}) then
   Switch finest solution with new produced population
   Else
   Back to step 2.5

Step 4. [Finding the best path]

1. To discover the subsequent shortest path, use Bellman ford algorithm.

4. Result and Discussion

This segment discusses the findings of the proposed algorithm. A MATLAB based customized simulator of WSN is used where 100 nodes are installed over an area size 100x100 for simulation as shown in figure 2 to figure 4.
**Figure 2.** Energy Level of 100 Sensor Nodes after 8 Iterations

**Figure 3.** Is the Output Graph Depicting the Nodes and their Energy Level after 8 Iterations
In the figures 2 and 3, we have done 8 iterations and calculated the energy level of all the nodes in the same, in figure 4, the clusters are formed based on the topographical area, the cluster heads are selected with maximum energy level in the cluster.

5. Conclusion
The proposed work is an energy effective process which may be applied to assign cluster heads to the most fit sensor node in a WSN and derive the next best path for information flow in case a sensor node is dead, through greedy approach. The Cluster Heads are distributed evenly in our proposed clustering algorithm for the load balancing purpose. Simulation results confirm that as a solution to overcome the energy drainage problem of sensor nodes, the proposed algorithm can be used and thus extending the lifetime period of the nodes. Further work is to be compared with the existing algorithms and then the efficiency and other parameters would be taken into consideration.

6. References
[1] F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, “Wireless sensor networks: a survey,” Computer Networks, vol. 38, pp. 393-422, 2002.
[2] Gupta, Govind P, “Efficient coverage and connectivity aware data gathering protocol for wireless sensor networks,” Recent Advances in Information Technology (RAIT), 3rd International Conference on. IEEE, 2016.
[3] Adamu Murtala Zungeru, “Classical and swarm intelligence-based routing protocols for wireless sensor networks: a survey and comparison,” Journal of Network and Computer Applications, vol. 35, pp. 1508–1536, 2012.
[4] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, “Energy efficient communication protocol for wireless microsensor networks,” in Proc. 33rd Annual Hawaii International Conf.
Syst. Sciences, vol. 8, p. 8020, Hawaii, USA, Jan. 2000.

[5] O. Younis, S. Fahmy, “HEED: a hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks,” IEEE Trans. Mobile Computing. Vol 3(4), pp. 366–379, 2004.

[6] Adnan, Md. Akhtaruzzaman and Razzaque et al., “A Novel Cuckoo Search Based Clustering Algorithm for Wireless Sensor Networks”, Advanced Computer and Communication Engineering Technology: Proceedings of ICOCOE 2015”, 2016, Springer International Publishing, 621-634.

[7] Latiff, NM Abdul, Charalampos C. Tsimenidis, and Bayan S. Shari, “Energy-aware clustering for wireless sensor networks using particle swarm optimization.” IEEE 18th International Symposium on Personal, Indoor and Mobile Radio Communications. IEEE, 2007.

[8] Bhatt D. P., Pareek V. (2015) Lifetime Enhancement of Wireless Sensor Networks Using Fermat Point and Data Aggregation Mechanism. In: Shetty N., Prasad N., Nalini N. (eds) Emerging Research in Computing, Information, Communication and Applications. Springer, New Delhi. https://doi.org/10.1007/978-81-322-2550-8_46

[9] Rao, P. C., Jana, P. K., & Banka, H., “A particle swarm optimization based energy efficient cluster head selection algorithm for wireless sensor networks” Wireless Networks.; 1-16, 2016.

[10] RejinaParvin, J., and C. Vasanthanayaki, “Particle Swarm Optimization-Based Clustering by Preventing Residual Nodes in Wireless Sensor Networks,” IEEE Sensors Journal, 15.8, pp. 4264-4274, 2015.

[11] Gupta, G. P. (2018). Improved cuckoo search-based clustering protocol for wireless sensor networks. Procedia Computer Science, 125, 234-240