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A bio-inspired clustering scheme in wireless sensor networks: BeeWSN

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Abstract

Wireless sensor networks can be used for a range of application starting from underwater to internet of things. It is the interconnection of wireless nodes called sensors deployed for a specific purpose. The nodes may be static or mobile in nature. The flat network structure may saturate the network when the number of nodes is very high. The clustering structure may solve the issue when clusters are formed at low cost. Several parameters need consideration during cluster formation and cluster head selection. These parameters are: nodes energy, mobility, mobility direction, nodes degree, etc. In this article, honey bee algorithm is used to select a cluster headset from existing nodes in the network and form clusters based on cluster heads. The problem is first formulated to the dynamic optimization problem and honey bee algorithm is applied in order to select the most suitable cluster heads in the network. The simulation results show that the proposed scheme outperforms existing algorithms.

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Keywords: HBA; WSN; Cluster based routing; Network Optimization

1. Introduction

Wireless sensor network (WSN) is the group of nodes or sensors that are interconnected with each other in order to share information.[1] It consists of sensors and a base station. The nodes may play the role of a router or a sensor. The sensor networks can be deployed for different application like environmental monitoring, disaster management, military operations and smoke detection etc. The nodes in the network may be static or mobile nodes. Due to mobility and limited components like power, processor, communication range, the design and development of protocol that fit into the sensor network is required. Different types of research issues still exist in the field of wireless sensor networks. One of the important issues is the routing of data from source to destination.[4] In past, flat based routing

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schemes were used to route data from source to destination. In flat based routing, the nodes play the role of a router and a sensor. In flat based routing schemes, the large number of control packets may saturate the network. Hence, the hierarchal based routing mechanism was introduced.

In hierarchal based routing schemes, the nodes are grouped into clusters. It is not necessary that every cluster must have a cluster head. In cluster head based hierarchal routing, a set of nodes are selected as cluster heads. The cluster heads are selected based on some criteria. The cluster heads are responsible to manage the nodes within the cluster. The communication between the clusters is the responsibility of cluster heads. Once the data is acquired from the nodes in the cluster, then, the cluster head send it to the destination or base station via other cluster heads if direct communication with the base station is not possible.

The cluster heads may be selected based on different criteria. In the papers discussed in the literature, the cluster heads nodes are selected based on remaining energy or mobility or node degree or speed. In some articles, a combination of some of the parameters is used to select the most suitable nodes for the role of cluster heads. Different optimization schemes like genetic algorithm,[3] ant colony optimization, memetic algorithm,[3] fuzzy logic,[8] neural networks etc. are used to form a cluster based network.

In this paper, the clustering problem in wireless sensor network is first formulated to dynamic optimization problem. The remaining energy of node, degree, speed and direction is used to select the cluster head. According to our knowledge, this is the first work that considers the said parameters during cluster head selection. Then, the cluster head set is selected through honey bee algorithm. The work is validated through simulation. The simulation was conducted in NS2. The simulation was performed for a number of rounds. The results were tested for cluster head duration, number of clusters, control messages overhead and re-affiliation rate. The results obtained during the simulation was compared with newLEACH,[5] MemeSen[2] and ANP.[6] The simulation results show that the proposed scheme outperforms existing schemes.

2. Related Work

In node rank-LEACH,[5] the cluster heads are selected based on node rank. The authors claim that the network lifetime is increased. The node rank algorithm selects the cluster heads based on the cost of a path and the number of links of nodes. The random selection of cluster heads is avoided in this approach.

Findings: In this scheme, the node speed and direction is not taken into account during cluster head selection process. So a node with high speed and different direction compared to its neighbors may be selected as a cluster head. It may create extra load on the network.

The authors of paper[6] form the clusters in WSN via Analytical network process model. The nodes remaining energy, distance from other nodes, distance from center, the frequency that a node performs the role of a cluster head and merged node are the main parameters taken into consideration during cluster head selection. The optimization is achieved via analytical network model. The authors claim that their proposed scheme outperforms existing methods.

Findings: The use of analytical model instead of other efficient optimization schemes such as honey bee optimization, neural networks etc. seems impractical. The proposed scheme is tested only for static nodes but now a days and in the future, most of the WSNs will be mobile. The proposed scheme may malfunction when the nodes in the network are mobile. The degree of node is not considered during cluster head selection and unbalanced clusters may be formed. This may result decrease in network lifetime.

An extended version of LEACH known as LEACH-CCH is proposed in.[7] In this protocol, mobile nodes are deployed randomly that are able to move freely from one location to another location. The time of maximum energy consumption of nodes is identified during the analysis of LEACH protocol. it is concluded that the nodes consume maximum energy during data transmission. The future position of the sensor nodes are predicted and the clusters are formed accordingly. The authors claim that the network life is increased.

Findings: The proposed scheme is compared with a fifteen years old LEACH protocol, many other algorithms exist that may outperform the proposed scheme like.[2]

An algorithm based on fuzzy logic for wireless sensor network is proposed in.[8] The aim of the research is to balance the difference between the energy efficiency and coverage. The cluster heads are selected on the basis of location and its expected energy consumption. Unequal clusters are formed to maximize the lifetime of the network.