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A Lion Optimization Based Energy Efficient Clustering In WSN

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Abstract

In a wireless sensor network (WSN), maintaining a lifetime is a critical task due to the limited battery supply. Hence, a new strategy for network lifetime optimization is needed to prolong the lifetime of the network .clustering is a well-known method to increase a network by the grouping of sensor nodes. In this work, Lion Optimization (LOA) based cluster head selection and routing protocol introduced for efficient cluster formation. LOA is a naturally inspired optimization algorithm motivated by the life span of lions in the forest. LOA is utilized to select a suitable cluster head by considering energy, distance to the base station, and delay. MATLAB simulation results show that proposed clustering achieves higher efficiency than other standard protocols

Introduction

WSN contains sensor nodes and is deployed randomly for various environmental applications like military, surveillance, and forest monitoring. These sensor nodes are always power-hungry and supplied by the battery. In order to tackle the energy constraints of sensor nodes, energy-efficient protocols have been proposed by various researchers. Clustering is one of the promising methods to increase the lifetime of the network.

Low energy adaptive clustering hierarchy (LEACH) is the very first self-organizing clustering algorithm to improve the lifetime of sensor networks. Various successors of LEACH protocols have been proposed for cluster head selections like LEACH-DCHS, TB-LEACH, LEACH-SWDN. But, these algorithms cannot assure the maximum optimization of the cluster head selection process.

This work proposes a new clustering by combing Eigenvector centrality and LOA optimization. Eigenvector centrality is used to identify the relationship among the nodes with respect to the node to node distance and node to base station distance. Then, LOA was utilized to find a suitable cluster head in terms of residual energy and distance.

Related work

Various clustering algorithms are proposed by various researchers by considering the quality parameters of networks.

Heikalabad, S. R et al. 2010 have proposed a new clustering protocol called HEECH by considering the energy and distance of the node. Simulation results of the proposed algorithm indicate that the proposed HEECH improves a node lifetime by about 56% when compared to other standard clustering protocols.

Zhang, J et al. 2016 have proposed a weight-based clustering algorithm called LEACH-WM. The weight for each node is calculated based on residual energy and distance from the base station .further, and a data aggregation strategy is used to remove redundant data. The proposed algorithm outperforms better than other clustering protocols of LEACH-DCHS and TB-LEACH.

Wang, H 2017 et al. have introduced a double cluster head selection algorithm by modifying standard low energy adaptive clustering algorithm (LEACH). The double cluster head selection is done by using a data fusion mechanism and information entropy. Implementation results show that the proposed method balances network energy considerably.

Mehta, R et al. 2012 has proposed a modified version of the LEACH algorithm named Equalized Cluster LEACH. The proposed method integrates the method of adoption for cluster head selection. Results show that Equalized Cluster LEACH reduces routing overhead and energy consumption compared to other protocols.

Jin, Z et al. 2015 have presented a routing protocol by jointly considering transmission count and link reliability. They also derived a generic analytic model from analyzing network lifetime. The proposed method achieves optimal cluster ratio and improved network lifetime

Ammari, H. M et al. 2012 have addressed the issues of clustering in terms of coverage cost and node location. They also derived the relation between sensing range and distance. Simulation results show that the proposed method attains guaranteed connectivity with low energy consumption.

Hemavathi N et al. 2019 have introduced a new clustering protocol with the consideration of the Received Signal Strength of the node. In the clustering phase, fuzzy logic is used, and cluster head selection is based on the energy, distance, and Received Signal Strength of the node. From the results observed that the consideration of signal strength has influenced a greater impact on network performance.

Younis, M. F. et al. 2006 have focused on developing clustering protocol including network security. Key management techniques were also developed in order to detect attackers in clusters. Compared to other security-based cluster protocols, the proposed cluster protocol detect more attackers with minimum energy overhead
Wang, W et al. 2009 has proposed a Hybrid Cluster Head Selection Leach using Simulated Annealing Algorithm. Simulated Annealing was used to find optimal cluster head in terms of energy, distance, and delay. The MATLAB simulation results show better energy consumption reductions and efficiency improvements.
Huang, H et al. 2012 have analyzed a routing problem in the network and formulated a new QoS-based routing protocol .initially, proposed a 2D plain routing protocol and ant colony optimization algorithm used for minimum overhead routing path. Simulation results indicate that the proposed QoS-based protocol can achieve better performance.
Karimi, M et al. 2012 has introduced two new algorithms, namely GP-Leach and HS-Leach. The evolutionary algorithms used for optimized cluster head selection. The implementation results show that our proposed methods are more efficient, and they improved the lifetime of the network.

Wang, J et al. 2018 has proposed a clustering method using the Kmedoids algorithm to find the optimal medoids between sensor nodes .by By using medoids, the suitable cluster heads are identified. The proposed algorithm outperforms in terms of energy and network lifetime.

Elbhiri, B et al. 2010 has developed a new Distributed Energy-Efficient Clustering method for heterogeneous WSN. This method is based on cluster head election probability in a round-robin manner. Results demonstrate that the proposed achieves 15% lifetime improvement compared to other clustering protocols.

3. Proposed System

The proposed clustering and head selection process is performed into two phases. Initially, all sensor nodes are clustered by using Eigen centrality. Then, cluster head selection is done by LOA optimization.

3.1 Eigenvector centrality

It is used to give the degree or betweenness of the node. In degree centrality, the degree centrality represents connectivity and distance from adjacent nodes. Here, nodes are grouped by centrality in order to form an efficient cluster.

3.2 LOA

LOA is a population-based optimal solution finding algorithm in a larger solution space. For optimization, each lion population is said to be a solution with a specific cost function. LOA divided into the following steps:
Initialization
Hunting
Moving Toward Safe Place
Roaming
Mating
Defense
Migration
LOA is built based on simulation of the solitary and cooperative behaviors of lions mentioned above.

3.3 Problem formulation and proposed optimization

The fitness function of proposed cluster selection in terms of energy, delay, and distance is
F=o1*dist+o2*energy+o3*delay
The LOA is used to find optimal clusters by solving the above fitness function. The distance from the member node to the base station is

$$\text{dist} = \max_{i = 1,2,\ldots,K}\{\frac{\sum_{j=1}^{N_i}(\text{Nm}_{ij}, \text{Nb})}{N_i}\}$$

Maximum delay from member nodes to the base station

$$\text{delay}_2 = \max_{i = 1,2,\ldots,K}\{d(\text{Nm}, \text{BS})\}$$

The total energy consumption

The whole network energy consumption of the entire network is

$$\text{Energy} = \sum_{i=1}^{K}(E_H^i + \sum_{j=1}^{N_i} E_m^{ij})$$

The proposed LOA optimized head selection explained below :

Algorithm
Input: N number of nodes
Output: form clusters and suitable cluster heads
Start
Initializing lion population
Calculate fitness function F for all solutions
For 1 to N
Compute →eigenvector
fori = 1→ k **do**
Cluster ←yrandom(1;n)
end for
While
For all clusters
forj = 1→ k **do**
CH ← Fitness function
Find the best solution

end for
end
until node dead

Result and Discussion

In this section, the performance of the proposed algorithm is compared with other clustering algorithms (ENERGY-energy-based cluster head, EXST-leach, DISTANCE-distance-based clustering) in terms of energy, lifetime, and packet delivery ratio. MATLAB simulation used for validation. For simulation, the node is created and deployed randomly. The average of packet delivery and energy consumption plotted and compared as shown in fig 1-fig3.

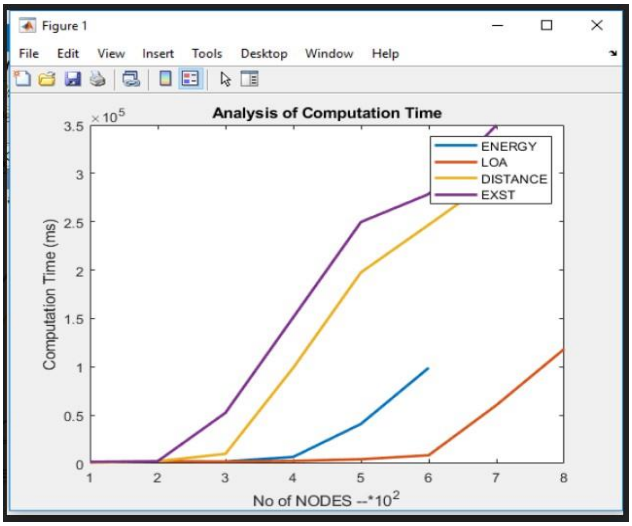

Figure 1 computation time

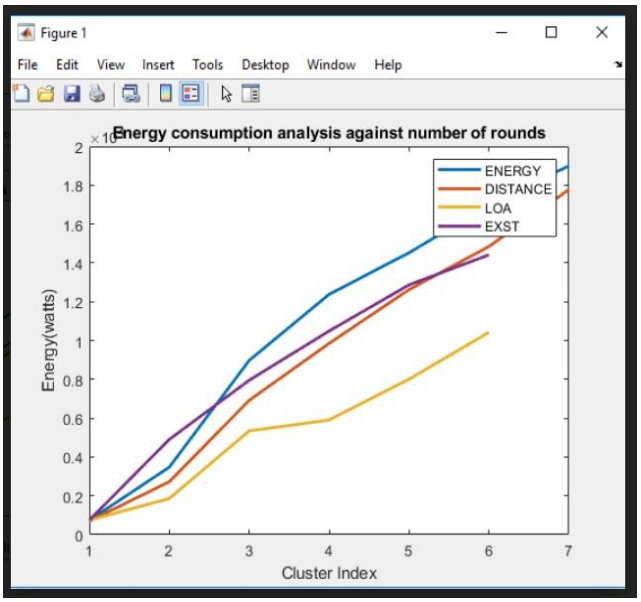

Figure 2 energy computation

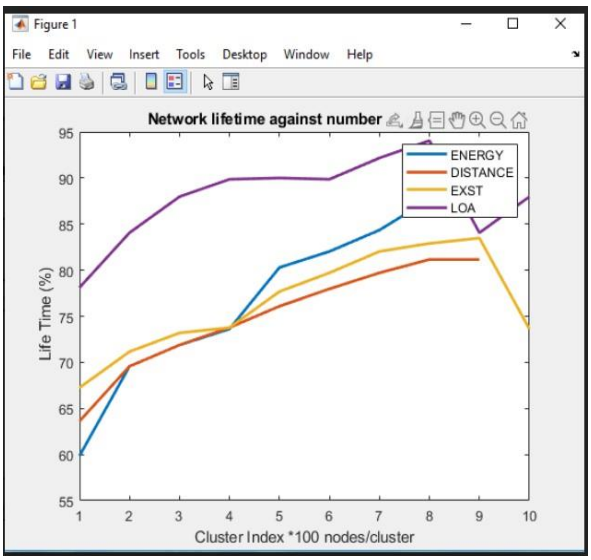

Figure 3 lifetime analysis

The graph observed that the proposed clustering method reduces. Overall delay and increased network lifetime due to selecting higher energy and minimum distance as a cluster head.

Conclusions

This work has introduced a new LOA-based energy-efficient r clustering protocol for WSNs. The selection of Cluster head is done using an adaptive optimization mechanism. The proposed mechanism concurrently considers both energy and distance as optimization parameters for cluster head selection. Future hybrid optimization will be applied to select cluster heads.

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