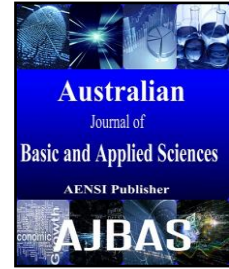




ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com



A Genetic Based Energy Aware Clustering In Heavily Populated Wsn

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ARTICLE INFO

Article history:

Received 6 March 2015

Accepted 25 May 2015

Published 29 June 2015

Keywords:

WSN, Energy level, Clustering Genetic replacement algorithm

ABSTRACT

Background: The biggest challenge of WSN is to enhance its life time. The sensor nodes in WSN have very limited energy power. Hence a mechanism to improve the energy consumption of sensor nodes is required. One such mechanism is clustering. Clustering enhances the lifetime of wireless sensor network to a great extent, by using multiple cluster heads we can appoint a leader based upon its current energy level. A problem with clustering is selecting the cluster members and cluster head in order to overcome this problem genetic algorithm is used which also further improves the battery life of wireless sensor network.

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To Cite This Article: Ch.Srilakshmi A Genetic Based Energy Aware Clustering In Heavily Populated Wsn, *Aust. J. Basic & Appl. Sci.*, 9(20): 574-579, 2015

INTRODUCTION

Wireless Sensor Network (WSN) can be used in many applications some of which are Disaster relief operations, Biodiversity mapping, intelligent buildings, Machine surveillance and preventive maintenance, Precision agriculture, Medicine and health care etc. A WSN contains sensor nodes that are small, battery constrained, low-cost. One of the major problems for a WSN is energy consumption

during communication between sensor nodes. The longer distance between sensor nodes, the more they consume energy.

By using clustering technique in WSN we can improve the lifetime of sensor nodes thereby increasing the WSN lifetime. The entire sensor nodes in wireless sensor network are divided into group of clusters. The sensor node that has highest energy within the cluster is nominated as cluster head.

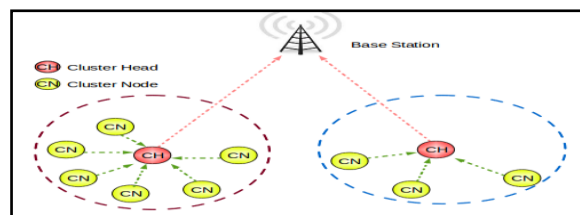


Fig. 1: Clustering in WSN

The sensor node’s responsibility within each cluster is to sense the data from the environment. The cluster head collects the data and sends the data to the base station. Communication within a cluster and with other clusters is done using the cluster head. This is the reason why the node having highest energy is chosen as cluster head.

The cluster head collects data from all member nodes in its cluster. These cluster heads then aggregates the collected data and sends it to the BS.

By doing so the communication cost is greatly decreased and improves the lifetime of WSN. After every round a member node in cluster, becomes cluster head depending on the residual energy of the current cluster head and the average energy amount of the member nodes in the cluster. In general, operational stages of classic WSNs are divided into node placement, network coverage, clustering, and data aggregation

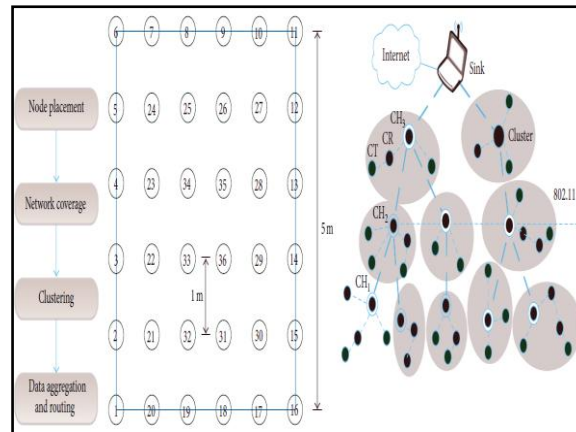


Fig. 2: Various stages of clustering

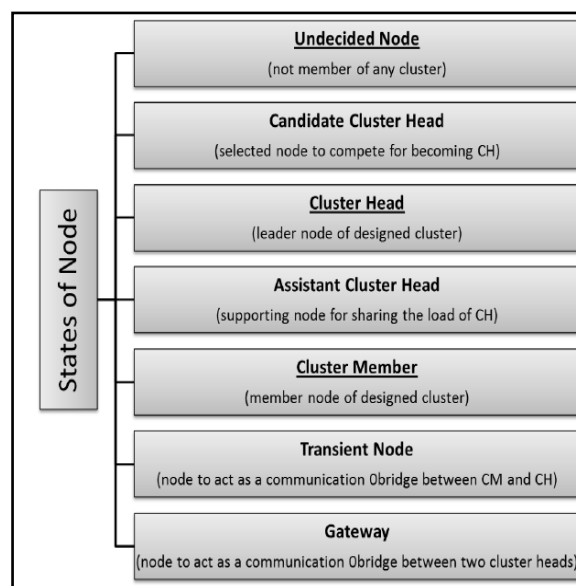


Fig. 3: Various states of nodes in a cluster

Apart from clustering mechanism, a genetic replacement algorithm is used to further enhance the life of wireless sensor network. The genetic replacement algorithm is used to minimize the communication distance in the network, which maximize the lifetime of the network. By using genetic replacement algorithm the sensor nodes are designed to transfer the event data to the sink node according to the grade diffusion algorithm.

Genetic algorithm (Goldberg, D., *et al.*, 1989) is a nonlinear search algorithm based on the genetic principles like selection and natural evolution. The algorithm begins with a set of solutions (represented by chromosomes) called population. Solutions from one or more population are taken and used to form a new population. The offspring's are selected according to their fitness. Using which the sensor nodes that has the highest balance battery life is chosen for transmission. The most fittest outer sensor nodes transmit to fittest inner nodes to transmit data to sink node or base station.

Algorithm:

Step1:-Generate random population of n chromosomes

Step2:- Evaluate the fitness $f(x)$ of each chromosome x in the population. This step is called fitness step

Step3:- A new population is created by repeating following steps

3.1:-Select two parent chromosomes from a population according to their fitness value

3.2:-Crossover step is performed, where genes of parent chromosomes are crossed to form a new offspring.

3.3:-Next Mutation is performed where the chromosome value is flipped or the position of chromosome is changed.

3.4 Place new offspring in a new population.

3.5 Use newly generated population for a further run of algorithm

Step4:- Return the best solution as current population

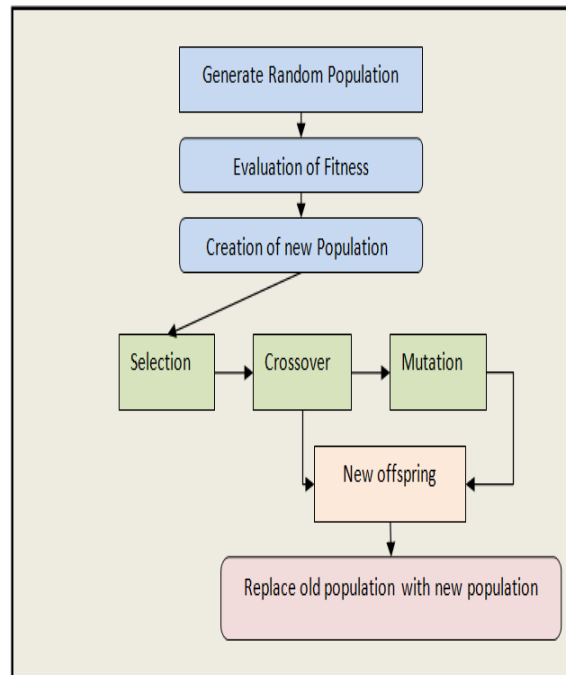


Fig. 4: Genetic Replacement Algorithm

II. Related Work:

For Lifetime extension of wireless sensor network (Dechene, D.J., *et al.*, 2008) the use of two or more cluster heads and hierarchical routing offers good result. In An Energy Efficient Clustering Scheme in Wireless Sensor Networks (Mao, Y.E., *et al.*, 2006), algorithms cluster formation, cluster head selection, and cluster communication is proposed to increase the lifetime of wireless sensor network. In LEACH (Erfan *et al.*, 2012), optimization of random cluster-head selection algorithm is proposed.

III. Proposed work:

The proposed work is based on the combination cluster-based approach and Genetic replacement Algorithm to optimize the lifetime of WSN. For enhancing the lifetime of wireless sensor network multiple cluster heads within the same cluster are chosen rather than a single cluster head. The Proposed clustering algorithm is divided into three phases namely initial population phase, setup phase and steady state phase.

A. Initial population phase:

In the initial population phase the Sensor nodes in WSN are randomly selected across the network to form a new population.

B. Cluster formation phase:

After selecting the potential candidate sensor nodes, a number of clusters are formed based upon the population size. The Cluster having the highest energy is selected as the leader, as the cluster head. The cluster head communicates with all other sensor nodes within a cluster, collect the sensed data and communicate it back to the base station.

C. Transfer Phase:

By using time division multiplexing scheme the various cluster nodes within a cluster transfer data to its cluster head. If a cluster head's energy becomes low, dynamically another suitable cluster head having high energy source is chosen. Eventually the cluster head transmit data to the sink node.

D. Intelligence based clustering using Genetic replacement algorithm (CGR):

The Genetic replacement algorithm is used to determine the number of cluster heads and choosing the best ones. Every chromosome in the population represents a sensor node and it is denoted as sequence of bits taking values 0 and 1. The Index of the chromosome act as the nodes ID. The value 1 in the index of the chromosome means that node is a cluster head and 0 means that the corresponding node is a cluster member.

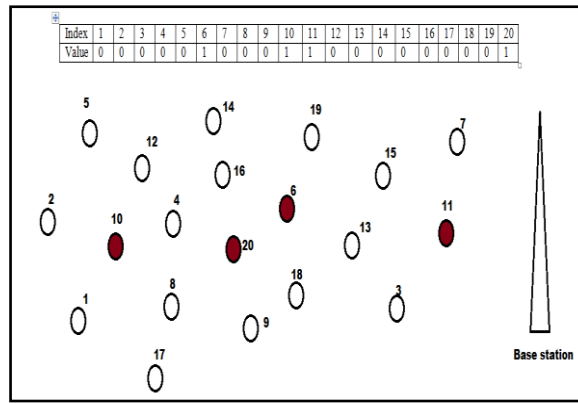


Fig. 5: Chromosomes and cluster heads; filled dots are the cluster heads

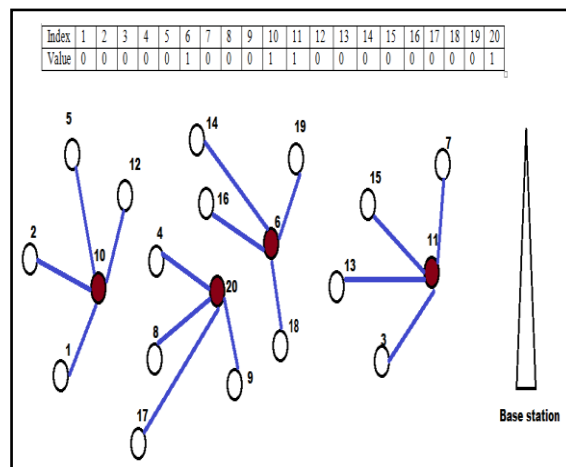


Fig. 6: Formation of clusters using Genetic algorithm

The Performance of cluster head has a major effect on the lifetime of wireless sensor network. Some of the parameters that affect the performance are cluster head distance, cluster head density, cluster head centrality and cluster head residual energy.

The Sum of the cluster Heads Distance SUM_{chd} to base station is the sum of all cluster heads distance from the base station and is defined as Equation (1).

$$Sum_{chd} = \sum_{i=1}^{hn} DISTchbi \tag{1}$$

Where hn is the number of cluster heads and $DISTchbi$ is the distance between the base station b or sink and cluster head i .

The second parameter is Sum of the cluster Heads Density SUM_{chs} , which is measured as the density of cluster heads.

$$Sum_{chs} = \sum_{i=1}^{hn} DENchni \tag{2}$$

Where hn is the number of cluster heads and $DENchni$ is the number of cluster heads in the network. More the value of SUM_{chs} better the performance of the network.

When there are equal numbers of cluster member nodes in each cluster then the node at the

center is the best choice to act as cluster heads. This is measured as sum of centrality of cluster heads, SUM_{chc} .

$$Sum_{chc} = \sum_{i=1}^{hn} CENTchci \tag{3}$$

where hn is the number of cluster heads and $CENTchci$ is the centrality of all cluster heads.

The most important parameter is the Sum of the cluster Heads Residual Energy, SUM_{chre} . The nodes having the highest residual energy is the best choice for selecting the cluster heads

$$Sum_{chre} = \sum_{i=1}^{hn} RESENchyi \tag{3}$$

where hn is the number of cluster heads and $RESENchyi$ is the remaining battery life of cluster heads.

E. General steps of data gathering:

The whole operation on the network is divided into two phases:

- 1) Broadcast phase
- 2) Data aggregation phase

Broadcast phase:

In this phase, the base station or sink node broadcasts messages to all potential sensor nodes which it thinks has the required data. The information broadcast contains information like complete network details, the query execution plan, the number of cluster heads, the members associated with each cluster head

Data aggregation phase:

In this phase, the cluster member nodes transmit the sensed data to their cluster heads and, each cluster head chooses the nearest neighbor cluster head (based on upon node having highest residual energy) or base station to transmit its message to the sink node.

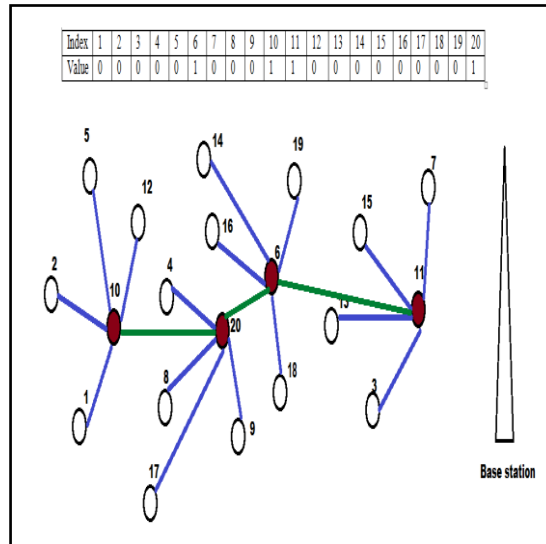
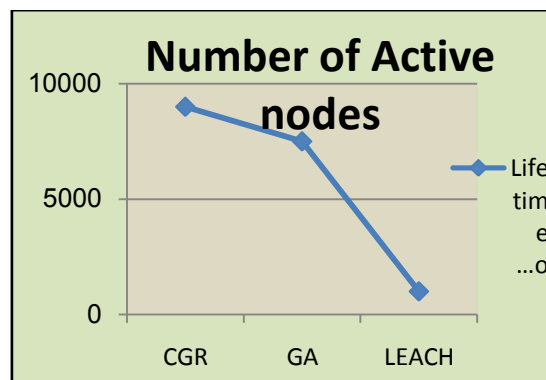


Fig. 7: Data aggregation between cluster heads

IV. Results:

For population size 91, The experiment was designed based on 3-D space, using 50 x 50 x 50 units, The Fig.8 shows the percentage of alive nodes

with respect to the number of transmissions (lifetime). This graph shows that clustering method extends the lifetime of WSN much more than Simple GA and LEACH.



IV. Conclusion and Future Work:

This paper proposes a cluster-based approach along with genetic replacement algorithm to enhance the lifetime of WSN. The genetic algorithm is used to select the best the cluster heads and their number and also to select the cluster members. Future enhancement of the proposed paper may involve the use of data aggregation tree which reduces energy consumption compared with clustering.

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