International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 13 (2015)

Cuckoo based Enhanced PEGASIS for Energy Efficiency in WSN

Harmanjit kaur
Lovely Professional University, Phagwara
Harmanjit147@gmail.com

Abstract
Due to non inheritable restriction of sensors there is always a vital issue on the way to utilize restricted energy effectively. Thus, solving the efficient-energy coverage problem is an important issue for a WSN. So, it is necessary to schedule the activities of the devices in a WSN to save the networks limited energy and prolong its lifetime. So, for increases the lifetime of the network, number of alive nodes present in the network and energy efficiency of the network increases. PEGASIS protocol uses for reducing the delay and enhancing the energy efficiency of the network because PEGASIS protocol is based on chaining structure. In every chain one node is selected as cluster head, which do the responsibility of routing from lower level cluster to higher level cluster. In this proposed work, the energy efficiency of PEGASIS protocol is improved and also increases the number of alive nodes using cuckoo search optimization. The simulation results are performed to verify the effectiveness of the Energy Efficiency problem in comparison with other algorithms.

Keywords—Wireless Sensor Network, Energy Consumption, Efficient Energy Coverage, Cuckoo Search Optimization.

I. INTRODUCTION

A Wireless Sensor Network (WSN) consists of a large number of tiny wireless sensor nodes that are typically densely deployed. Mobile communications and wireless networking technology has seen a thriving development in recent years. By technological advancements as well as application demands various classes of communication networks have emerged such as Ad hoc Networks, Cellular networks, Sensor Networks and Mesh Networks. Cellular Networks are the infrastructure dependent networks. Ad hoc networks are defined as the category of wireless networks that utilize multi hop radio relaying since the nodes are dynamically and arbitrarily located. Ad hoc networks are infrastructure independent networks [10].

Nodes measure the ambient conditions in the environment surrounding them. The measurements are then transformed into signals that can be processed to reveal some characteristics about the phenomenon. The data collected is routed to special node, called sink node (also called Base Station) [1]. Then, typically, the sink node sends data to the user via Internet or satellite, through a gateway. Combining the advantages of wireless communication with some computational capabilities, WSNs have an endless array of potential applications in both military and civilian applications including robotic, land-mine detection, target tracking, battlefield surveillance, wildfire detection, environmental monitoring, catastrophe monitoring, security, structural monitoring, industry, home, agriculture, traffic monitoring, for monitoring natural phenomena etc.[1]

In order to support data aggregation through efficient network organization and nodes can be partitioned into a number of small groups called clusters. The Cluster has a coordinator referred to as a cluster head and a number of member nodes. Clustering results in a two-tier hierarchy in which cluster heads (CHs) form the higher tier while member nodes form the lower tier. Member nodes report their data to the respective CHs. CHs aggregate the data and send them to the base station either directly or through other CHs [2]. Because CHs often transmit data over longer distances they lose more energy compared to member nodes. Network may be reclustered periodically in order to select energy-abundant nodes to serve as CHs thus distributing the load uniformly on all the nodes. To achieve energy efficiency, packet collisions, and clustering reduces channel contention resulting in better network throughput under high load. The Clustering has been shown to improve network lifetime, a primary metric for evaluating the performance of a sensor network. Although there is no unified definition of "network lifetime" as this concept depends on the objective of an application, common definitions include the time until the first/last node in the network depletes its energy and the time until a node is disconnected from the base station [2].

The important components of WSN are discussed below:

- **Sensor Node:** A sensor node is the core component of a WSN. The Sensor nodes can take on multiple roles in a network such as simple sensing; data storage; routing; and data processing.
- **Clusters:** Clusters are the organizational unit for WSNs. Dense nature of these networks requires the need for them to be broken down into clusters to simplify tasks such a communication [2].
- **Cluster heads:** Cluster heads are the organization leader of a cluster and they often are required to organize activities in the cluster. All these tasks include but are not limited to data-aggregation and organizing the communication schedule of a cluster [3].
- **Base Station:** The base station is at the upper level of the hierarchical WSN. This provides the communication link between the sensor network and the end-user.
- **End User:** The data in a sensor network can be used for a wide-range of applications [1]. Therefore, a particular application may make use of the network data over the internet, using a PDA, or even a desktop computer.

II. ROUTING PROTOCOLS IN WSN

Energy consumption can be reduced by the use of various techniques like data aggregation, clustering, data-centric methods, etc. The routing protocols can be classified as flat, hierarchical or location-based as follow:

Flat networks: In flat networks, all nodes are equal. Hence each node plays the same role. This network has no logical hierarchy. It uses a flat addressing scheme. Routing Information Protocol (RIP) is an example of a flat routing protocol.

Hierarchical networks: In hierarchical networks, the nodes are partitioned into a number of small groups called clusters. Each cluster has a cluster head (CH) which is the co-ordinator of other nodes. These CHs perform data aggregation so that energy inefficiency may be reduced. The cluster heads may change. The node which has the highest energy acts as the CH. Hierarchical routing is an efficient way to lower energy consumption within a cluster. It has major advantages of scalability, energy efficiency, efficient bandwidth utilization, reduces channel contention and packet collisions. Low Energy Adaptive Clustering Hierarchy (LEACH), Hybrid Energy-Efficient Distributed Clustering (HEED) etc. are examples of hierarchical networks.

Location-based networks: In location-based clustering, the location of the sensor nodes plays a significant role. Base stations are used to route data to specific destinations. In these protocols, position awareness of the sensor nodes is important to route data to destinations. The distance between neighboring nodes can be estimated on the basis of incoming signal strengths. According to location-based protocols, if there is no activity then nodes should go to sleep to save energy. Location-Aided Routing (LAR) and Distance Routing Effect Algorithm for Mobility (DREAM) are examples of location based protocols.

The single-tier architecture is not scalable because the sensors are not capable of long communication. Hierarchical clustering results in a two-tier hierarchy in which CHs form the higher tier and member nodes form the lower tier. The sensor nodes transmit their data to the corresponding CH nodes. The CH nodes aggregate the data (thus decreasing the total number of relayed packets) and transmit them to the base station (BS) either directly or through the intermediate communication with other CH nodes. Because the CH nodes send all the data to higher distances than the member nodes, they spend energy at higher rates. To balance the energy consumption, new CHs (node with maximum energy in a cluster) may be selected.

III. PROPOSED WORK

Due to huge transmission of data through the sensor nodes, lots of energy wastage exists in wireless sensor network, which decreases the network lifetime. The lifetime of the network depends upon each transmission means how much energy is spend in each transmission. So, for increases the lifetime of the network, number of alive nodes present in the network and energy efficiency of the network increases. PEGASIS protocol uses for reducing the delay and enhancing the energy efficiency of the network because PEGASIS protocol is based on chaining structure. In every chain one node is selected as cluster head, which do the responsibility of routing from lower level cluster to higher level cluster. In this work, cuckoo based energy efficient pegasis protocol has been proposed to achieve the following objectives:

- With the number of rounds improving number of alive nodes.
- To analyze and developing high energy efficiency routing protocol with PEGASIS.
- On the basis of cuckoo search define opportunistic routing.

Basic Design of work

Initializing the WSN parameters such as number of nodes, routing protocols, area size, base station, energy transmitted/received, amp energy and data packets. Then the deployment of nodes is done. The whole scenario of WSN is established. The protocol of WSN named PEGASIS is modified by using cuckoo search optimization then it is implemented in the scenario created. The overall performance will be analyzed.

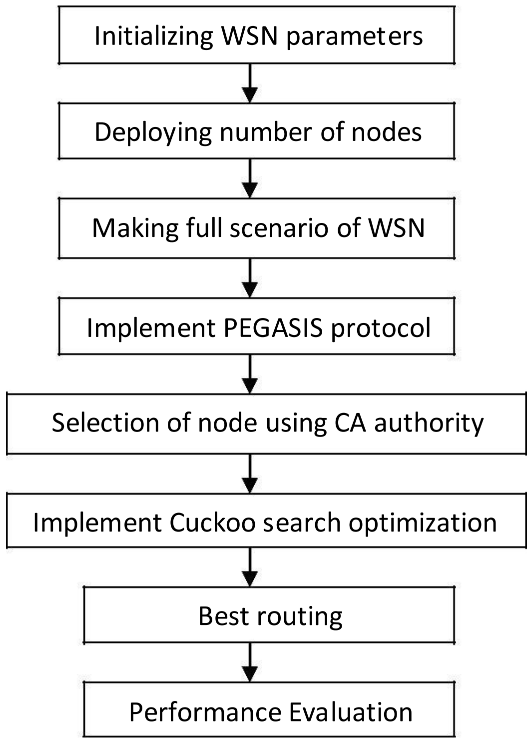

Fig 1. Basic Design

Radio Model for Pegasis

The basic standard model, where radio dissipates E_{elec}=50nj/bit to run the circuitry of both transmitter & receiver. For the transmitter amplifier ∈amp=100pj/bit/m^2. Due to channel transmission an energy loss r^2 is considered. To reach the intended recipient, the radio has power control & can expand the minimum required energy. The following equations are used for a k-bit message & to calculate transmission and receiving costs a distance d.

For Transmission:

$$E_{tx}(k,d) = E_{tx-elec}(k) + E_{tx-amp}(k,d) \quad (1)$$

$$E_{tx}(k,d) = E_{elec} * k + E_{amp} * k * d^2 \quad (2)$$

For Receiving

$$E_{RX}(K) = E_{RX-elec}(K) \quad (3)$$

$$E_{RX}(k) = E_{elec} * k \tag{4}$$

Cuckoo Search Algorithm

New solutions are obtained with the following equation:

$$X_i^{t+1} = x_i^t + \alpha \oplus Lev'y \tag{5}$$

Lev'y describes the random walk to obtaining the new solutions. α is the step size which is adjusted according to the scale of problem of interest. Lev'y flight is a random walk and the step size of lev'y also random with the distribution as follows:

$$Lev'y \sim u = L^{-\lambda} \ (1 < \lambda \leq 3 \ ) \tag{6}$$

Rastrigin function is non-convex function. This is used for testing problem for optimization algorithms. Firstly it was proposed by the Rastrigin as a 2-dimenional function.

Equation for Rastrigin function:

$$f(x) = An + \sum_{i=1}^{n}[xi^2 - Acos(2\pi xi)] \tag{7}$$

$where\ A = 10\ \&\ xi \in [-5.12, 5.12]$

It has a global minimum value at x=0

IV. SIMULATION & ANALYSIS

Simulation Setup

In this work, chain based approach is used which is based on the enhanced PEGASIS. Cuckoo search is used to implement PEGASIS for energy efficiency & network life. This simulation focuses on the number of alive sensor nodes and the energy efficiency of the network. For different algorithms network average energy & cost per iteration are the important indications to measuring the performance. In this simulation, 100 nodes are placed randomly in 100*100 area. The simulation parameters used are shown below:

Table 1: Simulation Parameters.

PARAMETERS	VALUE
Number of nodes	100
Area	100*100
Transmitted energy (Etx)	50nj/bit
Received energy (Erec)	50nj/bit
Efs	10pj/bit
Emp	0.0013pj/bit
Eo	0.5
Rmax	2500
Da	0.6
Eda	5nj/bit

A proposed chain based approach which is based on enhanced PEGASIS using cuckoo search approach is used to implement the desired solution for energy efficiency & to improve network lifetime. The simulation area is considered as 100 *100 meters^2 with 100 sensor nodes has been considered.

The enhanced chaining based on Cuckoo PEGASIS is as shown in fig 2.

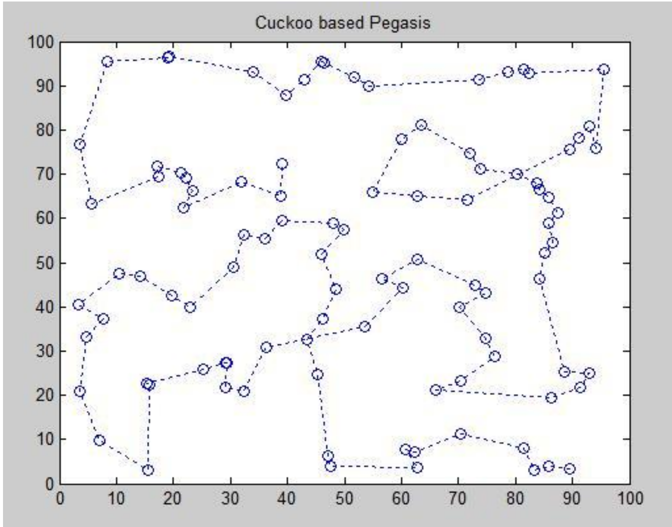

Fig 2. Chain formation in cuckoo based PEGASIS

Parameter Analysis

- **Number of Alive Nodes**

In case of cuckoo based PEGASIS, the numbers of alive nodes are more as compare to the previous work because in our work, an efficient routing optimization technique is used in an energy saving manner. We have saved a lot of resources by using innovative chain based approach. Fig 3 is showing the number of alive nodes with time.

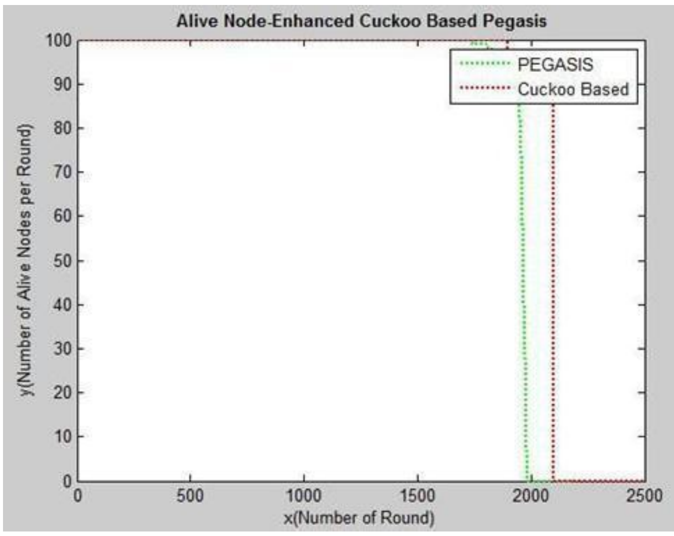

Fig 3. Number of Alive Nodes

- **Energy Consumption**

Fig 4 explains that the energy consumption is less in case of proposed work using Cuckoo based PEGASIS protocol because in opportunistic routing the routes are smaller than previous routes that are why the energy consumption is less. The average energy of all nodes per round in cuckoo based PEGASIS is higher than IEEPB. This proves that the energy efficiency of cuckoo based PEGASIS is better than IEEPB.

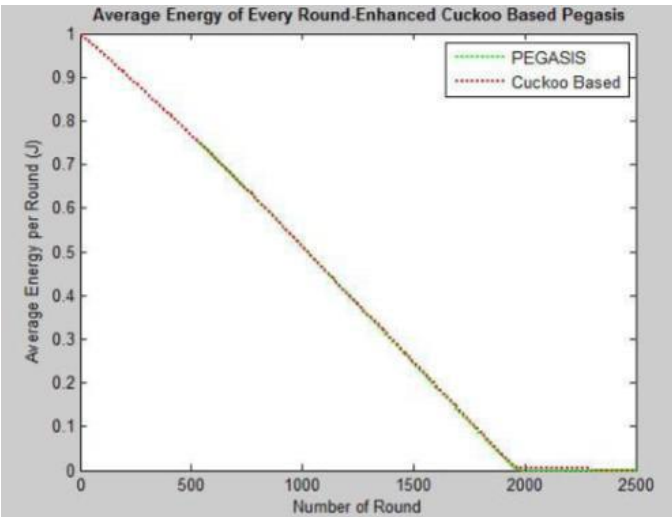

Fig 4. Energy Consumption

V. CONCLUSION

Wireless sensor network consist of number of sensor nodes to form a large network. Environment conditions like sound, temperature, pressure, direction, speed etc are measured by WSN. In WSN lots of energy wastage in sensor nodes which decreases the networks lifetime. The lifetime of the network directly depends upon the transmission, in each transmission how much energy is spent. To increases the lifetime of the network a chain based PEGASIS protocol used. Which is an energy efficient protocol; this reduces the delay present in the network and enhancing the energy efficiency of the network. In each chain only single node is selecting as a cluster head. Cluster head knows all the information of their chain members. PEGASIS protocol with cuckoo search optimization algorithm increases the number of alive node and energy efficiency of the network. At the end conclude that the proposed work enhances the performance of system which can be used in future work for further improvement of WSNs. Further in future work, to enhance the protocol by improving the more number of alive nodes for efficient network life and also simulate same scenario on different software.

References

[1] Al-Karaki, J.N., and A.E.Kamal, ”Routing techniques in WSN: a survey”, IEEE wireless communication, 2004, 11:6-28.

[2] Daixian Wu, Yang Zhang, Zhou Quan, Chunming Tang in, “An energy efficient trusted dynamic routing protocol for wireless sensor network”, Fourth international conference on emerging intelligent data and web technologies, 2013.

[3] N Suganthi, M. Chella Premiga & A. SivaShanmathi, “A trust aware routing with shortest path framework for wireless sensor networks”, Vol 3, ISSUE 1, 2013.

[4] Guoxing Zhan, Weisong Shi, Julia Deng, “ Design And Implementation Of Tarf: A Trust-Aware Routing Framework For Wsns”, IEEE transactions on dependable and secure computing, vol. 9, no. 2, 2012.

[5] Sunita Rani and Tarun Gulati, “An Improved PEGASIS Protocol to Enhance Energy Utilization in Wireless Sensor Network”, International Journal of Advanced Research in Computer Science and Software Engineering, November, Volume 2, Issue11, 2012.

[6] Shujiang LI, Xin MA, Xiangdong WANG and Minghao TAN, “Energy- efficient multipath routing in wireless sensor network considering wireless interference”, Springer-Verlag Berlin Heidelberg, 2011, DOI 10.1007/s11768-011-0263-4.

[7] Ming Tao, Dingzhu Lu and Junlong Yang, “An Adaptive Energy-aware Multi- path Routing Protocol with Load Balance forWireless Sensor Networks”, Springer Science+Business Media, 2010, DOI 10.1007/s11277-010-0169-3.

[8] Meenu and Vandhana, ”Modified PEGASIS in WSN to increase Network Lifetime”, International Journal of Computer Applications, August Vol. 52, No.19, 2012.

[9] Md Arif Ali and Abha Kiran Rajpoot, ”Development of energy efficient routing protocol using Hop PEGASIS in Wireless Sensor Networks”, International Journal of Computer Science & Engineering Technology, Vol. 5 No. 02, feb 2014.

[10] Sandeep Kumar E, G.P. Mohanraj and Raghuchandra R. Goudar, ” Clustering approach for Wireless Sensor Networks based on Cuckoo Search Strategy”, International Journal of Advanced Research in Computer and Communication Engineering, June, Vol. 3, Issue 6, 2014.

[11] Feng Sen, Qi Bing and Tang Liangrui, “An Improved Energy-Efficient PEGASIS-BasedProtocol in Wireless Sensor Networks”, Eighth International Conference on Fuzzy Systems and Knowledge Discovery, 2011.

[12] Ahmed S. Tawfik, Amr A. Badr and Ibrahim F. Abdel-Rahman, ” One Rank Cuckoo Search Algorithm with Application to Algorithmic Trading Systems Optimization”, International Journal of Computer Applications, February, Volume 64– No.6, 2013.

[13] Navpreet Singh, Viney Popli Barinder and Paul Singh, ” Relative Analysis of Hierarchical Routing in Wireless Sensor Networks Using Cuckoo Search”, International Journal of Advanced Research in Computer Science and Software Engineering, November, Volume 4, Issue 11, 2014.

[14] Gurpreet Kaur Bhatti and Jatinder Pal Singh Raina, ”Cuckoo based Energy Effective Routing in Wireless Sensor Network “ International Journal of Computer Science and Communication Engineering, volume 3, issue 1, 2014.

[15] K. Romer and F. Mattern, “The design space of wireless sensor networks, ” Proc. IEEE Conference on Wireless Communications, vol.11, no. 6, 2004, pp. 54–61.

[16] Rafe Alasem, Ahmed Reda and Mahmud Mansour, "Location based energy efficient reliable routing protocol for wireless sensor network "World Scientific and Engineering Academy AND C Society(WSEAS) Stevens Point, Wisconsin, US, 2011.

[17] Ali Norouzi and Abdul HalimZaim, "An Integrative Comparison of Energy Efficient Routing Protocols in Wireless Sensor Network", Wireless Sensor Network, 2012, pp.4, 65-75.

[18] G. Zhan, W. Shi, and J. Deng, "Design, implementation and evaluation of tarf: A trust-aware routing framework for dynamic wsns, " Wayne State University, Tech. Rep. MIST-TR-2010-003, oct. 2010

[19] Meenakshi Diwakar and Sushil Kumar, "An Energy Efficient level based Clustering Routing protocol for Wireless Sensor Networks "International Journal Of Advanced Smart Sensor Network Systems (IJASSN), Vol 2, No.2, 2012

[20] R.U.Anitha, N. Tamil, and P. kamalakkannan, "Performance Evaluation Of Energy Efficient Cluster Based Routing Protocols In Mobile Wireless Sensor Networks", International Journal of Engineering Science and Technology, Vol. 5 No. 06S, 2013, 90-94.

[21] Elham Shadkam and Mehdi Bijari, "Evaluation The Efficiency Of Cuckoo Optimization Algorithm", International Journal on Computational Sciences & Applications, Vol.4, No.2, April 2014.