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A Novel Fuzzy and Grey Wolf Optimized Clustering Algorithm for WSN

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ABSTRACT

In a modern world, Wireless Sensor Networks (WSNs) have become extensively used inan enormous amount of applications due to their infrastructure-less, distributed and dynamic in nature. In those WSNs, hierarchical methodsincrease the performance of the network and increase its lifetime. Clustering is a well knowing technique to prolong the network life cycle and increase network performance. Here ,a new clustering protocol using fuzzy centrality clustering and Grey Wolf Optimized (GWO) cluster head selection. This Grey Wolf Optimizer (GWO) is motivated by the character of grey wolves for hunting process .More precisely, firstly, centrality clusteringis applied to grouping sensor nodes according to fuzzy Closeness Centrality and Eccentricity. MATLAB simulation used to verify the effectiveness of proposed selection method.

Keywords

GWO,WSN, Cluster Head,LEACH, Matlab

1.INTRODUCTION

Progressively, all the applications in need of data acquisition from the physical world in anautomatic manner like body area network, military and environmental monitoring applications This requirementsuggests the development of a new type of networks. Such networks, make it possible to capture and find particular elements called sensors.[1-10]Besides, they work on small batteries with minimumenergy. Therefore, their power requirement must be optimized in order to improve life for those devices.

A number of clustering protocols have been recommended to increase network performance. These protocols can be categorized into three types. First type based on controlling the transmission power level WSN node.[11-18]]In the second type, best-effort routing path identification based on power optimization in the third type control the network topology control by sleep scheduling methods. Clustering is the most useful technique for load balancing in networks.

Here , a new clustering protocol using fuzzy centrality measure and Grey Wolf Optimized (GWO) [4] cluster head selection. This Grey Wolf Optimizer (GWO) is motivated by the behaviour of grey wolves in leadership hierarchy and hunting mechanism in nature.[19-23]

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More precisely, firstly, centrality clustering is utilized to grouping sensor nodes with respect to fuzzy Closeness Centrality and Eccentricity[5].

The rest of paper is organized as preliminaries,proposed system, implementation results and conclusion.

2. PREMILARIES

Centrality

The centrality of the node is used to give the relative importance of the node .it is classified into the types offollowing :Betweenness Centrality-BC, Closeness Centrality-CC and Eccentricitioty. This measures used to identify separation and closness between the nodes in order to fulfill shortest path and central node.

The BC of any node v is expressed as:

$$C_b(v) = \sum_{a \neq v \neq b} \frac{\delta_{ab}(v)}{\delta_{ab}}, (1)$$

The CC of any node v is expressed as:

$$C_c(v) = \frac{N-1}{\sum_{a \neq v} d(v,a)}, \quad (2)$$

The EC of any node v is expressed as:

$$E(v_a) = max_b d(v_a, v_b), \ (3)$$

where d(va; vb) denotes the separation between the nodeva and node vb.

GWO

Grey wolf is thought-out as apex predators and belongs to the Canidae family.In a food chain process,grey is the top leader in a group of 5-12. The basic steps of grey wolf hunting are tracking, racing, encircling, approaching the prey and finally attack toward the prey.

Encircling prey

The process of encircling of prey modelled mathematically as follows :

$$\vec{D} = | \vec{C} \ . \overrightarrow{X_p}(k) - \vec{X}(k) |$$

$$\vec{X}(k+1) = \overrightarrow{X_p}(k) - \vec{A} \ . \ \vec{D} \quad \ldots..(4)$$

where t denotes the current iteration, ~A and ~C are coefficient vectors,

Hunting

In a hunting process,the top wolf named as a leader and other wolf considered as alpha,beta and delta.The hunt is commonly lead by the alpha. Thebeta and delta also contribute tohunting.In hunting, wolf updates their position towards prey based on the position of the best search agents. The position updatesare as follows :

$$\vec{X}1 = \overrightarrow{X_\alpha} - \overrightarrow{A_1} * (\overrightarrow{D_\alpha})$$

$$\vec{X}2 = \overrightarrow{X_\beta} - \overrightarrow{A_2} * (\overrightarrow{D_\beta})$$

$$\overrightarrow{X}3 = \overrightarrow{X_\delta} - \overrightarrow{A_3} * (\overrightarrow{D_\delta}) \ (5)$$

Attacking prey

In attacking stage,the wolf decreases the value of ~a and choose random value in the period of [-2a, 2a] wolves frequently search based on the locations of other wolves.

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3.RELATED WORK

Wendi RabinerHeinzelman et al 2000 have introduced a routing protocol by randomized cluster head selection called LEACH (Low-Energy Adaptive Clustering Hierarchy) to uniformlyallocate the energy load among the sensors in the network.

El Rhazi, et al 2008 has proposed a proposed centrality based clustering protocol for data gathering sensor network.It utilizes network energy maps and Quality-of-Service (QoS) necessities. The clustering difficulties is modelled as a hypergraph partitioning and final solution attained usingtabu search heuristic.

Younis, O et al 2014 have introduced a protocol called HEED (Hybrid Energy-Efficient Distributed clustering) for cluster head selection

Quan, Z., et al 2007 et al proposed a clustering protocol called robust energy-aware clustering architecture (REACA). They analyzed the performance of the REACA network in terms in terms of lifetime,delay and power consumption.

Guo, L et al 2010 have proposed a weighting based decision making protocol for cluster selection.Latiff, N. M et al 2012 have proposed Particle Swarm Optimization (PSO) based grouping algorithm. ThePSO objective of concurrentlyreducing the intra-cluster distance and optimizing the lifetime of the network. The outcomes ofthe proposed protocol are compared with the standard protocols

Phanish, D et al 2017have introduced a stochastic geometry-based communication model for data gathering in WSN. The proposed study showsthe impact of data aggregation .Ni, Q et al 2017 have presented a clustering protocol by combining fuzzy clustering and particle swarm optimization.

4.PROPOSED CLUSTERING ALGORITHM

Fuzzy Centrality Clustering

Proposed clustering initialization using Fuzzy centrality clustering.Initially, the whole network divided into k initial clusters by elbow method. Then find a weighted matrix according to the centrality and eccentricity of a node using clustering.

The main objective of the proposed algorithm is to reduce overall energy consumption and choose best cluster heads among cluster member nodes.in this work following parameters are considered for cluster head (CH) selection.

1) Maximum separation fromCMto its CH

The entire network separated into K clusters and an average distance of between node is expressed as

$$\text{dist}_1 = \max_{i = 1,2,\ldots,K}\left\{\frac{\sum_{j=1}^{N_i}(CM_{ij}, CH_{ij})}{N_i}\right\} \quad (6)$$

where d(CMij ;CHi) denotes the distance between CMij and its CHi.

2) Maximum separation fromCH nodes to the BS

$$\text{dist}_2 = \max_{i = 1,2,\ldots,K}\{d(CH_i, BS)\} \quad (7)$$

Total energy consumption is expressed as

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$$E_{sum} = \sum_{i=1}^{K}(E_{CH}^{i} + \sum_{j=1}^{N_i} E_{mem}^{ij})(8)$$

EiCdenotes energy consumption for CH.

The overall objective function is expressed as

f = a1 Etsum +a2 distt1 + a3 distt2

In above fitenessfunction weighting of distt1; distt2;Etsum, with a1 + a2 + a3= 1. Here,we assign 0.25 for a2 and a3 by giving equal importance to distance and assign 0.5 to a1.

Algorithm 1 The Proposed Algorithm

Find the total cluster-T using conventional elbow technique
Matrix→ Fuzzy centrality Cluster (T; n)
Repeat
Process each node to some cluster
For d1 = 1 < T do
Repeat
Initialize population and best search agent for alpha, beta and gamma.
For m = 1 <S do
For d2 = 1 <m do
Process node yi to the nearest member
End for
Estimate fitness function
Update current position by equation (LocalBest)
Update xα, xβ, xδ using equation 5
End for
Until cover all cluster
End for
Until cover all nodes

5.Result and discussion

The proposed clustering protocol implemented using MATLAB tool. For simulation, the number of node-set to 150 andthefactors considered tabulated in Table.1

Table.1factors considered for simulation

Parameter	Value
Number of nodes	150
Initial energy of sensor node (Ei)	1J
Distributed area	500*500

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Transmission energy (Eelec)	30nJ/bit
Packet length(l)	3000 bit
a1(factors in objective function)	0.25
a2(factors in objective function)	0.25
a3(factors in objective function)	0.5

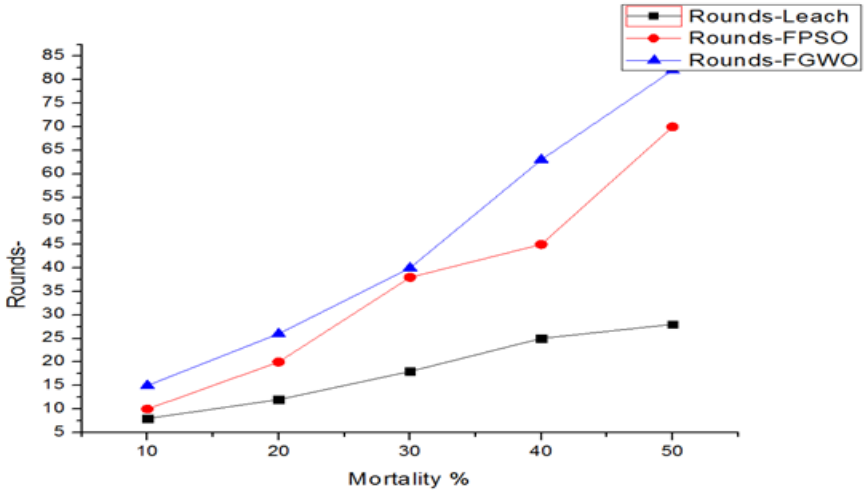

Figure 1Mortality versus rounds

The GWO based clustering shows considerable performance improvement in terms of packet delivery rate ,living rate and andenrgy consumption comapared to other LEACH and fuzzy-particle swarm clustering algorithms as shown in From Figure 1 and 2 ,3.

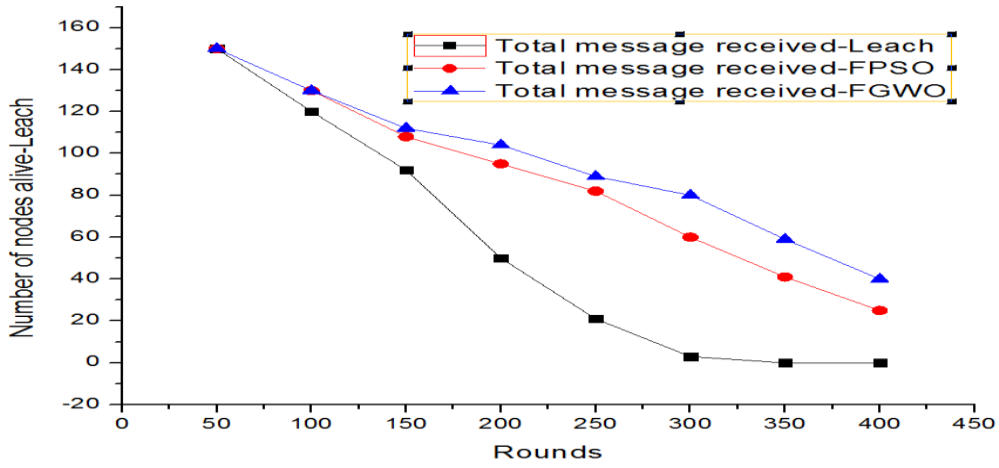

Figure2 Rounds versus the number of nodes alive

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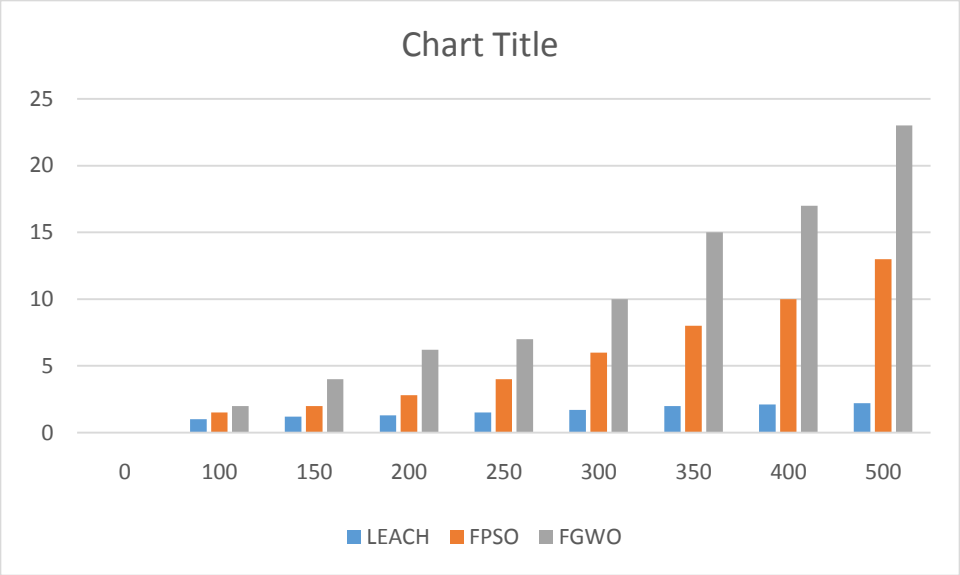

Figure 3 Number of round versus packets delivered per bit-10 power 7

6.CONCLUSION

Fuzzy and GWO optimized energy and distance efficient clustering scheme is proposedfor WSNs. In GWO, the fitness function is aimed at considering the parameters of node to distance as well asthe energy consumption.Simulated results are compared with the other standard protocol. Simulations results proved the efficiency of proposed method.

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