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Multi-level Stable and Energy Efficient Clustering Protocol in WSN: A Review

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Abstract - In the homogeneous wireless sensor network, all the nodes have same energy and cannot take the benefits of node heterogeneity. Here, multi-level stable and energy efficient clustering protocol is studied, where network structure is divided into clusters. In each cluster, some advance nodes and normal nodes deployed randomly and super nodes assigned to cover the different sensing area. An ACO-PSO hybrid algorithm is applied for the path planning problem. Ant colony optimization is applied for the corresponding solutions and Particle Swarm Optimization is used to optimize the parameters in ACO and the parameters are selected self-adaptively. By applying this technique, the performance can be enhanced and results would be better

Keywords - *Wireless sensor network, heterogeneity, Ant colony optimization, Particle Swarm optimization.*

1. Introduction

Wireless Sensor Networks (WSNs) have become popular in variety of applications such as military surveillance, environmental, transportation traffic, temperature, pressure and vibration monitoring. To achieve fault tolerance. WSNs consist of hundreds or even thousands of sensors randomly distributed with in the region. All the nodes report sensed data to Base Station (BS) often called sink. Nodes in WSNs are power constrained due to limited battery resource, and they might be placed where they cannot be accessed, so, impossible to recharge or replace. To save energy, regular and long distance communication should be avoided to prolong network lifetime [1]. Sensor nodes take self decisions to accomplish sensing tasks, constructing network topology and routing policy. Therefore, it become important to design energy efficient algorithm for enhancing robustness against node failures and extending lifetime of WSNs. Efficiently Grouping sensor nodes in form of clusters is beneficial in minimizing the energy utilization. Numerous energy efficient protocols are made based on clustering structure [7] . In clustering, nodes assemble themselves in form of clusters with one node acting as the Cluster Head (CH)[3,4]. All cluster member nodes transmit sensed data to their CH, while the CH aggregate data received and forward it to the remote BS[6,8].

Clustering can be formed in two kind of networks i.e., homogenous and heterogeneous. WSNs having nodes of same energy level are called homogenous WSNs[4,5]. Low Energy Adaptive Clustering Hierarchy (LEACH)[2,9], Power Efficient Gathering in Sensor Information Systems (PEGASIS) and Hybrid Energy-Efficient Distributed Clustering (HEED) are examples of cluster based protocols which are designed for homogenous WSNs. These algorithms poorly perform in heterogeneous regions. Nodes have less energy will expire faster than high energy nodes because these homogenous clustering based algorithms are incapable to treat every node with respect to energy. In heterogeneous WSNs, nodes are deployed with different initial energy levels. Heterogeneity in WSN may be the result of re-energizing of WSN in order to extend the network lifetime.

1.1 TRANSMISSION BETWEEN NODE AND SINK

In single-hop transmission, each sensor node can send data to the sink through a single-hop i.e. by long distance

transmission. But the limitation of this transmission is that it is not optimal in terms of energy consumption [4]. In order to overcome this drawback, we need to decrease the distance thus can increase energy efficiency and prolong the network lifetime and this can be achieved by Multi-hop. In multi-hop transmission each node routes it data through other nodes and these nodes send the data to sink, thus it decreases the transmission distance and energy consumption when other node act as routers. Limitation of this method is that the energy of node located near the sink will drop quickly. So in order to overcome the limitation found in Multi-hop transmission, another solution to decrease energy consumption is clustering method.

II M-SEEC PROTOCOL

1.1 Multi-level stable and energy efficient clustering protocol

M-SEEC depends on the network structure that is divided into the clusters. In SEEC protocol, each cluster has an advanced nodes and normal nodes which deployed randomly in the cluster.

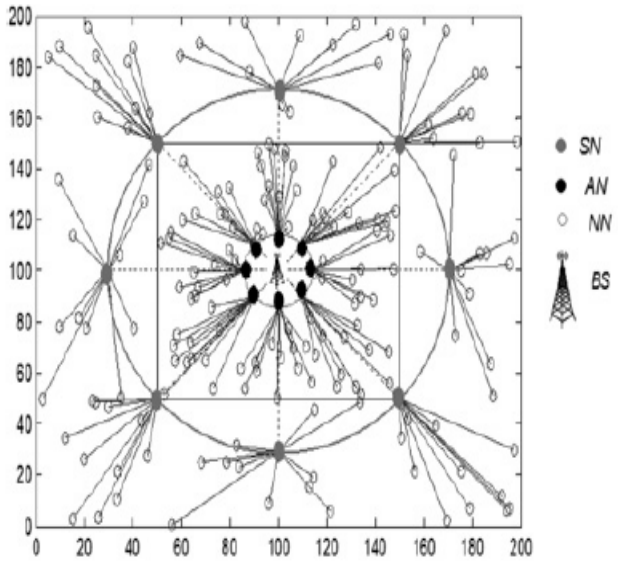

Fig 1. Network Model of M-SEEC

In M-SEEC, the most powerful supper nodes are assigned to cover the distant sensing areas. Each type of nodes has its role in the form of sensing, aggregation or transmission to the sink (Base Station). Nodes are deployed randomly in the field with a different group of energy values. The Network is divided into clusters and each cluster has a powerful super nodes, advanced nodes and normal nodes[4]. In M-SEEC, M_{SN} is the percentage of the total number of nodes equipped with β times more energy than the normal nodes (NN), called as a super nodes (SN). Total initial energy of the 3 level heterogeneous networks is given by:

$$E_{total} = n.E_0 + M_{AN}.(1+\alpha).E_0 + Msn.(1+\beta).E_0$$

Therefore, the three-level M-SEEC has $(\alpha . M_{AN} + \beta . M_{SN})$ times more energy.

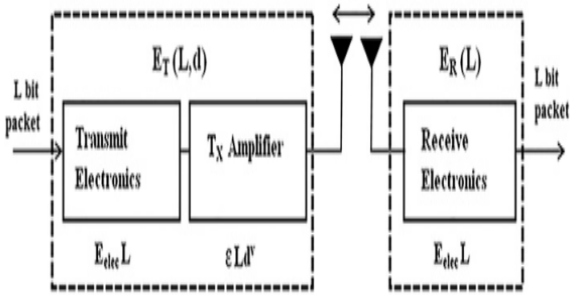

Fig 2. Radio Model

For transmitting L-bits message over a distance d, the energy expended by the radio modelis given by

$$E_T(L,d) = \begin{cases} L \cdot E_{elec} + L \cdot \varepsilon_{fs} \cdot d^2 & \text{if } d \le d_0 \\ L \cdot E_{elec} + L \cdot \varepsilon_{mp} \cdot d^4 & \text{if } d > d_0 \end{cases}$$

III SWARM INTELLIGENCE TECHNIQUES

3.1 Ant Colony Optimization

Ant colony optimization is a metaheuristic technique of finding the optimal solution based on the natural behavior of ants including their mechanism of cooperation and adaptation [10]. At first, the ants wander randomly. When an ant finds a source of food, it walks back to the colony leaving "markers" (pheromones) that show the path has food. When other ants come across the markers, they are likely to follow the path with a certain probability. If they do, they then populate the path with their own markers as they bring the food back. As more ants find the path, it gets stronger until there are a couple streams of ants traveling to various food sources near the colony. The ACO algorithm is based on following three things.

i. Each path followed by the ant is associated to the candidate solution.

ii. The amount of pheromone deposited is proportional to the quality of corresponding candidate solution of the target problem.
iii. When there are more than one path, the ant choose the path with more pheromones deposited on it.

The major weakness of the ant colony algorithm is that it converges slowly at the initial step and takes more time to converge.

3.2 Particle Swarm Optimization

Particle swarm optimization (PSO) is a computational method that reduces the problem by iteratively trying to improve the candidate solution with improved quality [2,4]. PSO optimizes a problem by having a population of candidate solutions.

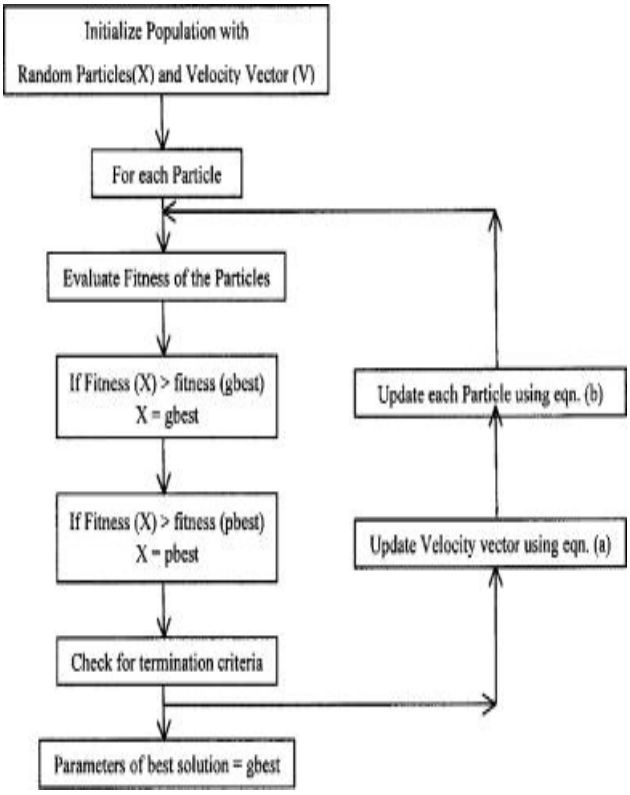

Fig 3. Algorithm of PSO

3.3 Hybrid PSO with ACO

Hybrid algorithm has less total link delay and least communication cost compared with conventional ACO. This hybrid algorithm is very useful in mobile communications. This hybrid algorithm exhibits better performances when compared to ACO approach. Ant Colony Optimization (ACO) algorithm uses mobile agents as ants to discover feasible and best path in a network [10]. ACO helps in finding the paths between two nodes in a network and acts as an input to the Particle Swarm Optimization (PSO) technique, a Meta heuristic approach in SI. Particle Swarm Optimization (PSO) finds the best solution over the particle's position and velocity with the objective of cost and minimum End-to-end delay [11].

IV CONCLUSION

In this paper, we have proposed the hybrid ACO-PSO algorithm which is best for solving the path problem. The parameters in ACO can be optimized by PSO and the parameters can be chosen self-adaptively which enhances the performance of ACO. In future work, we can implement some other optimization technique on cluster head selection and also work on WSN 3D environment.

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