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An Optimized Technique for Chain Head Selection in Pegasis Protocol for WSN

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***Abstract*—** Wireless Sensor Network (WSN) consists of sensor nodes which sense, process and transmit information. The most important parameter that is of great significance in a sensor network is its lifetime. In this research work, an optimized technique for chain head selection in Pegasis protocol has been proposed on the basis of genetic algorithm, gravitational search algorithm and fuzzy logic. Experimental results indicate that the proposed approach results in significant reduced energy consumption thereby enhancing the network lifetime.

***Keywords*—** wireless sensor network, Pegasis, fuzzy, genetic algorithm, gravitational search algorithm

I. Introduction

Wireless Sensor Networks are systems of light weight nodes that sense, process and transmit information, such as, temperature, dampness, vibration and so forth. The cluster head accumulates that information and sends it to the base station. The cluster head may directly receive the information from the sensor nodes or through a network of sensor nodes. There is no pre-conveyed framework. These sensor nodes accumulate different kinds of information and work together [1].

Network lifetime is a critical parameter for WSN. In different circumstances, a system may progress towards becoming non-useful if major number of nodes die early in the network due to energy constraints. So balancing the power amongst the nodes in the network is a fundamental factor for improving the lifetime of the whole network. Many steering conventions have been presented in WSN in light of a wide range of instrument and advancement criteria [1]. This paper proposes an optimized technique for cluster head selection in Pegasis protocol on the basis of genetic algorithm, gravitational search algorithm and fuzzy logic. First section introduces the wireless sensor network, the sensor nodes and the need of an energy efficient routing protocol. In second section, various researches done in this field have been discussed. Third section discusses about the proposed work; fourth section of this paper presents the simulation parameters and the fifth section enumerates the experimental results of the proposed technique. Finally section fifth concludes the findings of the proposed work.

II. Related Work

PEGASIS is compared to LEACH and its performance has been evaluated in [2]. Darji et al. proposed machine learning based protocol. Conventional protocols, for example, LEACH, PEGASIS, TEEN and so forth are not suitable for the Energy Harvesting-Wireless Sensor Network (EH-WSN). The prerequisite of such a network is the low energy utilization. Machine Learning approach has been utilized for limiting power consumption. The results indicate an increase in the overall network lifetime [3].

Garg et al. investigated the contending issues of energy utilization in remote sensor systems. To accomplish this, the authors suggested Gravitational Search algorithm (GSA) as the choice of Cluster Head (CH) selection so that the energy of the sensor nodes is utilized consistently without any significant loss of connectivity in the network. The proposed GSA based LEACH has been shown to give increased lifetime [4].

Bath et al. proposed PEGASIS protocol utilizing Genetic Algorithm to develop information directing chain. The results indicate that the PEGASIS along with GA dispense minimum energy thereby increasing the network lifetime [1].

Gawade et al. suggested a Centralized Energy Efficient Distance (CEED) based protocol to uniformly disseminate energy among all sensor nodes. The CEED protocol has been compared with LEACH and LEACH with Distance Based Thresholds (LEACH-DT). The comparative investigations demonstrate that CEED is more energy efficient amongst the three and leads to enhancement of the network lifetime [5].

Akila et al. reviewed and examined the ongoing issues in Wireless Sensor Networks. The paper discusses ongoing methodologies for maintaining a strategic distance and energy utilization in Wireless Sensor Networks and deliberated upon the different solutions provided by different authors [6].

Parvin et al. proposed a novel strategy for information conglomeration utilizing portable sink nodes in Wireless Sensor Network to enhance the lifetime of the sensor nodes. The sink nodes are utilized in the network to aggregate the detected information from the Cluster Heads that are situated at a distance from the Base Station. System lifetime is enhanced with the assistance of sink nodes by decreasing the burden of Cluster Heads. In the proposed work, nodes are permitted to shape as bunches and no Cluster Head selection is done. The task of Cluster Heads is taken care by the recently added versatile sink nodes which gather the detected information, collect it and transmit it further. This results in enhanced lifetime of the sensor nodes. Gravitational Search Algorithm (GSA) is the method utilized for bunch development and transmitting the information to accomplish better throughput and network lifetime [7].

Karthikeyan et al. discussed that the most critical issue with sensor networks is the low hub detecting range and limited power. The authors suggested Grouping as one of the approach that could be used to increase the hub detecting range. The proposed strategy utilizes the benefit of signal-to-noise ratio (SNR) for multi bouncing and power effective assembling in sensor data frameworks (PEGASIS) with a specific end goal to expand the existing lifetime of the network [8].

Feng et al. proposed an Improved energy efficient PEGASIS-based protocol (IEEPB). IEEPB uses a novel technique to construct the chain, and uses the weights assigned to sensor nodes on the basis of residual energy, distance between a sensor node and base station for the cluster head selection [9].

Rina Mahakud et al. discuss energy management in Wireless Sensor Networks using PEGASIS protocol. In PEGASIS, every node transmits data with its immediate neighbor, forming a greedy chain and selecting a leader node from the chain that gathers the information from the neighbors to be transmitted to the base station. Therefore the normal energy spent by every node per round is decreased and it in turns brings down the transmission capacity of the whole network affecting its lifetime. The paper suggests a method for transmission of information to the base station through the shortest possible route. This would lead to less power utilization and enhance the life time of the network adequately [10].

Gotefode et al. proposed an energy efficient protocol in Wireless Sensor Network using Fuzzy rule and Tree Based Routing Protocol. The results indicate proper load balancing leads to less energy consumption thereby increasing the network lifetime [11].

III. THE PROPOSED APPROACH

In this section, the proposed optimization technique is discussed. This paper proposes a method for energy minimization with efficient chain head selection using hybridization of optimization techniques Fuzzy Logic, Genetic Algorithm and Gravitational Search in Pegasis protocol in Wireless Sensor Network. For the computation of chain head election probability Fuzzy Logic is used and the Genetic Algorithm and Gravitational Search Algorithm method is used to check for if there exists a node which lies in range of closest distance. The steps to implement the proposed technique are as under:

1. Initialize the network by taking initial energy, number of nodes, and location of base station for the network and total of number of nodes.
2. Broadcast the message from the base station to each node to construct the chain and collect the information of network such as the distance of each node from the base station, distance between other nodes and node ids.
3. Search for farthest node from the base station utilizing bubble sort approach and initialize building of chain from that node.
4. Compute the distance between the alive nodes and then connect them to the end node. Likewise do for other nodes also.
5. Replicate this process to create the chain for all the nodes.
6. Select the chain head that will interact with the base station using the factor given as: factor=fuzzy value * min (mean (GA optimized value), mean (GSA optimized value));

This factor is then being used to check if there exists a node which lies in range of closest distance.
This node will send the information to the base station.

IV. SIMULATION RESULTS

A. Performance Parameters

To evaluate the performance of the proposed technique, four evaluation metrics: remaining energy, alive nodes, dead nodes and packets sent to base station (BS) are used. The performance parameters and their respective values have been listed in table 1.

Table 1: Performance Parameters

PARAMETERS	VALUE
Network Size	100 X 100 meter^2
Sink	(50, 50)
Number of Nodes	100
Initial Energy of Node	0.50 Joule
E_{elect}	50 nJ/ bit
E_{fs}	10 pJ/ bit/ m^2
E_{amp}	0.0013 pJ/ bit/ m^4
E_{fusion}	5 nJ/ bit/ message
Data Packet	2000 bits

Remaining Energy: Remaining energy is the estimation of the energy left from the total energy of the network. It can be calculated by using equation (1):

$$Energy = (E_{elec} * size) + (E_{amp} * size * distance^2) \quad (1)$$

Alive Nodes: Alive nodes represent the number of nodes alive at a particular round. It can be calculated by subtracting number of dead nodes from total number of sensor nodes. Alive nodes can be calculated as:

Alive nodes = total number of sensor nodes – number of dead nodes (2)

Packets Sent to Base Station: Data packet Delivery is the amount of data moved successfully from one place to another in a given round. Data Packet Delivery can be calculated as:

$$Data\ Packet\ Delivery = Energy\ consumed/(data\ packet\ size * E_{elec}) \quad (3)$$

Dead Nodes: Dead nodes represent the number of nodes dead at a particular round. It can be calculated by subtracting number of alive nodes from total number of sensor nodes. Alive nodes can be calculated as:

Dead nodes = total number of sensor nodes – number of alive nodes (4)

V. RESULTS AND DISCUSSION

A. Comparison based on Alive Nodes

Figure 1 shows the comparison of the proposed technique with modified Pegasis GA GSA with Fuzzy, Pegasis with GA GSA, Pegasis with fuzzy and Pegasis on the basis of alive nodes. It is clear that the proposed technique has a greater number of alive nodes as compared to the existing techniques.

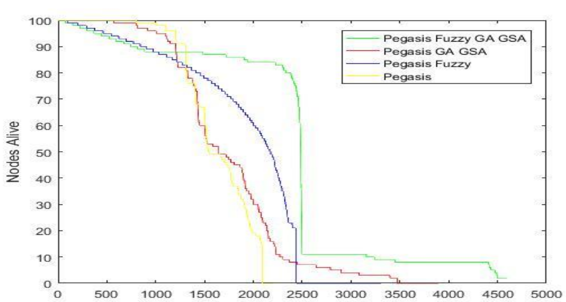

Figure 1: Comparison on basis of alive nodes of proposed technique with existing techniques

B. Comparison based on Dead Nodes

Figure 2 shows the comparison of the proposed modified Pegasis GA GSA with Fuzzy, Pegasis with GA GSA, Pegasis with fuzzy and Pegasis on the basis of dead nodes. It is clear that the proposed technique has fewer dead nodes as compared to the existing techniques.

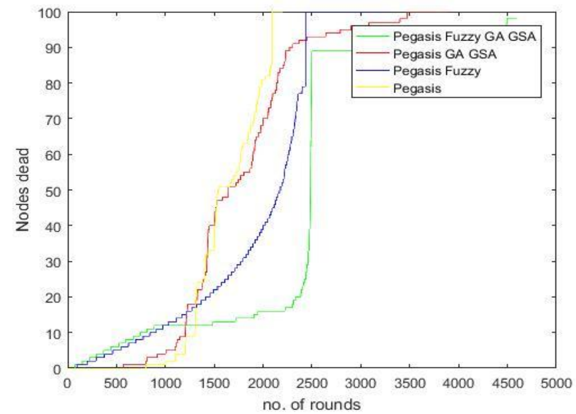

Figure 2: Comparison on basis of dead nodes of proposed technique with existing techniques

C. Comparison based on Packets Sent to Base Station

Figure 3 shows the comparison of the proposed modified Pegasis GA GSA with Fuzzy, Pegasis with GA GSA, Pegasis with fuzzy and Pegasis on the basis of Packets Sent to Base Station.. It is clear that the proposed technique sends more packets to base station as compared to the existing techniques.

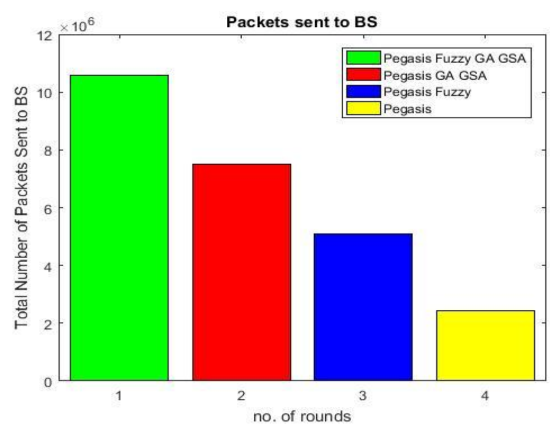

Figure 3: Comparison on basis of packets sent to base station of proposed technique with existing techniques

D. Comparison based on remaining network energy

Figure 4 shows the comparison of the proposed Pegasis GA GSA with Fuzzy, Pegasis with GA GSA, Pegasis with fuzzy and Pegasis on the basis of remaining energy in the network. It is clear that the proposed technique leads to considerable energy savings as compared to the existing techniques.

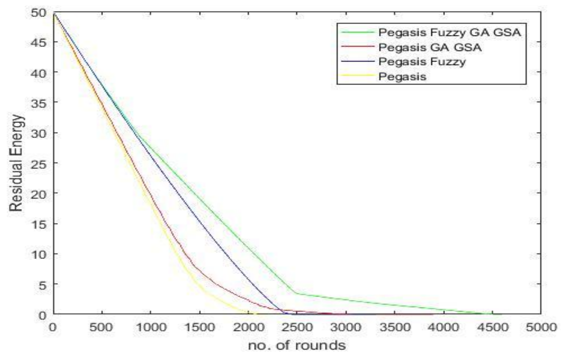

Figure 4: Comparison on basis of packets sent to base station of proposed technique with existing techniques

VI. CONCLUSION

This paper proposes a method for energy minimization with efficient chain head selection using hybridization of optimization techniques Fuzzy Logic, Genetic Algorithm and Gravitational Search in Pegasis protocol in Wireless Sensor Network. For the computation of chain head election probability Fuzzy Logic is used and the Genetic Algorithm and GSA method is used to check for if there exists a node which lies in range of closest distance. Results are evaluated on the basis of number of alive nodes, number of dead nodes, remaining energy and number of packets sent to base station. Proposed technique Modified Pegasis with hybridization of Fuzzy, GA and GSA is compared with existing techniques, modified Pegasis with GA GSA, Pegasis and Pegasis with fuzzy on the basis of these parameters. Results show that proposed technique gives more number of alive nodes, and packet sent to base station whereas less number of dead nodes as compared to existing techniques. Comparing the results from the basic Pegasis Protocol, the proposed technique has achieved 51% efficiency in the network lifetime.

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Authors Profile

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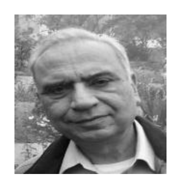

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