



## Relative Analysis of Hierarchical Routing in Wireless Sensor Networks Using Cuckoo Search

Navpreet Singh\*

Principal, F.C.E.T. Polytechnic Wing  
Ferozeshah, Punjab, India

Viney Popli

Head, Applied Sciences  
F.C.E.T., Ferozeshah, Punjab, India

Barinder Paul Singh

Assistant Professor, ECE Department  
F.C.E.T., Ferozeshah, Punjab, India

**Abstract**— Wireless sensor networks are those networks which are composed by the collection of very small devices mainly named as nodes. These nodes are integrated with small battery life which is very hard or impossible to replace or reinstate. For the sensing, gathering and processing capabilities, the usage of battery is must. Therefore, the battery life of Wireless Sensor Networks should be as large as possible in order to sense the information around it or in which the nodes are placed. The concept of hierarchical routing is mainly highlighted in this paper, in which the nodes work in a hierarchical manner by the formation of Cluster Head within a Cluster. These formed Cluster Heads then transfer the data or information in the form of packets from one cluster to another. In this work, the protocol used for the simulation is Low Energy adaptive Clustering Hierarchy which is one of the most efficient protocol. The nodes are of homogeneous in nature. The simulator used is MATLAB along with Cuckoo Search Algorithm. The Simulation results have been taken out showing the effectiveness of protocol with Cuckoo Search.

**Keywords**— Wireless Sensor Network (WSN), Low Energy adaptive Clustering Hierarchy (LEACH), Cuckoo Search, Cluster Head (CH), Base Station (BS).

### I. INTRODUCTION

The Wireless Sensor Networks (WSNs) in general, composed of immense extent of sensor nodes organized profusely over a definite perceptible region. The nodes or sensors necessitate diminutive power for their action and inexpensive in nature also. These nodes or devices are supplied with entrenched microcontrollers, radio receivers and energy systems for the development of sensing and processing of information. The devices or nodes sense the information from the environment surrounding them. The sensed data is then gathered or collected by the node on intermediate side. The intermediate node then transmits the gathered data to the Base Station (BS) which is also called Main Node or Central Node. This main node then makes contact with the client or user or also called end user. The end user is then contacted by the Base Station. The process of conveyance of information or data is done by using the technique named Routing. Routing mechanism plays a vital role for the transference of information because the path is provided by the routing [1]. The transmission becomes proficient if the routing is competent and becomes ineffectual by the exploitation of disorganized routing. Apart from the concept of routing, the passage of information also depends largely on the nature of protocol used. Various routing protocols are used in last decade which show an imperative role in enhancing the lifetime of network by providing the path which is efficient in nature [2]. The basic architecture of WSN is shown in the figure 1.

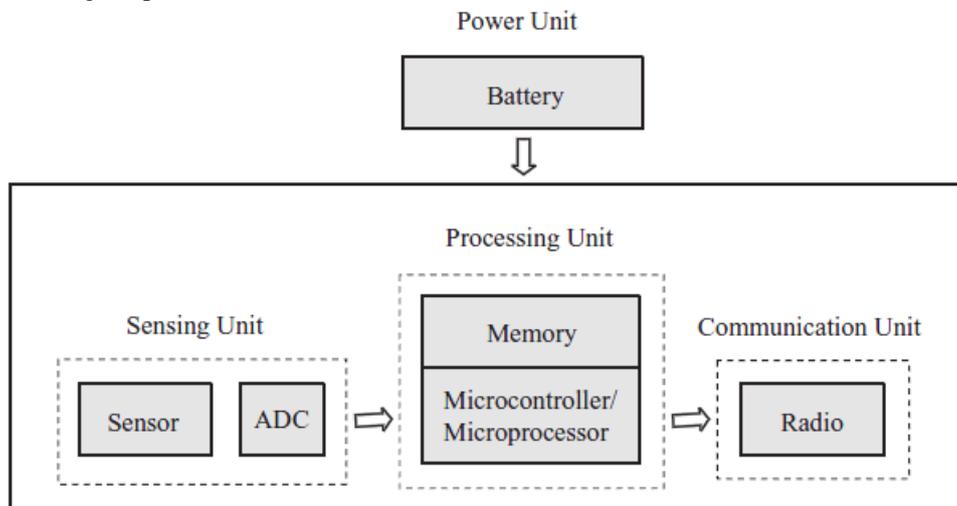


Fig. 1 Architecture of Wireless Sensor Network

Figure 1 shows the fundamental architecture of Wireless Sensor Network which demonstrates the integration of a collection of components used for the development of WSN. The clarification of the components used for the formation of WSN is enlightened in the points below:

- a) A radio transceiver with an internal antenna or connection to an external antenna,
- b) Microcontroller,
- c) An electronic circuit to provide interfacing with the sensors and a power source, more often a battery or an embedded form of energy harvesting.

**A. Topologies of Wireless Sensor Networks**

Apart from this, the WSNs nodes are generally structured in one of three types of network topologies called Star Topology, Cluster Tree Topology and Mesh Topology.

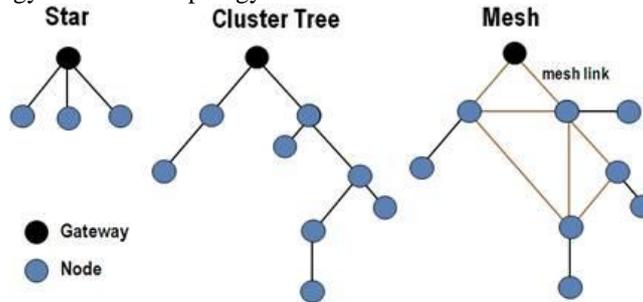


Fig. 2 Topologies of Wireless Sensor Network

In a star topology, each and every node makes contact directly to a gateway node. In a cluster tree network, each node connects to a node higher in the tree and then to the gateway, and data is routed from the lowest node on the tree to the gateway. Finally, to suggest improved consistency, Mesh Networks feature nodes which can unite to multiple natures of nodes in the system and pass data through the majority dependable route accessible. This mesh link is often referred to as a router [3] [4].

**B. Routing and Various Routing Protocols in Wireless Sensor Networks**

- **Flat networks** - The first type of routing protocols are the multi-hop at routing protocols. In at networks, each node usually exhibits the equivalent role and sensor nodes work together together to complete the sensing task. Because of large number of these nodes, it becomes infeasible to assign a global identifier to every node and led to data centric routing, where the BS releases some queries to certain areas and waits for the data or information from the sensors positioned in the preferred areas. Routing Information Protocol (RIP) is an example of a Flat routing protocol [4].

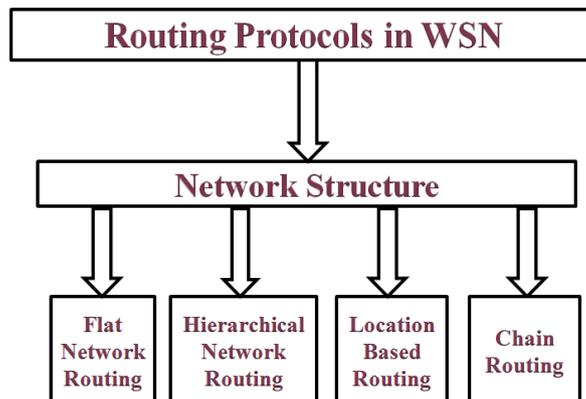


Fig. 3 Routing Techniques in Wireless Sensor Networks

- **Hierarchical networks** - Hierarchical routing is also called cluster-based routing, proposed mainly in wireline networks, is a well-known technique with special advantages related to scalability and proficient communication. As such, the concept of hierarchical routing is also used to perform energy-efficient routing in WSNs. In a hierarchical routing design, nodes with higher energy are used to process and transmit the information while the nodes having lower energy nodes are be used to execute the sensing process within the immediacy of an aim. Low Energy Adaptive Clustering Hierarchy (LEACH) is an efficient and one of the most prominent protocols used in this concept of routing in which the formation of cluster heads takes place for the transference of data from source node to destination node [5].
- **Location-based networks** - In location-based clustering, the location or locality of the sensor nodes plays an important role. BSs are put forward for the routing of data to specific destinations. In these networks, the position awareness of the sensor nodes becomes important to route data to destinations. The distance between contiguous or neighboring nodes can be predictable on the foundation of potency of arriving signal. According to location-

based routing's protocols, if there is no activity then nodes should go to sleep mode to save energy. Location-Aided Routing (LAR) and Distance Routing Effect Algorithm for Mobility (DREAM) are examples of location based protocols [6] [7].

- **Chain Routing** - Chain Routing is an efficient and most widely used routing technique now days because of the formation of Leader Node instead of CHs. In this technique, node sends the data to nearest neighbor node in order to transfer data to BS. The node has to send all of its data to its nearest node and the receiver node act as leader node. Power Efficient Gathering in Sensor Information System (PEGASIS) is an efficient chain based routing protocol [4].

Various energy efficient optimization algorithms like Ant Colony Optimization algorithm, Particle Swarm Optimization algorithm and Fuzzy rules [8] have been proposed during last decade which enhance the energy efficiency of WSN in number of ways. In this paper, Cuckoo Search Scheme is being implemented along with one of an efficient hierarchical routing protocol LEACH. After discussing some of the challenges and advantages of WSN in section I, the rest of the paper is organized as follows. Section II discusses about the concept of LEACH protocol and Section III focuses on Cuckoo Search algorithm. Results and Simulation is shown in Section IV. Section V describes the conclusion and future scope of the proposed work.

## II. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY AND CUCKOO SEARCH

Low Energy Adaptive Clustering Hierarchy (LEACH) is a hierarchical routing's an efficient routing protocol which works on the formation of CHs within a cluster. The CHs then make contact with each other for the transference of data from one node to another until the data reaches to the final node i.e. BS. LEACH was proposed in the year 2000 by Heinzelman [2] which is also known as Hierarchical Clustering algorithm for sensor networks [3]. The concept of distributed cluster formation in the implementation of LEACH protocol gives the about regarding its cluster-based nature. The working of LEACH protocol is based on the concept of hierarchical routing scheme in which the formation of two layered structure take place. The one layer is used for the selection of the CH while the second layer is used to route the data from one node to another [9]. LEACH protocol works on two phases which are named as setup phase and steady state phase. The work of setup phase is to select the CHs after the proper association of clusters. On the other hand, the transference of data from one node to another node takes place in the second phase named as steady state phase. To reduce the effect of overhead, the duration of second phase i.e. steady state phase is kept longer than that of setup phase [4]. The working of LEACH protocol in terms of transmitting and receiving of data is based on the allocation of diverse set of Code Division Multiple Access (CDMA) codes which helps in the secure interlink among the nodes. The data received by the CH from the node has to be compressed first before the transmission of data to the BS. This prevents the congestion within the network which helps in increasing the efficiency of the network [13]. The nodes in LEACH protocol are homogeneous in nature which means that all the nodes are equipped with same amount of energy levels and are capable to perform the same tasks of sensing, gathering or compressing and transmitting the data. This is one of the biggest disadvantages in LEACH protocol where the energy level of BS is same as that of other nodes deployed. This also reduces the efficiency of LEACH protocol because the communication at larger distances gets affected by the same energy level of BS as that of other nodes [4]. The equation used for the working of LEACH is shown beneath [14].

$$T(n) = \frac{p}{1 - p(\text{rmod}(\frac{1}{p}))} \quad \text{if } n \in G$$

Cuckoo Search is an optimization algorithm which was mainly developed to provide efficiency to WSNs. This algorithm is inspired by necessitate brood parasitism of some of the varieties of cuckoo by lying their eggs in the nests of other host birds. Some of the hosts' birds can connect variance with the obtrusive cuckoos. Cuckoo Search is entirely based on three idealized regulations.

- Each cuckoo put down one egg at an instance, and deposits its egg in a arbitrarily preferred nest.
- The finest nests with superiority of eggs will bring over to the next creation.
- The quantity of accessible hosts' nests is predetermined, and the egg laid by a cuckoo is exposed by the host bird with a possibility.

## III. PROPOSED METHODOLOGY

Energy Efficiency is one of the most considerable concerns in WSNs on which the lifetime of a network can be determined. WSNs are integrated with a small or restricted battery source which is very hard of impossible to recharge after the drainage. Hence, many energy efficient techniques are proposed to deal with this vital issue. Many energy efficient routing protocols and algorithms have been put forward to minimize this issue. But, there are some of the drawbacks faced in all the methods applied. LEACH protocol is one of an efficient protocol used to control this issue but because of the deployment of homogeneous nodes, the protocol is not as efficient as required. Hence, in this paper an improved variant of LEACH protocol is proposed which works on the concept of heterogeneity of nodes so that all the nodes can carry out diverse set of tasks. This variant of LEACH protocol is taken as Improved LEACH. The proposed heterogeneity lies in the term of energy allocated to the nodes. The node with higher energy among other nodes in the cluster becomes the CH in the proposed variant of LEACH protocol. By this reason, the CH node can cover or make contact with the far away nodes in order to transfer the data to the larger distances. The overhead also get minimized by the homogeneity in the energy level of the nodes. The comparative analysis of both of the protocols is discussed in the section of results and discussion. The flow of work is discussed in seven stages which are discussed as follows.

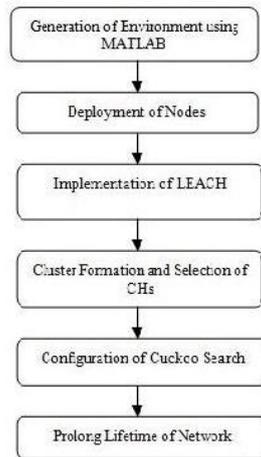


Fig. 4 Proposed Methodology

Figure 4 clearly shows the working of proposed paper. The first process is used for the generation of environment using MATLAB and the deployment of nodes takes place in step 2. The LEACH protocol is then implemented in step 3 and the formation of clusters occurs in step 4. After this, the election of CHs takes place in the same step, step4. The Cuckoo Search is then applied at step 5. In step 6, the network lifetime get enhanced.

#### IV. SIMULATION RESULTS AND DISCUSSION

In this section, the simulation results and discussion has been carried out. The whole of the work is done by using core i5 processor workstation have MATLAB 7.11. The simulation results show that the lifetime of network increases when LEACH protocol is used along with Cuckoo Search algorithm than that of traditional LEACH protocol.

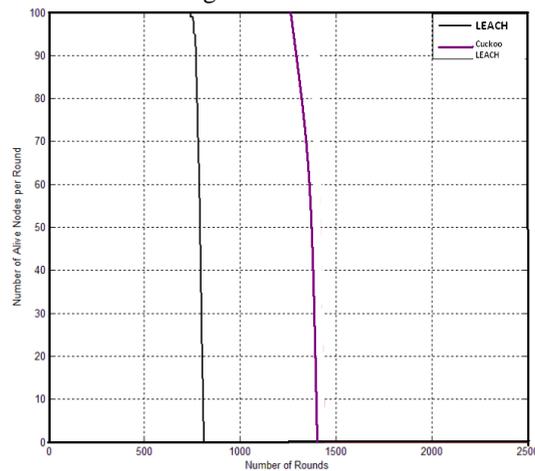


Fig. 5 Lifetime of Network

Figure 5 clearly shows that the lifetime of LEACH protocol is more than that of traditional LEACH protocol when get modeled with Cuckoo Search algorithm. The traditional LEACH protocol loses all of its energy at maximum of 800 rounds while LEACH with Cuckoo Search crosses 1400 rounds and died at 1450 approx.

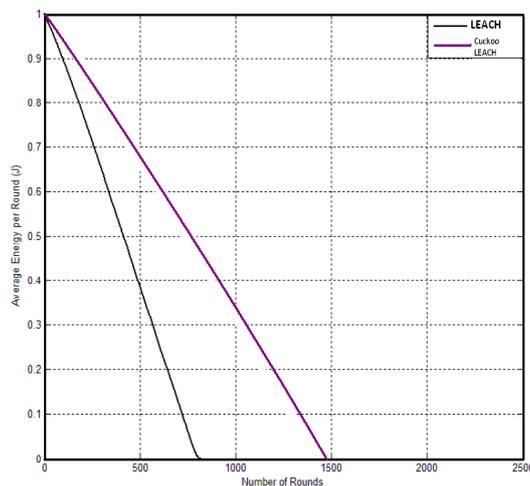


Fig. 6 Residual Energy of Network

Figure 6 represents the average remaining energy of the nodes which is also called residual energy. Again, the residual energy of LEACH with Cuckoo Search is more than that of conventional LEACH protocol. Hence, the simulation results show that the LEACH protocol shows efficient and effective results when used along with Cuckoo Search algorithm.

## V. CONCLUSION

In this section, we can conclude that the energy efficiency is one of an imperative issue which occurs mainly in Wireless Sensor Networks. To enhance the lifetime of network, LEACH protocol comes out to be more efficient which is a part of hierarchical routing. LEACH transfers the data or information from source node to destination node or BS by the formation of hierarchical networks along with CH within a cluster. The LEACH protocol comes out to be more efficient and significant when used with Cuckoo Search algorithm which is an optimization algorithm.

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## AUTHORS BIOGRAPHY



**Er. Navpreet Singh** received his Bachelor of Engineering degree from Nagpur University in the year 1998. He has done his MBA from Punjab Technical University, Jalandhar and Masters of Technology from Karnatka University in 2005 and 2012 respectively. He is currently serving as the post of Principal (Polytechnic Wing), Ferozpur College of Engineering and Technology, Ferozeshah. He has 16 years of work experience. His area of interest includes Digital Electronics and Wireless Communication.



**Mr. Viney Kumar Popli** passed his M.Sc. from Guru Nanak Dev University, Amritsar, India, in 2003, M.Phil. from Madurai Kamraj University, Madurai, India, in 2008. He is pursuing his Ph.D. degree in Mathematics. He is currently an Assistant Professor and Head, Department of Applied Sciences and Humanities, at Ferozpur College of Engineering and Technology, Ferozeshah. He has 11 years of work experience. His area of interest is Fuzzy logic and Boolean Algebra.



**Er. Barinder Paul Singh** received his Bachelor of Technology and Masters of Technology Degrees from Shaheed Bhagat Singh State Technical Campus, Ferozpur, India, in 2010 and 2014 respectively in Electronics and Communication Engineering. He is currently working as the post of Assistant Professor in Department of Electronics and Communication Engineering at Ferozpur College of Engineering and Technology, Ferozeshah. He has 4.5 years of work experience. His area of interest includes Wireless Sensor Networks, Ad-hoc Networks and Fuzzy Logic. He has 5 publications in reputed international journals.