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Energy efficient cluster based protocol and Dynamic Path Identification using BFO

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Abstract
The wireless sensor network usually consists of a large amount of battery-powered sensor nodes. For lifetime delay, it is of utmost importance in WSNs to proposal a clustering protocol in hybridization of tree structure that minimizes energy consumption while achieving the end-to end delay constraint to meet applications' requirements. Wireless sensor systems are becoming an active subject of research, where sensors are units with sensing, processing, & wireless networking ability. They can automatically collect the data & report the quantities to the sink. Recently, several wireless sensor systems have been designed and deployed for kinds of applications. An important role in many WSN operation models and applications, such as average access scheduling, information fusion, beam-forming, target tracking, etc. WSNs are used in a wide range of potential applications together with military, medical coordination, & robotic examination, which explains the significant attention drawn by these types of networks in research field. As demonstrated by, since sensor nodes are usually battery powered, conserving their energy & prolonging the system life time are prime goals while designing protocols for those networks. There is very less substructure in used in WSN. WSN contains of large amount of nodes which may vary from rare thousands to obtain the information from the atmosphere. So an efficient approach is needed for the optimize routing by using swarm intelligence approach to increase the lifespan of the network in terms of throughput, packet delivery, end to end delay with less error rate probability.

Keywords: BFO, WSN, Path Identification, Tree

Introduction

Wireless sensor network

Wireless sensor networks (WSNs) are most important technology in this century. WSN composed of various nodes called as sensors. By the advancement in area of microelectronic mechanical systems (MEMS) as well as wireless communication technology small, cheap and smart sensors are positioned in physical area and connected through wireless links and the internet provides remarkable opportunities for various applications. WSN is a network in which nodes are deployed at physical area of interest or very close to that area for monitoring that particular area. The locations of sensors need not to be pre-planned. Embedded microprocessors and radio transceivers are combined with sensors nodes. Sensor nodes are used for sensing the data, processing the data and for communication purpose. These deployed sensors are connected with wireless connection. Sensors sense the information of particular area in which they are deployed and forward that information to the common point for further processing on that information.

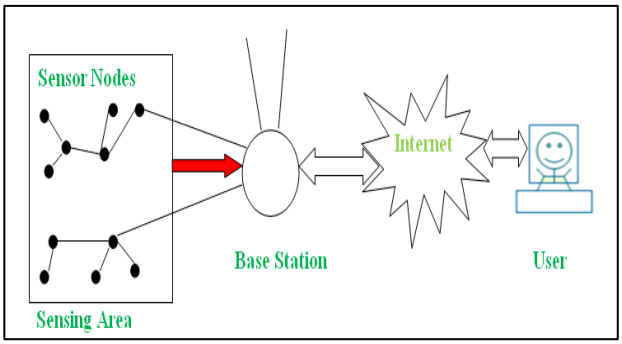

Fig.1: A general layout of a wireless sensor network [4]

Bacterial Foraging Optimization Algorithm

Nowadays, the term efficiency is necessarily present in every engineer's vocabulary. Concepts such as performance and cost cannot be neglected in a competitive society such as ours. Minimizing cost and/or maximizing performance can be considered as an optimization problem. So that, to optimize is to find the best solution to a certain designated problem. Every method has a set of problems to which it is more indicated. This depends on a series of problem characteristics, specially the function describing it, is not easily obtainable. Therefore, a good general understanding of the problem and of optimization method is needed.

Bacterial Foraging Optimization Algorithm (BFOA) is proposed by Kevin Passino (2002), is a new comer to the family of nature inspired optimization algorithms. Application of group foraging strategy of a swarm of E.coli bacteria in multi-optimal function optimization is the key idea of this new algorithm. Bacteria search for nutrients is a manner to maximize energy obtained per unit time. Individual bacterium also communicates with others by sending signals. A bacterium takes foraging decisions after considering two previous factors. The process, in which a bacterium moves by taking small steps while searching for nutrients, is called chemotaxis. The key idea of BFOA is mimicking chemotactic movement of virtual bacteria in the problem search space.

Literature Survey

Heinzelman et al. [1] proposed low-energy adaptive cluster hierarchy (LEACH). It is based on randomized rotation of the CHs to distribute the energy load among the sensor nodes evenly in the entire network. Each node elects itself as a CH based on a probabilistic scheme and broadcasts its availability to all the sensor nodes present in the area. The received signal strength is the prime parameter for determining the communication distance between the nodes. The CH performs aggregation of the packets received from all the nodes present in their cluster. Also, all the nodes get a chance to become the CH to balance the overall energy consumption across the network. Although the complexity of LEACH is low, the algorithm is not energy efficient due to irregular distribution of the CHs.

Kumar et al. [2] proposed energy-efficient heterogeneous clustered (EEHC) scheme in heterogeneous environment in which a percentage of nodes are equipped with more energy than others. The nodes play the role of a cluster head based on the weighted election probabilities according to the residual energy. Though the concept of heterogeneity is introduced, this protocol does not consider different parameters for the selection of CHs.

Distributed hierarchical agglomerative clustering (DHAC) [16] classifies sensor nodes into appropriate groups instead of simply gathering nodes to some randomly selected CHs. The application and the evaluation of methods of various techniques such as SLINK, CLINK, UPGMA, and WPGAM, with quantitative and qualitative data, are demonstrated in this method. The hybrid energy-efficient distributed protocol (HEED) [17] is single-hop clustering protocol in which CHs are selected based on a hybrid metric consisting of residual energy and neighbors proximity. Nodes having high residual energy and operating under low communication cost can become CHs. Multiple CHs are used for transferring the data to the base station using the concept of multihop communication. But HEED does not guarantee the optimum number of elected CHs. Multicriteria decision-making-based approach, trapezoidal fuzzy AHP (FAHP), and hierarchical fuzzy integral [18], have been investigated in clustering on WSNs. The selection of cluster heads is optimized to develop a distributed energy-efficient clustering algorithm using three criteria including energy status; QoS impact and location. According to these criteria, each node computes a composite value by using fuzzy integral, which is mapped onto the time axis, and a time-trigger mechanism makes the node broadcast cluster-head information.

Karaca et al. [3] proposed analytic hierarchy Process (AHP), which is used to centralize CH selection scheme. The factors contributing to the network lifetime are residual energy, mobility, and the distance to the involved cluster centroid. CHs are selected in each cycle based on the mobility and the remaining energy of the nodes. It is reported that the AHP approach improves the network lifetime remarkably.

Farzad Tashtarian et al.[4]proposed a theory for controlling the mobility of sink in event-driven application to bring out the extreme lifetime of WSN. In event driven applications the mobile sink with limited velocity has to gather the catches data from particular group of sensor nodes. This problem is NP hard. This approach is more effective for controlling the mobility.

Wang Liu et al. [5] proposed a Mobility Assisted Data Collection model in which the parameter like mobile sink, velocity of mobile sink and journey path of the mobile node is included. Many other MADC schemes does not discuss about the factors like throughput ability which is maximum data gathering rate & lifetime which will be related with certain data gathering rate. This approach explores behavior of WSN with respect to one and more mobile sink. Result shows network with mobile sink performed well as compare to network with static sink. MADC parameter can also be adjusted to enhance data gathering rate and lifetime is increased.

Shuai Gao et al. [6] proposed a scheme called Maximum Amount Shortest Path (MASP). This scheme conserves the energy and increase the throughput of the network. Zone partition scheme based two phase communication protocol is design for implementation of MASP scheme. MASP is for path constrained, mobile sink. There is mapping

between sub sink and nodes which leads to maximum data collection by sinks and to balance energy utilization. MASP enhances the energy efficiency.

Flowchart

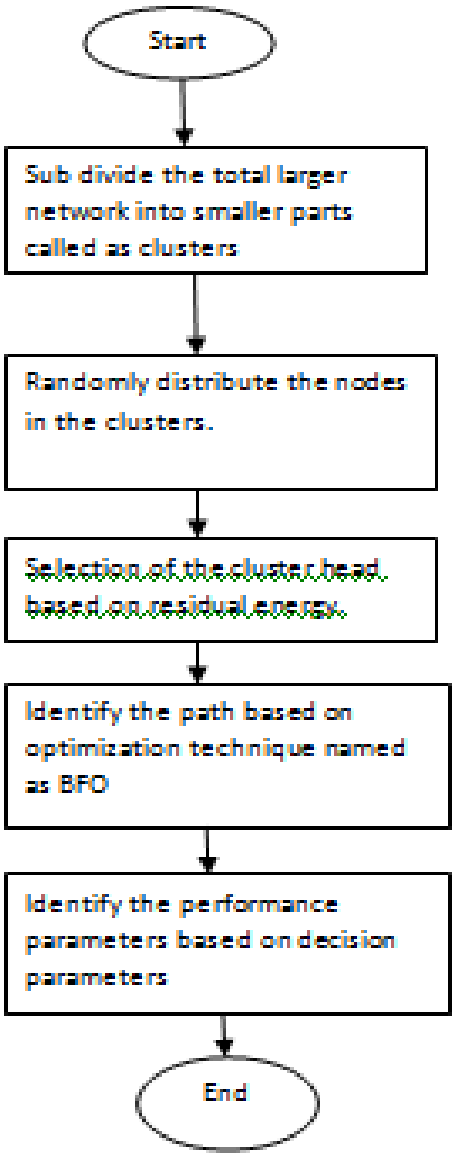

Fig. 2: Flowchart

Algorithm

For each round:

1. According to clustering sensor networks, CHs and the CNs are selected from each cluster.
2. Each node has to calculate its fitness value that depends on the energy of the node and find the probability which depends on the pheromone and the distance to chosen as CH.
3. Update final set of cluster heads on the basis of comparison between the probability and threshold factor of CH and the CNs of the cluster.
4. Update fitness value of selected CHs.
5. Time schedule is assigned to each node by its CHs, assigned time schedule is used to transfer the data from CNs to CHs.
6. Find maximum probability of CHs and select CH as CH Leader.
7. CH sends data to their CH leader.
8. CH leader transmitted data to the sink node.

Results Analysis

Network Configuration

Table 1: Network Configuration

Parameter	Value
Deployment Field	1000*1000
Data packet Size	200 Bytes
Control Packet	25 Bytes
Number of Node	100-350
Initial Cluster radius	25m
Sink Position	At Right Top
Initial Energy	25J
Threshold Distance	75M
Deployment method	Random
Rotated Time	25S
Radio Model	CC4220

Performance Parameter

a) **Packet Delivery Ratio:** It Measure that how many packet has been delivered successfully from source sensor to the destination sensor.

b) **Energy Consumption**: How much energy has been consumed while sending the data from source sensor to the sink node?

c) **Throughput: H**ow much packets has been delivered per unit interval of time.

Network Interface

This interface shows various sensor nodes lying randomly in the clusters. Each sensor node sends the data to the cluster head and cluster head by locating the optimal path sends the data to the sink node. Sink node position is on the right top.

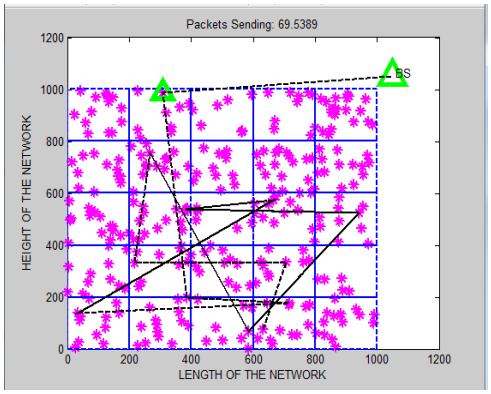

Fig. 3: Network Interface

Energy Consumption

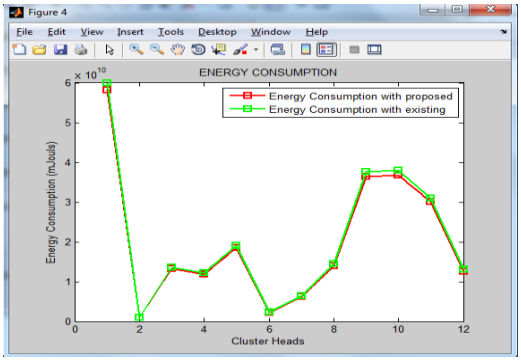

Fig. 4: Energy Consumption Comparison for existing and proposed

These performance figures show that there is less energy consumption in cluster id. That means while identifying the optimal path using BFO less energy is consumed compared to when there is no optimality algorithm. Fig. 4.2 shows the energy consumption in network while using BFO. Fig 4.3 shows the energy consumption for base technique.

Throughput

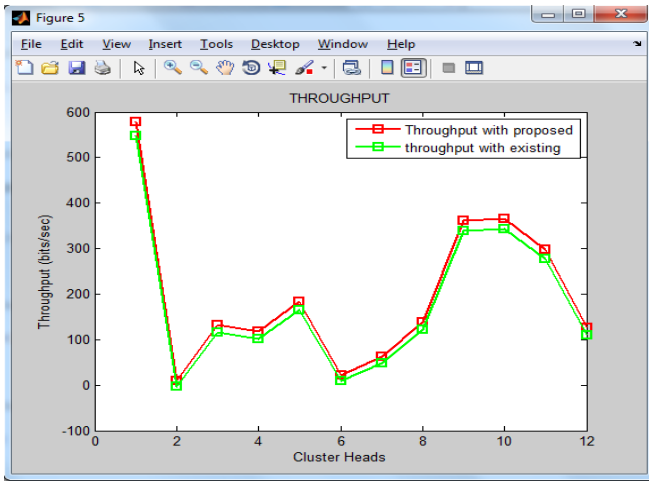

Fig. 5: Throughput comparison for existing and proposed

Above figures shows the throughput of the BFO and While using random cluster. Throughput in case of network having Genetic algorithm is more efficient compared to the network having no genetic algorithm. More number of packets will be delivered to the sink by adopting the optimal path. Such that at initial and at the end more packets are being delivered.

Packet Delivery Ratio

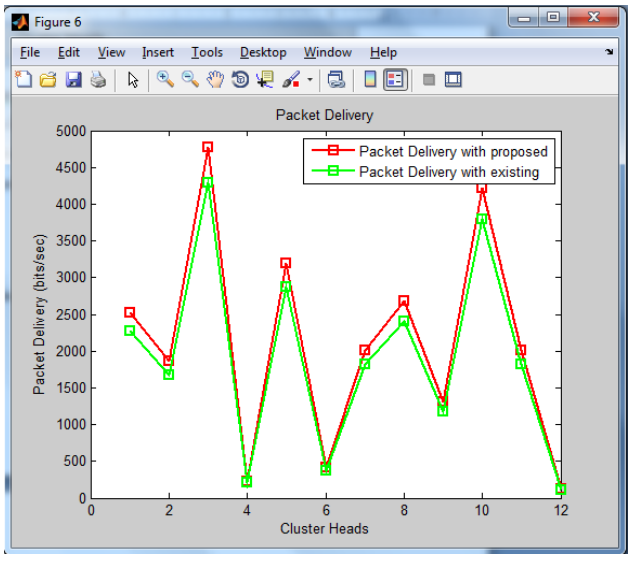

Fig. 6: Packet Delivery Ratio Comparison for existing and proposed

This figure shows the packet delivery ratio for BFO and Random cluster. When optimal path will be identified using Genetic algorithm more packets are being delivered to the destination. Because less energy is consumed. With less energy more packets are being delivered. Fig. 4.6 shows the packet delivery for network with BFO and Fig. 4.7 shows the packet delivery with random cluster.

Tree based path

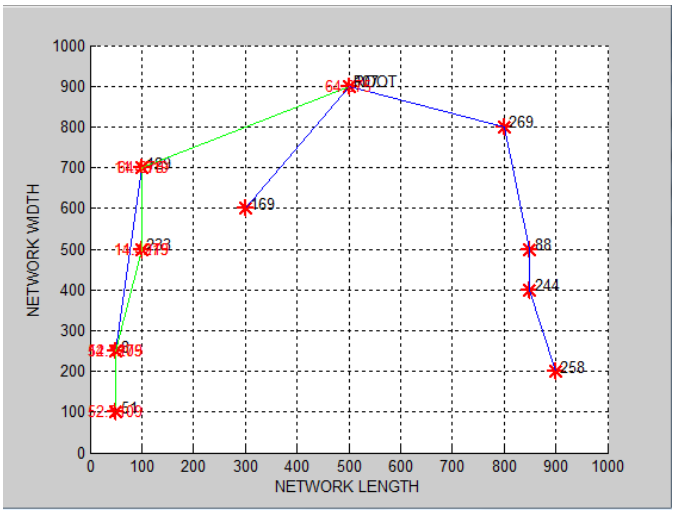

Fig. 7: Tree based path

Percentage Improvement

Table 2: Comparative Table

Parameters	Existing	Proposed	Improvement
Throughput	174.2141	182.21	4.3%
Packet Delivery Ratio	1571.381	1901.435	17.35%
Energy Consumed	0.352628	0.320454	9.12%

This table shows the improvement in all the parameters like throughput, Packet Delivery Ratio, and energy consumed. There is an improvement of 4.3%, 17.35%, and 9.12% resp.

Conclusion

WSN is the wireless sensor network having various clusters. Each cluster has randomly distributed nodes. In each cluster one cluster head is chosen based on max. Residual energy. One sink node lies outside the network at fixed position. With the help of BFO optimal path will be identified so that with less energy max. Data can be sent to the sink node. Each time path will be identified which is optimal path. Compared to it in random cluster each cluster head sends the data individually to the base station. Various performance parameters like Remaining Energy, Packet Delivery ratio, and Throughput has shown improvement compared to the base technique. More number of packets are being delivered with less time and energy. In current framework BFO as genetic algorithm for optimal path identification is performed. In future network with different types of configuration can be further tested. In current settings we have taken fixed sensor node and fixed sink node. We can test this technique for moving sensor node and moving sink node.

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