ISSN: 2229-6948(ONLINE)
DOI: 10.21917/ijct.2020.0324

A TRUST BASED CLUSTER HEAD SELECTION APPROACH USING RBFO AND HYBRID BFO-BSO FOR WIRELESS SENSOR NETWORK

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Abstract

The devices to create a connected network are demanded by the communication task which involves in the wireless sensor network for disseminating and collecting the information based on the radio transmission. The network lifetime's extension in the operational environment is the essential aim of the WSNs for exchanging the batteries of sensor node is an unfeasible or impossible activity probably. The selection of CHs is targeted in the clustered network that reduces the energy and transmission costs. It's essential to make the optimal selection of CH to improve the lifetime of a network. However, Non-deterministic Polynomial (NP) hard is considered for CH selections. The natural swarm inspired algorithms such as Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), and Hybrid algorithm (Bacterial foraging Optimization) BFO-BSO (Bee Swarm Optimization) have search their path into the domain and effectiveness is proved. An approach of a trust-based cluster head selection is introduced for improving the efficiency in terms of choosing the cluster head. To compute a trust level for every node, a designing of trust model is done and is implemented. By using the additional three parameters in addition to the hybrid approach such as trust value, residual energy, and the number of neighbors, the cluster heads are chosen. For choosing of cluster head, the T-BOA is adapted to achieve the different objectives such as increased performance of a network, reduced end to end delay, and decreased usage of energy in this work.

Keywords:

T-BOA, Trust Model, ACO, BAT Algorithm, WSN, Cluster Head Selection, BFO–BSO, PSO

1. INTRODUCTION

For ad-hoc wireless networks, the emerging paradigm is considered as Wireless Sensor Network (WSN). A wide range of autonomous devices with the hundreds or thousands in number that are contained in the network and they are called as sensor nodes. The sensor node is composed of different types of devices such as a restricted quantity of memory, a processor with limited processing power, and a sensor board and it is considered as a low-power constrained device. A sensor board may include various types of sensing devices like a battery that facilitated the energy and a radio for the sensor node for wireless communication respectively. In general, sensor nodes are energized through the battery. The sensor nodes are functioning for about couple of months to years when organizing the nodes as unattended for long period of time. Hence, an inadequate resource in WSN is energy and it's crucial to maintain the effective usage for improving the lifetime of an entire sensor network.

For heterogeneous WSN, an algorithm of effective multi-level cluster based on link correlation was adopted as level-k cluster heads. The network's lifetime is improved significantly and the energy efficiency is increased by implementing the network coding on those nodes [1]. This new protocol is showed that it could able to extend the lifetime during which no node is used more energy and balance the consumption of energy based on the simulation results [2]. According to the residual energy of the sensor and distance between the cluster in WSNs, the associate cluster head selection context is reduced the cluster head's overload, decreased the overhead of clustering process, and re-clustering is also restricted. Thus, the energy consumption is reduced in the cluster for large-scale and dense senor networks [3]. The diameter of multi-hop clusters is controlled by a Connection-Constrained WSN (CCWSN) based on a connection bound for each Sensor Nodes (SN) for multi-hop WSNs. This system will assist to improve the lifetime of a network and to derive the appropriate cluster size. The re-configuration is not required by the method of static clustering that would lead to the additional time overhead and consumption of energy [4].

With processing the simulations through the software Network Simulator-2 (NS-2), the consumption of energy of routing protocols of LEACH for WSNS system is evaluated. The level of energy usage [5] is affected by the number of clusters. The transmission of data packets with less energy efficiently and improved the longevity of a network are achieved based on the cluster based routing protocol's simulation results by indicated method when compared to LEACH and LEACH-C [6]. By including the geometric distance between the candidate's nodes to the BS, two distance-based clustering routing protocols are used known as DBEA-LEACH and DB-LEACH that chose a cluster head node. The node's residual energy is also examined and it is higher than the average residual energy level of nodes in the network [7].

In [8], LEACH protocol's version is known as Optimized LEACH (OP-LEACH) is proposed with the objective of reducing the consumption of energy in the WSN. Based on OMNET++ simulator, both proposed OP-LEACH and existing LEACH protocols are processed through extensive simulations. The performance of OP-LEACH is well than the protocol of LEACH. By comparing with homogeneous environment of LEACH [9], the simulation results of LEACH heterogeneous environment is showed that the reduced energy usage and increased lifetime based on a Matlab. In the homogeneous environment, the deploying of an algorithm of homogeneous fuzzy logic based clustering has been done hexagonally. In addition to the reduction of data redundancy that is being transmitted by the sensor nodes [10], the sensing area is covered efficiently.

Two types of folds have been involved in an algorithm of hybrid clustering such as K-Means unsupervised learning algorithms are used to choose the sensors that belong to each cluster Based on an arbitrary number of clusters and Genetic Algorithms (GA), Particle Swarm Optimization (PSO) are used separately for choosing the efficient CHs that were included the tests with number of experiments for different layouts. By comparing with the KGA [11], the better results are provided by KPSO. The selection of cluster head is encompassed by a Fuzzy

and Ant Colony Optimization (ACO) based MAC or Routing Cross-Layer Protocol (FAMACRO) for WSNs. With Unequal Hybrid Energy Efficient Distributed Clustering, Distributed Energy Efficient Hierarchical Clustering, and Energy Efficient Unequal Clustering and Improved Fuzzy Unequal Clustering protocol, the clustering and inter-cluster routing protocols are compared. FAMACRO is showed that 82% more energy efficient, sends 91% more packets, and has 5% to 30% more lifetime of a network achieved than the Improved Fuzzy Unequal Clustering protocol [12].

With the BSO and BFO, the selection of CH is optimized based on a hybrid algorithm is presented. The local optimum is considered in BFO. To restrict this, the hybridization of BFO with BSO is done in a pipeline manner. Owing to the high solution quality, less computational burden, simplicity, and fast convergence, BSO is the best technique to solve the problems of WSN optimization. The performance results are shown by the proposed algorithm of BFO-BSO that includes the lower average end to end delay (s), improved network's lifetime, selection of the formation of clusters, and improved network's lifetime [13].

2. LITERATURE SURVEY

The collection of data by the nodes is same in [14] that will lead to the redundant transmission. The choosing of cluster head and efficient organization of nodes into clusters are considered major aspects of WSN as the nodes are energy constrained characteristic. The data can be sent to the cluster head by all nodes and the data aggregation can be considered in these nodes. By depending on the number of bits which are being transmitted and distance between the nodes, the energy is needed to send the data. However, routing protocols are made classified as data centric, location based, and hierarchical protocols. The distributed algorithm is utilized by the clustering protocols for the purpose of selecting the cluster head.

In [15], the author has been proposed an improved CH-Management technique based on Particle Swarm Optimization (PSO) which is termed as PSO_DDE to increase the lifetime of a network. To evaluate the optimal region, PSO_DDE is incorporated. According to the information of fitness, the populace of nodes is updated by the algorithm that can be expected the best solutions to operate the WSN.

In [16], the author is proposed an algorithm of improved cluster head selection with soft computing to attain the data aggregation of an efficient sensor networks. The evolutions of parameters are investigated and compared with the various algorithms like KBFO, LEACH, Hybrid BFO-BSO, and Refined-BFO (RBFO) algorithm.

3. HIERARCHICAL TRUST BASED BAT OPTIMIZATION APPROACH (HITBOA)

Two layers are included in the method of HiTBOA such as Layer 1 (the higher layer) and Layer 2 (the lower layer). Different types of devices like RFID devices, sensors, machines, people, etc. with their ID and no assigning of IP are contained in the Lower layer. The cloud or Internet can't be accessed by these devices directly. These are considered as a crucial part of the network as they are included the parts of ITS system and cluster head is playing an essential role. The processing of forming a dynamic cluster and choosing CH will be done in this layer. Sensed data will be collected by each node and send that data to their respective CH when this is completed. These data will be aggregated and send to either to the higher layer's Powered-Node or Layer 1. Powerful IP-enabled devices are contained in this layer that supported with IoT functions that include IEEE802.15.4e in MAC layer, 802.15.4-2006 in the physical layer, an application layer with COAP protocol, and 6 lowpan supported network layer. In Layer 1, the involved devices are to be supported the battery life with longevity for making real-time processing and communication. All parts of a considered network can be covered by the multiple base stations in this layer and connecting all parts in a mesh topology. To understand the entire network's scenario, Layer 2 nodes are enabled.

In various possible ways, the communication of devices in both layer 2 and layer 1 can be done. By relying on whether BS is within the transmission range, one CH might be communicated with two base stations, two CH might communicate with one BS, and one CH might communicate with one BS.

3.1 DETAILS OF HITBOA MODEL

The information of the proposed model of HiTBOA is described in this section. An approach trust-based cluster head selection is introduced for improving the efficiency of CH selection. For determining a trust level for each node, a trust model is designed and exploited. The cluster heads are chosen by using three parameters such as trust value, residual energy, and the number of neighbours in addition to the hybrid approach. The assumption for a design is demonstrated and the trust model is proposed. To create the cluster and choose its CH, the trust model's output is utilized.

3.1.1 Assumptions

According to the concept of neighbour counting, the proposed model of HiTBOA is developed that indicated the connectivity in addition to the node's residual energy. By considering the assumption of making a cluster formation within the radio transmission range of a node, it is designed additionally. By using the model of UDGM (unit disk graph medium), the random deployment of all nodes in the network is assumed. To prepare the network as dynamic, the mobility is implemented for the nodes.

3.1.2 Trust Model:

By depending on the given node's trust computation, a security-based trust is developed. To calculate and manage the nodes' trustworthiness in the proposed algorithm, two levels are included such as BS level and node level (normal node and CH node).

3.1.3 Clustering Model: T-BOA-based Clustering

Based on the Bat Optimization Algorithm and trust level (presented above), the clustering model is recommended in this paper. The problem of clustering can be considered as an issue of optimization since the problem is targeted to determine the efficient outcome from all feasible solutions generally. Bat Optimization Algorithm (BOA) will be exploited and it is performed well in terms of efficiency and accuracy than the other algorithms. When compared to GA, PSO, and harmony search,

BOA is more powerful and it utilizes the benefits by combining those algorithms.

The following steps are contained in the approach of Trust with Bat-based Optimization as shown in Fig.1.

1. *Initiation of Election Process of Cluster Head*: With the broadcasting of a message to the network of all nodes for sending their IDs, residual energy level, and list of neighbours, the selection process of cluster head is initiated by BS. The trust values for their neighbours are calculated.
2. *Preparing a List of Candidate's Information*: By aggregating the gathered trust values about each one, the final trust value is determined by BS for all nodes. A final list is prepared by BS that includes Residual Energy (RE_i), Node Id (N_{id}), Number of Neighbours (Neighbors number), and Final Trust Value (T_i).

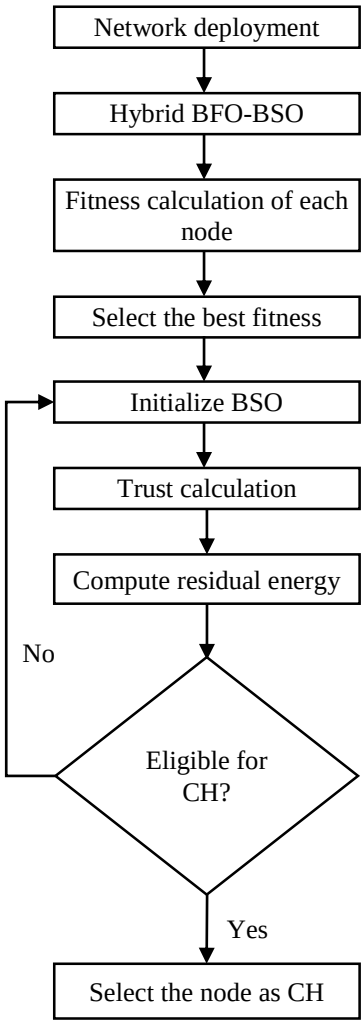

Fig.1. Flow-Chart of T-BOA Approach

4. RESULTS AND DISCUSSION

The evaluation of proposed cluster model is processed in this section. By using NS-2 simulator, all the conducted experiments are processed. Based on the following characteristics, the testing of proposed method is done under the heterogeneous network. Consider a network with 30 numbers of nodes which are distributed randomly and deployed in the region of 1000 m × 1000 m. Based on different metrics like average trust value of CHs, network's lifetime, and average residual energy, the proposed model is evaluated.

Two benchmark models of BFO-BSO and RBFO performances were compared with the proposed algorithm based on the listed parameters and same network type or model that are mentioned in Table.1. For ideal unstructured network, the mobility of Random Way Point (RWP) is utilized and the transmission range is set to 250m. Two types of scripts are exploited such as the first one (code.tcl) for generation of random traffic for constant bit rate (CBT) of 512 bytes based on the UDP protocol. For all tests, 20s of simulation time has been set. We used number of clusters are 8 in simulation process.

Table.1. Parameters for Simulation

Parameter	Value
Application Traffic	CBR
Transmission rate	512 packets/0.05sec
Radio range	250m
Topology	Random
Propagation model	Two way ground
Packet size	512 bytes
Maximum speed	30m/s
Simulation time	20000ms
Number of nodes	30
Area	1000×1000
Clusters	8
Initial energy	100j
Routing protocol	AODV
Maximum packets	10000

The experiments are conducted in two steps. The verifying of plan's viability is considered in the initial step. Deep study of investigation is processed in the second step to analyze the parameters such as throughput, the delay, and consumption of energy which are described below.

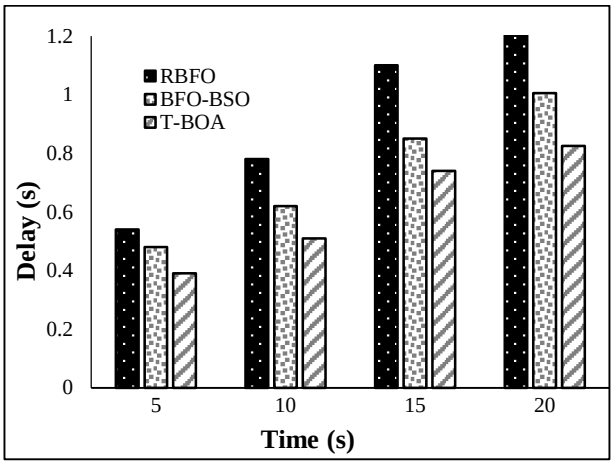

Fig.2. End-to-End Delay

The network's delay is shown in Fig.2 and the delay should be lower for achieving best performance. Based on the results, the proposed new model like T-BOA is provided less delay in the network when compared to the existing methods such as RBFO and BFO-BSO which gave more delay in the network.

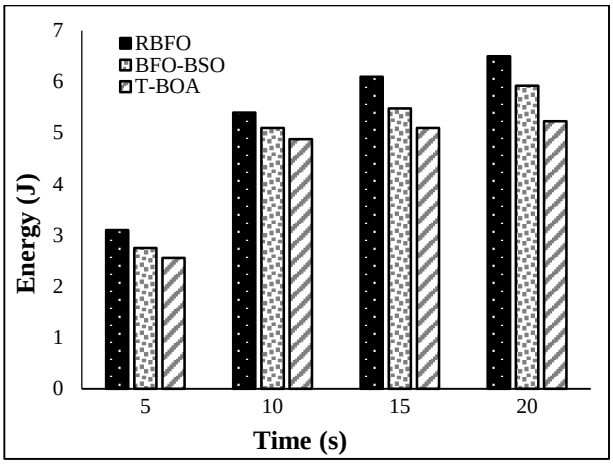

Fig.3. Energy Consumption

The network's energy usage is displayed in Fig.3 and the energy conservation should be less in terms of best performance. Less consumption of the network is provided by the proposed new method T-BOA by comparing with the previous techniques such as RBFO and BFO-BSO that facilitated higher consumption of energy for entire network.

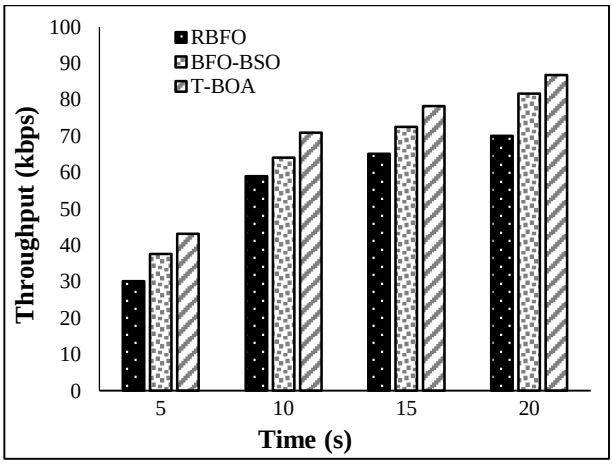

Fig.4. Throughput

The network's performance is mentioned in Fig.4 and the throughput should be more to analyze the performance of a network. When compared to the prior methods such as RBFO and BFO-BSO that provides lower throughput, new technique like T-BOA is giving high throughput in the network.

5. CONCLUSION

For Wireless Sensor Network, T-BOA based Cluster Head Selection is processed and determined the performance by measured parameters for the formed number of clusters that includes consumption of energy, throughput and end to end delay. The performances of T-BOA, RBFO and Hybrid BFO-BSO are measured and compared with the previous algorithms RBFO and BFO-BSO that are illustrated in detail with literally and graphically. The improved lifetime is provided by the optimization algorithm T-BOA and the battery life is increased. The comparisons parametric evaluations are viewed that the overall performance is higher for T-BOA than Hybrid BFO-BSO and RBFO.

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