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An energy-aware clustering approach for routing mechanism in WSN using Cuckoo Search

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Abstract:-

Background/Objectives: In WSN, numerous obstacles are there in providing Quality of Service (QoS) routing at some preferred level. The main concern of the routing protocols in WSN is to offer energy-efficient framework. To propose an energy-efficient routing protocol, stability, and overall lifetime have a major role. Therefore, this research article has an objective to propose an energy-efficient clustering method in WSN using cuckoo search for routing protocol.

Methods/Statistical analysis: This research has proposed a route discovery process with the cluster heads (CH). The CH distortion of CH has been identified later on, and for the optimization of battery life, Cuckoo Search (CH) optimization algorithm has been used.

Findings: It has been discovered that with the utilization of the proposed CS mechanism, the CH method becomes speedy, and the selected CH helps in the prevention of packet loss as of maximal energy.

Improvements/Applications: With the usage of the CS method, an enhancement has been noticed in proposed work through remaining battery power, throughput, and Packet Delivery ratio (PDR). To be precise, 3.9% of improvement has been drawn then conventional methods.

Keywords: WSN, Clustering, routing mechanism, Energy efficiency, Cuckoos Search

1. Introduction

WSN is an interconnection of sensor nodes that are connected through a wireless medium. WSN finds application to monitor the physical and environmental condition of remote places [1]. WSN suffers from fewer energy resources, limited computing capacity, and wireless communication might be broken most of the time that creates network failure problem. Therefore, it is the requirement of a wireless network, that the sensor nodes must contain a battery with finite power. But, in practice, it is not possible. Thus the primary concern of this paper is to reduce the energy consumed by sensor node [2]. Figure 1 represents the structure of WSN, which comprises n number of nodes denoted by a red circle. These sensor nodes help to collect information from a remote area and for further processing, pass the information to the computer system through the gateway node. As the data is transmitted from one to another node throughout the network, therefore, each sensor node absorbs energy during reception and transmission of the data. In WSN, the energy consumed by sensor nodes is divided into two types (i) useful energy consumption, (ii) wasteful energy consumption. Useful energy consumption comprises of the energy consumed by a various factor such as sending and receiving data, processing, and forwarding query request. Wasteful energy consumption consists of energy consumed by sensor nodes during idle state and retransmission of data during packet collision. Therefore, we can say that a small part of the energy is utilized during transmitting and receiving the data, and most of the energy is wasted [3].

To minimize the energy consumption rate in WSN, we need to discover an optimal route from the source node to the destination node using the routing protocol, which focuses on energy consumption rate during transmission of data. There is a lot of routing protocol available that operates on the basis of energy consumption parameter, and some useful routing protocols are analyzed by various researchers, which is helpful to minimize energy consumption rate in WSN like LEACH (Low-energy adaptive clustering hierarchy), PEGASIS, etc.[4].

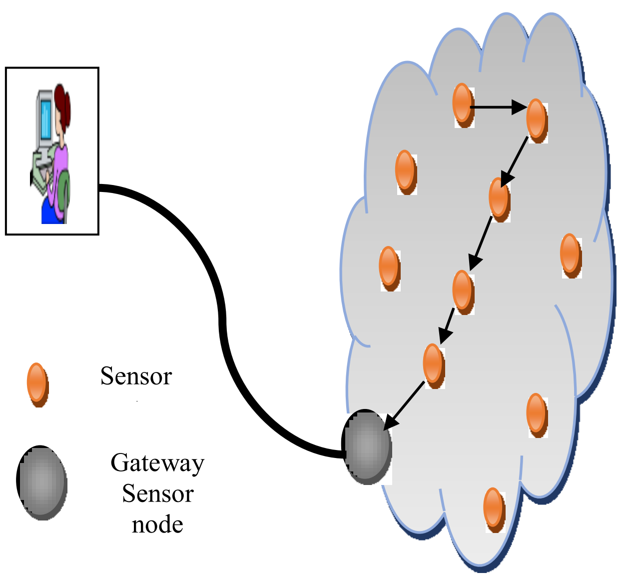

Figure 1.Wireless sensor network

The PEGASIS routing protocol is the most effective in WSN due to their nature. PEGASIS has an advantage that it has less transmitting distance as compared to LEACH and other routing protocols because it forms a chain between the sensor nodes so that every node receives and transfers to the close neighbor.

1.1. Major issues of WSN

Wireless sensor networks are the main component of the system as they can be integrated into a complex system. Sensor nodes are placed in the remote network where the human being is not approachable [5]. Like, in the forest, if the fire exists, then the sensors can convey a message to any of the mobile devices connected to the wireless sensor network. Thus, in this way, sensor nodes have to operate continuously for an extended period and hence required battery supply continuously. As we know that Li-ion batteries power nodes, so it becomes necessary to consume power effectively and thus to increase the lifetime of the network In order to solve the issue of power consumption, a lot of research work has been done so far.

1.2. LEACH

LEACH (Low Energy Adaptive Clustering Hierarchy) is a routing method that info is delivered to the data sink or foundation train station in a cluster-based approach. You can find a handful of factors to get remembered, such as increasing network lifetime, lessening power use as well as carrying out info control in second-time beginner's nodes to reduce the number of transmissions. It was suggested by Wendi B [6]. This is a cluster-based power structure that complete network is separated into groups, as well as every bunch, has a cluster-head designated to it. Chaos creation is active with every circular plus the bunch brain accounts for the data collection from each of the nodes of the bunch; the idea operations the data as well as directs your compiled info for the foundation train station. Figure 2 suggests the underlying architecture of Cluster Head (CH) to Base Station Communication [7].

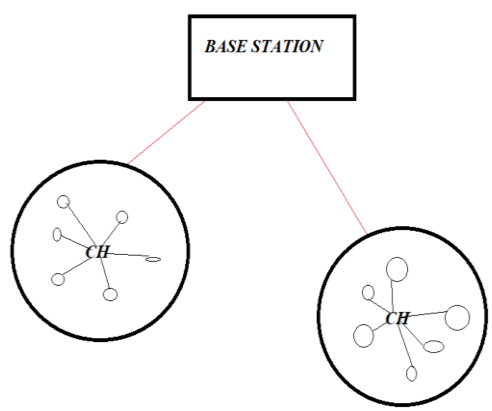

Figure 2.Connections between nodes and base station for LEACH

Throughout LEACH, cluster-heads are usually selected at random even so the power put in for every single circular is actually well-balanced as each of the sensor nodes employs a chance to get elected as being a cluster-head. For any bulletin, 5% from the entire sensor nodes are usually cluster-heads. A benefit is actually whose helps prevent info redundancy at the sink/base train station. There is absolutely no expert to be able to expert conversation amongst the nodes from the bunch. Figure 2 displays on the web connectivity involving sensor nodes with LEACH method [8].That process is broken down straight into rounds just about every series is made of a pair of levels:

1.3. PEGASIS routing protocol

PEGASIS (Power-Efficient Gathering in Sensor Information System) is a chain based hierarchical energy-efficient routing protocol. It works on the principle of greedy chain algorithm. In this approach, the fastest sensor node is selected, which is linked to the nearest node [9]. Figure 3 represents the greedy chain algorithm for 5 sensor nodes, namely, 1,2,3,4. In the figure above node 1 is far away from the BS (base station) [10]. The neighbour node of node1 is node 2 and node 4. The sensor node 1 is connected to node 2; this is because the distance from node 1 to node 2 is less as compared to the distance from node 1 to node 4. In this way, node-2 is connected to node 3, and node 4 is connected to node 4 and so on. At last, node 4 is connected to the BS. In case of failure of a node within the network, for example, node 3 is failed due to some reasons, then node 2 pass data to node 4.

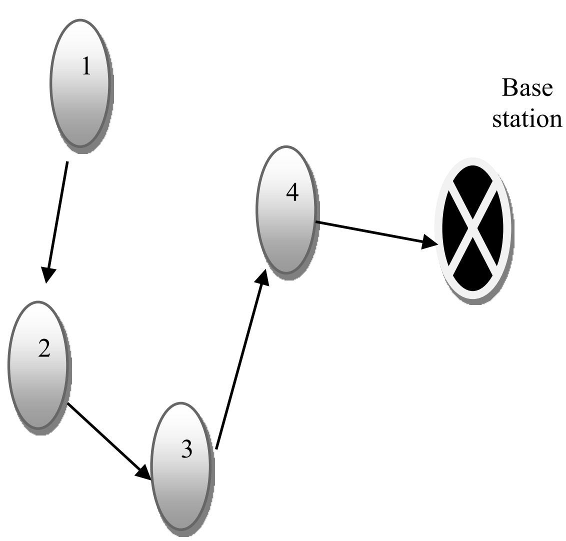

Figure 3. Greedy chain algorithm

In PEGASIS, sensor nodes received data from the previous node and fuse its own data to create a single packet and forward that packet to the neighbor node [11]. The CHs in both the protocol may get affected by external intrusive nodes or element, and in such a scenario, a lot of battery will be consumed. The proposed work model aims to optimize battery life by making the network adaptive towards intrusion alerts. The rest of the paper is organized in the following manner. Section II represents the proposed work model; Section III evaluates the proposed work model based on Quality of Service (QoS) parameters. Section IV concludes the paper.

2. Proposed Work Model

The proposed work model is segregated in three steps.

- Route Discovery through Cluster Heads
- Identification of Distortion in Cluster Heads
- Optimization of Battery Life by Identifying Intruder Through Cuckoo Search(CS)

Algorithm 1: Identify CHS

$Input: Associated\ Residual\ Energy\ of\ Nodes$ Output: CHs Count , CHs

// First of all, it is required to identify how many cluster heads are possible in one go

1. $N\ \ = nodes;\ \%\ number\ of\ nodes$
2. $M\ \ = sqrt(height * width)$
3. $distance_{To_{BS}} = sqrt\left(\left(sink_x - i_{source_x}\right)^2 + \left(sink_y - i_{source_y}\right)^2\right)$
4. $kOpt\ = \frac{(N*10)}{sqrt(2*pi)}$ // $kOpt\ will\ return\ total\ number\ of\ CHs\ required$
5. $Sort\ Nodes\ as\ per\ their\ residual\ energy$
6. Select top $CHs\ as\ per\ kOpt\ requirement$
7. $End\ Algorithm$

The selected CHs will propagate the data from one end to another end. After every simulation, the residual energy of CHs will decrease as it will be consuming a lot of energy in receiving and transferring the data elements. When any node in the Cluster stands higher energy as compared to the existing CH then the procedure for that particular Cluster is repeated. When the energy consumption raises above a limited threshold, it is noted that the network has fallen under some external threat or intrusion. In such a scenario, the prevention mechanism is applied to utilize CS.

Algorithm 2: Application of CS

$Inputs : Consumed\ Energy\ , Remaining\ Battery\ Life$

$: Output : Non\ Fit\ CH$

1. $Total_{Eggs} = Count(Total\ Consumed\ Energy * Remaining\_Battery)$
2. $Egg_{Structure} = (Total\ Consumed\ Energy * Remaining\_Battery)$
3. $Current_{Egg} = [];$
4. $Cuckoo_{Threhold} = [];$
5. $for\ Egg_{pop} = 1: Total_{Eggs}$
6. $Current_{Egg}(Egg_{pop}) = Egg_{Structure}(Egg_{pop});$
7. $Cuckoo_{Threshold}(Egg_{pop}) = mean(Current_{Egg});$
8. $fit = Cuckoo\_Fit(Current\_Egg, Cuckoo\_Threshold);$
9. end

Table 1.CS fitness function

1	$If\ Egg_{Value} * Travel_{time} < Cuckoo_{Fit_{Threshold}} * Travel_{time}$
0	$Otherwise$

The CS inspects each cluster head as CS is the one who is transferring the data. CS takes two parameters as input, namely the energy consumption of each CH the remaining battery of each CH. A fitness function is designed, which makes the judgment parameters as input parameters and also takes the travel time of the cuckoo bird from nest to food source. Every Cuckoo Bird leaves its nest in search of food leaving the eggs behind. The eggs in the nest changes as per their growth rate. The cuckoo bird is always aware that there will be some change in the egg architecture by the time she is outside. She also has an idea about the amount of change in the heating element of the egg. That is termed as $Cuckoo_{Fit_{Threshold}}$ in the proposed work. Egg_{value} is a multiplicative element of consumed energy and remaining battery of the CHs. Based on these two inputs, the proposed algorithm identifies which CH is not performing well. It may be due to intrusion or may be due to any other physical damage in the sensor node. In such a case, the CH is immediately replaced by another sensor node.

3. Results and Discussion

This section depicts the results obtained after the simulation of the proposed work. For the simulation, 100 to 2000 iterations are considered, and the results have been represented in the form of tables and graphs by comparing the effects of proposed work with the current work. Parameters, such as Remaining battery power, Throughput, and PDR are considered for the analysis.

Table 2.Comparison of remaining battery power

Number of iterations	Remaining battery power (exiting work)	Remaining battery power (proposed work)
100	2490	2495
200	2356	2380
400	2260	2280
600	2125	2180
800	2000	2100
1000	1990	1999
1200	1700	1800
1400	1600	1700
1600	1500	1580
1800	1000	1200
2000	500	600

The graphical representation shown in Figure 4, 5, and 6 is the comparative analysis of proposed work with the conventional techniques. For the execution of the simulation work, the cuckoo search optimization algorithm has been considered. While considering the assessment of Remaining battery power, it can be seen that the battery power remained, in the end, is more in the case of proposed work than the existing work

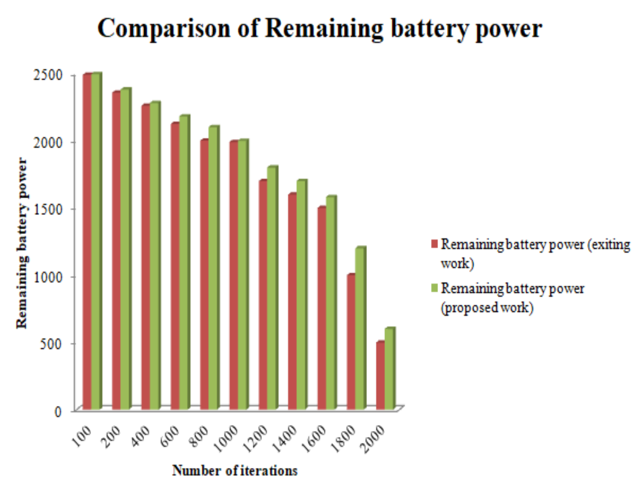

Figure 4.Remaining battery power

Table 3.Comparison of throughput

Number of iterations	Throughput (exiting work)	Throughput (proposed work)
100	22.5	35.2
200	13.4	18.5
400	7.8	12.5
600	4.6	8.5
800	5.1	10.1
1000	5.4	10.2
1200	4.9	9.8
1400	5.0	11.1
1600	5.4	12.5
1800	4.8	8.4
2000	2.5	10.2

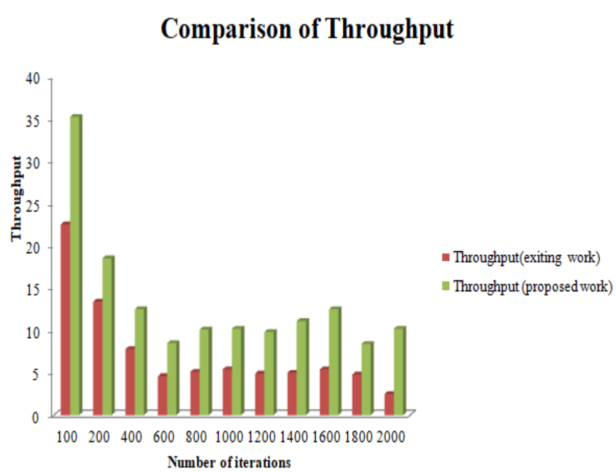

Figure 5.Comparison of throughput

Table 4.Comparison of PDR

Number of iterations	PDR (exiting work)	PDR (proposed work)
100	0.05	0.20
200	0.80	1.0
400	0.75	0.80
600	0.55	0.69
800	0.40	0.60
1000	0.20	0.40
1200	0.91	0.80
1400	0.11	0.29
1600	0.12	0.20
1800	0.60	0.75
2000	0.40	0.50

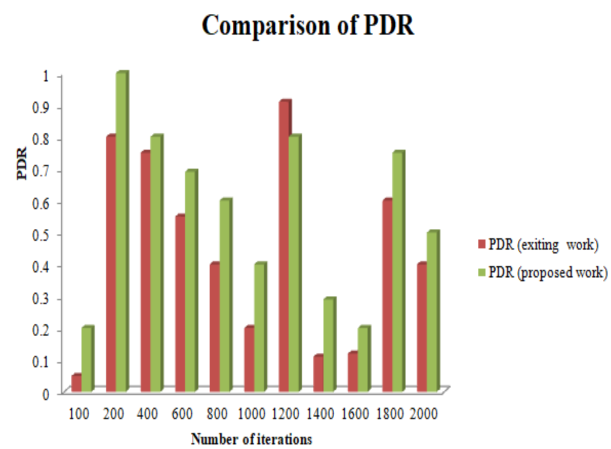

Figure 6.Comparison of PDR

There is an enhancement of 3.9% of battery power in proposed work during comparative analysis. In the case of throughput, the average value of existing performance is 8.23, whereas the average value of the proposed throughput is 14.26. 42.28% of improvement is seen in the proposed throughput than the conventional method. For PDR, 0.44 is the average for existing work, and 0.52 is the average of proposed PDR. 15.38% of effectiveness is seen in the proposed PDR than the existing one.

4. Conclusion

WSNs are of supreme importance because they are responsible for maintaining routing, data forwarding, and ensuring reliable multihop communication in the network. The main requirement of wireless sensor networks is to extend network energy efficiency and longevity. Researchers have developed LEACH and PEGASIS protocols to reduce energy consumption in the network. Though existing routing protocols suffer from many disadvantages in terms of energy and power consumption. In this research work, an energy-efficient clustering mechanism has been proposed using cuckoo search optimization algorithm. There is an enhancement of 3.9% of battery power in proposed work during comparative analysis. In the case of throughput, the average of the actual performance is 8.23, while the average of the recommended throughput is 14.26. A 42.28% improvement can be seen in the recommended throughput compared to the traditional approach. For PDR, 0.44 is the average of the existing work, and 0.52 is the average of the recommended PDR. The recommended effective rate of PDR is 15.38% instead of the existing PDR.

5. References

[1] H. Kim and S. Han, "An Efficient Sensor Deployment Scheme for Large-Scale Wireless Sensor Networks," in *IEEE Communications Letters*, vol. 19, no. 1, pp. 98-101, Jan. 2015.

[2] S. Gowrishankar, T. G. Basavaraju, D. H. Manjaiah, Subir Kumar Sarkar, "Issues in wireless sensor networks," *Proceedings of the World Congress on Engineering*, vol. 1, pp. 978-988, 2008

[3] Agrawal Palak, P. R. Pardhi, "Routing Protocols For WSN," *International Journal Of Computer Science And Applications*, vol. 8, no. 1, 2015.

[4] Y. Choi, I. Syed, H. Kim, "Event information based optimal sensor deployment for large-scale wireless sensor networks," *IEICE Trans. Commun.*, vol. E95-B, no. 9, pp. 2944-2947, Sep. 2012

[5] V. Karthikeyan, A. Vinod, P. Jeyakumar, "An Energy-Efficient Neighbour Node Discovery Method for Wireless Sensor Networks," *arXiv preprint arXiv:1402.3655*, 2014

[6] S. K. Singh, M. P. Singh, D. K. Singh, "A survey of energy-efficient hierarchical cluster-based routing in wireless sensor networks," *Int. J. Adv. Netw. Appl.*, vol. 2, no. 2, pp. 570-580, Sep. 2010.

[7] Farooq Muhammad, Omer Abdul, Basit Dogar, Ghalib Asadullah Shah, "MR-LEACH: multihop routing with low energy adaptive clustering hierarchy," *Sensor Technologies and Applications (SENSORCOMM) 2010 Fourth International Conference*, pp. 262-268, 2010.

[8] A. Karthikeyan, V. Jagadeep and A. Rakesh, "Energy-efficient multihop selection with PEGASIS routing protocol for wireless sensor networks," *2014 IEEE International Conference on Computational Intelligence and Computing Research*, Coimbatore, 2014, pp. 1-5

[9] J. Kulshrestha and M. K. Mishra, "DPEGASIS: Distributed PEGASIS for chain construction by the nodes in the network or a zone without having global network topology information," *2017 International Conference on Multimedia, Signal Processing and Communication Technologies (IMPACT)*, Aligarh, 2017, pp. 13-17.

[10] R. Dutta and S. Gupta, "Energy-aware modified PEGASIS through packet transmission in wireless sensor network," *2016 Fourth International Conference on Parallel, Distributed and Grid Computing (PDGC)*, Waknaghat, 2016, pp. 443-446

[11] D. Baghyalakshmi, Ebenezer Jemimah, S. A. V. Satyamurty, "Low latency and energy-efficient routing protocols for wireless sensor networks," *Wireless Communication and Sensor Computing 2010. ICWCSC 2010. International Conference on*, pp. 1-6, 2010.

[12] A Razaque, KM. Elleithy, "Energy-efficient border node medium access control protocol for wireless sensor networks," *Sensors*, vol. 14, no. 3, pp. 5074-117, Mar. 2014.

[13] A. Razaque, M. Abdulgader, C. Joshi, F. Amsaad and M. Chauhan, "P-LEACH: Energy-efficient routing protocol for Wireless Sensor Networks," *2016 IEEE Long Island Systems, Applications, and Technology Conference (LISAT)*, Farmingdale, NY, 2016, pp. 1-5.

[14] R. Meelu, R. Anand, "Performance evaluation of cluster-based routing protocols used in heterogeneous wireless sensor networks," *International Journal of Information Technology and Decision Making*, vol. 4, no. 1, pp. 227-231, 2011.

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