

Energy Efficient Scheme Based on Low Energy Adaptive Clustering Hierarchical Protocol for Wireless Sensor Network using HG LEACH

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Abstract— Sensor network is worked on battery power. The main limitation of wireless sensor network is energy and network life time. To solve this problem we propose the network area in Q-LEACH protocol on the basis of dividing whole network into four quadrants and each quadrant performs separately. In LEACH-E protocol, all nodes have same energy and same probability of suitable the cluster head. After the first round, energy level of each node changes and the amount of residual energy of each node is used to select cluster head nodes. Cluster head (CH) selection is based on the highest energy by the base station. Experimental results show that when to compare the performance with existing system and the proposed system is very efficient in terms of network life time, energy consumption. The experiment shows that HG-LEACH protocol has better network life time in the network.

Key words: Wireless Sensor Network-(WSN), Low-Energy Adaptive Clustering Hierarchy- (LEACH), Q-LEACH (Quadrature Low Energy Adaptive Cluster Hierarchy) Cluster Head (CH), Base Station- (BS)

I. INTRODUCTION

A wireless sensor network is a group of sensor nodes arranged in a field to monitor physical conditions separately. It can measure several physical conditions like pressure, sound, humidity, speed, temperature, load, etc. [1].

II. ROUTING PROTOCOLS

The routing protocols are implemented to optimize energy consumption in the network. It defining set of rules to specify how message packets transfer from source to destination in a network powerfully and with less amount of energy consumed. Figure 1 shows the classification of routing protocols in WSN [3].

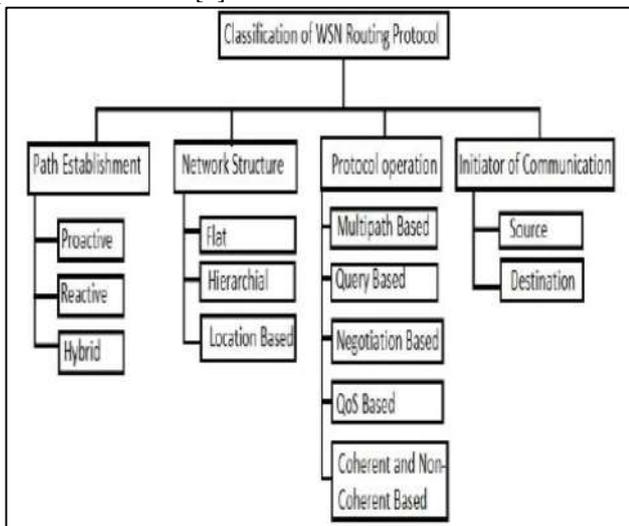


Fig. 1: Classification of WSN Routing Protocols [3]

Many routing algorithms were developed for wireless networks. All main routing protocols proposed for WSNs divided into seven categories as shown in Table 1 [4].

Category	Representative Protocols
Location-based Protocols	MECN, SMECN, GAF, GEAR, Span, TBF, BVGF, GeRaF
Data-centric Protocols	SPIN, Directed Diffusion, Rumor Routing, COUGAR, ACQUIRE, EAD, Information-Directed Routing, Gradient-Based Routing, Energy-aware Routing, Information-Directed Routing, Quorum-Based Information Dissemination, Home Agent Based Information Dissemination
Hierarchical Protocols	LEACH, PEGASIS, HEED, TEEN, APTEN
Mobility-based Protocols	SEAD, TTDD, Joint Mobility and Routing, Data MULES, Dynamic Proxy Tree-Base Data Dissemination
Multipath-based Protocols	Sensor-Disjoint Multipath, Braided Multipath, N-to-1 Multipath Discovery
Heterogeneity-based Protocols	IDSQ, CADR, CHR
QoS-based protocols	SAR, SPEED, Energy-aware routing

Table 1: Routing Protocols for WSNs [4]

III. HIERARCHICAL PROTOCOLS

Many research projects in the last few years have searched hierarchical clustering in WSN from different views. Clustering is an energy-efficient communication protocol that can be used by the sensors to report their sensed data to the sink [4]

Here explain a sample of layered protocols in a network is collected of several clumps (or clusters) of sensors. Each clump is managed by a special node called cluster head which is responsible for coordinating the data transmission activities of all sensors in its clump [4]

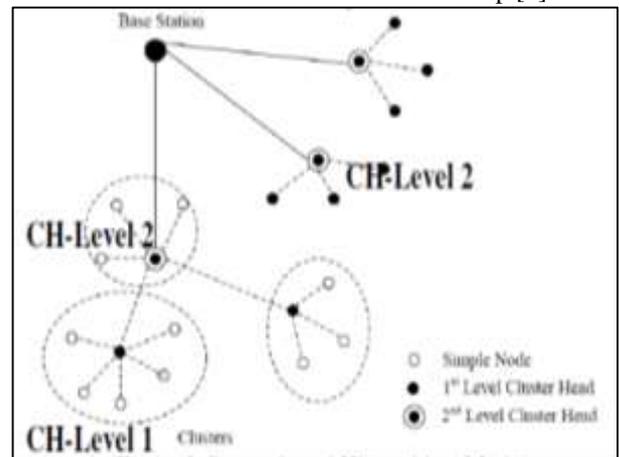


Fig. 2: Cluster-based Hierarchical Model [4]

A sample of layered protocols in a network is collected of several clumps (or clusters) of sensors. Each clump is managed by a special node called cluster head which is responsible for coordinating the data transmission activities of all sensors in its clump [8].

As shown in Figure 2, a hierarchical approach divides the network into clustered layers. Nodes are grouped into clusters with a cluster head that has the task of routing from the cluster to the other cluster heads or base stations. Data moves from a lower clustered layer to a higher one. [8].

A. Advantages of Clustering:

- Minimization of energy consumption of intra cluster and inter cluster network
- Scalability of the network
- Network life time extending
- Reduction of information packet extend
- Handling heterogeneity of network [10]
- Clustering in sensor networks offers the spatial reprocess of all the used resources which increases the capacity of system.
- The information of routing that is transmitted can only shared between cluster heads or with cluster gateways. By imposing this condition lessens the number of transmissions that is achieved for routing information [11].

B. Disadvantages of Clustering:

- The spending of energy on cluster-heads has not been tackled because nodes will absorb with more calculation and communiqué of data to superior level.
- There is no real life situation but only an idyllic network is assumed.
- Different clusters have load imbalance possibly.
- The Overhead is not deemed and related with the cluster-heads selection [11].

IV. LOW-ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

LEACH- Low-energy adaptive clustering hierarchy is a mainly popular clustering-based hierarchical routing algorithm proposed by Wendi. LEACH is a classic adaptive clustering algorithm proposed by Heinzelman[9].

LEACH is the first and most popular energy-efficient hierarchical clustering algorithm for WSNs proposed for reducing power consumption. The clustering task is rotated between the nodes based on duration. Direct communication is used by each cluster head (CH) to forward the data to the base station (BS). It uses clusters to delay the life of the wireless sensor network [4].

The cluster heads communicate the aggregated data from the cluster to the base station directly. The other member nodes of a cluster periodically send their sensed data to the cluster head and rest all other time. Each node selects its cluster by comparing received signal strength of advertisement message sent by elected cluster nodes in each round [8].

LEACH divides the network into some cluster of sensors created by using localized coordination and control. Not to reduce the amount of data that is broadcasted to the

sink but make routing and data broadcasting more scalable and robust.

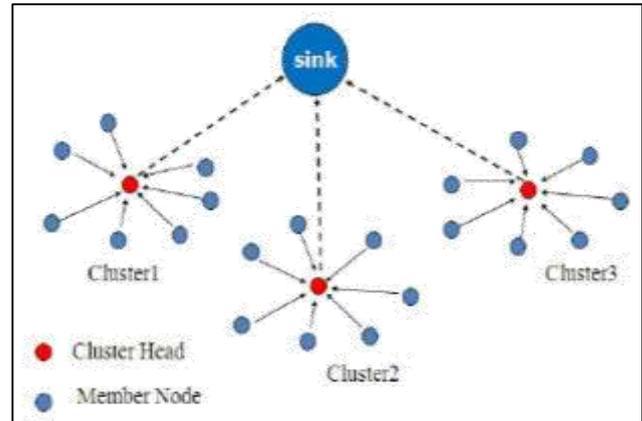


Fig. 3: Clustering technique in LEACH [8]

The operation of LEACH is divided into two phases

- 1) A setup phase to arrange the network into clusters, CH advertisement, and transmission schedule creation and
- 2) A steady-state phase for data aggregation, compression, and transmission to the sink [4].

V. VARIANTS OF LEACH

A. E-Leach:

It creates the cluster head selection method capable by creating the remaining energy of the cluster head nodes as very important part. It will choose these cluster nodes fit into the cluster head or not in the next round. E-LEACH will create better election process of cluster head nodes [2]. E-LEACH protocol increases the cluster head selection process.

The LEACH protocol and energy-LEACH protocol splits into many rounds and each round covers cluster formation phase and cluster steady phase.

- 1) In cluster formation phase, each node chooses whether to go into cluster head or not by matching with residual energy ;
- 2) Some nodes with more residual energy go into cluster heads and send cluster head information to inform other nodes. The other nodes with less residual energy go into common nodes and send information about joining cluster to a cluster head ;
- 3) In cluster steady phase, nodes in a cluster send data giving to TDMA table, and cluster heads receive, fuse and send data to sink. The network reforms the cluster head selection procedure in a new round after a period of time [6].

B. Q-Leach:

Q-LEACH protocol is a grouping of conventional Quadrant based directional routing protocol and Low Energy Adaptive Clustering Hierarchy (LEACH) protocols. This protocol takes the benefits of both Q-DIR routing protocol and LEACH protocol [7].

Q-DIR is a restricted flooding routing protocol centers on a quantified zone using location information supplied by a location service. The location information of the source and destination nodes is associated in the route request (RREQ) packet and shown.

Figure 4 shows the participating nodes in total flooding algorithm. Upon receiving the RREQ, destination

node will send a route reply message (RREP) back to source via the path taken to reach the destination that was appended in the RREQ as it criss-crosses across the network.

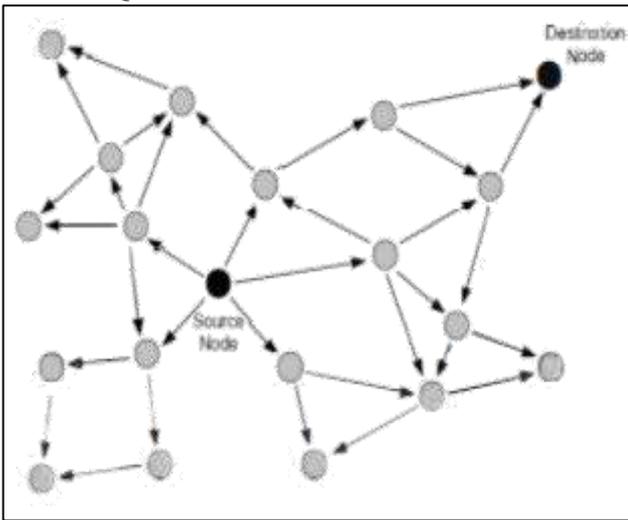


Fig. 4: Participating nodes in total flooding algorithm [5]

Receiving the RREQ, destination node will send a route reply message (RREP) back to source over the path taken to reach the destination was added in the RREQ as it criss-crosses across the network.

By applying restricted flooding on the quadrant, the path increase feature in AODV, the number of nodes contributing in the route discovery will be reduced and eases the routing overhead. The amount of energy used between the source and destination is limited so increasing the energy skill of the network.

Figure 5 shows less participating nodes if restricted flooding is worked based on the same quadrant middle is located compared to source and destination. It reduces the number of routing packets that traverse through the network.

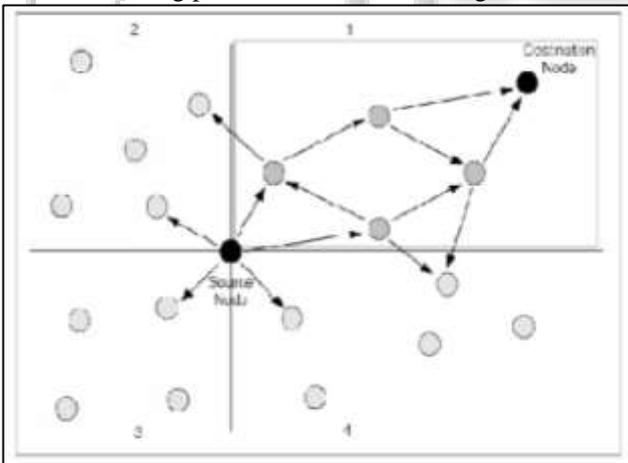


Fig. 5: Less participating nodes in q-dir algorithm [5]

Q-LEACH is a routing protocol to takes the advantage of both locations based routing protocol and hierarchical based routing protocol. Restricted flooding concept is broken in the nodes are located nearer to the destination or in a helping zone broadcasts the packet. Distance and forwarding zone information are calculated at the individual nodes to decide their development to destination.

These nodes show the packets and the process is repeated at each central node until it reaches the destination and uses clustering procedures in which nodes are arranged

into cluster and cluster head is distributed to each cluster to execute the data combination and merging to reduce the energy consumed by nodes in the cluster [5].

VI. PROPOSED WORK

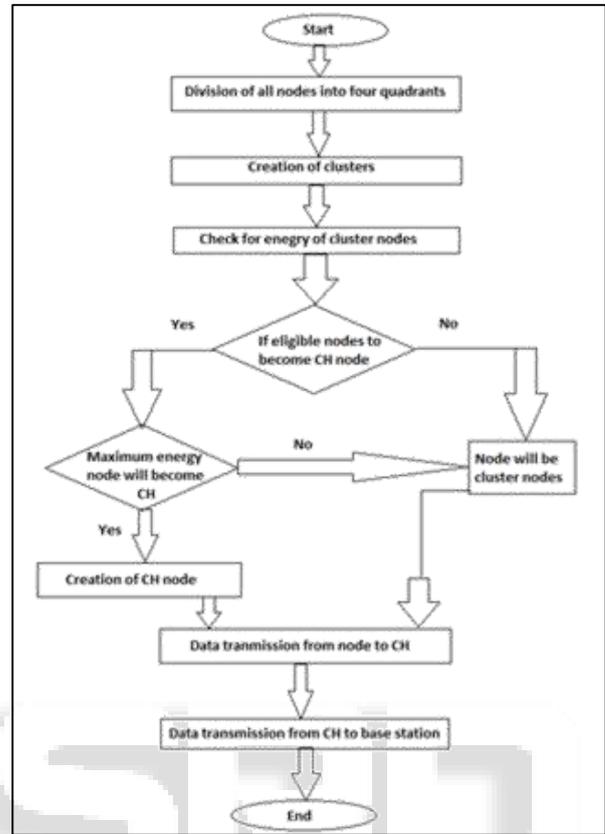


Fig. 6: Flow chart of proposed work: HG-LEACH

VII. SIMULATION RESULTS

Implementation Tool MATLAB is used for the implementation of algorithm and is powerful language for technical computing. MATLAB stands for MATrix LABoratory because its basic data element is a matrix (Array). MATLAB is used for math computations, modeling and simulations, data analysis and processing, visualization and graphics, and algorithm development.

MATLAB is a software package for high-performance numerical calculation and visualization. It offers a collaborating environment with hundreds of built-in functions for technical computation, graphics and animation and easy extensibility with its own high-level programming language.

The main features of MATLAB are as below:

- 1) It supports high level graphics programming (for examples like 2-D Graphics, 3-D Graphics, Color and Lighting, Animation and Audio and Video)
- 2) It supports calculations like Linear algebra, data analysis, signal Processing, Polynomials and Interpolation etc
- 3) It supports external interfaces (like interfaces with C, java and Fortran Programs)

In this experimental analysis, the performance of the existing and the proposed system is compared. Wireless sensor network is operated by battery power. So energy consumption and life time of network is very important.

There are following parameters shown in below table.

Parameters	value
Network Size	100m * 100m
Number of nodes (n)	100
Initial Energy (E_0)	0.5 J
Probability of a node (p)	0.1
Radio electronics energy (E_{elec})	50 nJ/bit
Radio amplifier energy (E_{mp})	0.0013pj/bit/m ⁴
Radio amplifier energy (E_{fs})	10 pj/bit/m ²
Data Aggregation Energy (E_{DA})	5NJ/bit/signal

Table 2:

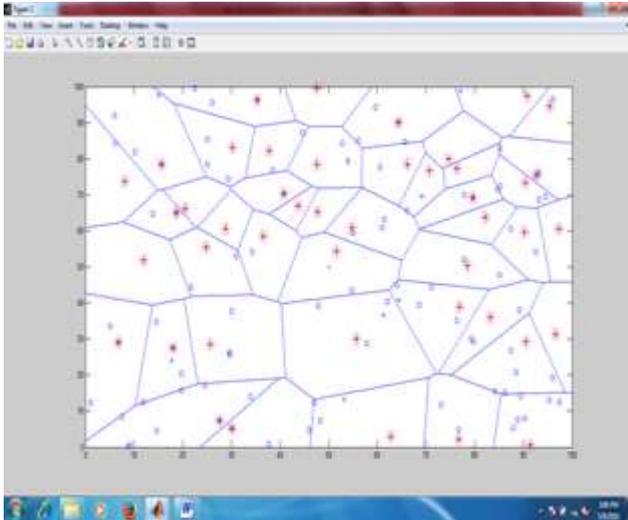


Fig. 7: Initial Configuration In LEACH

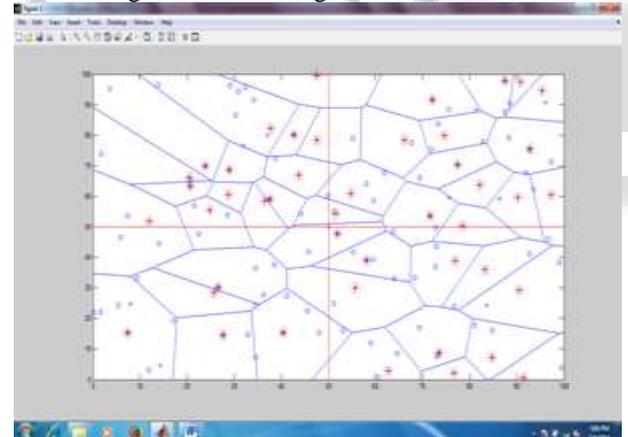


Fig. 8: Initial Configuration In Q-LEACH And Energy LEACH

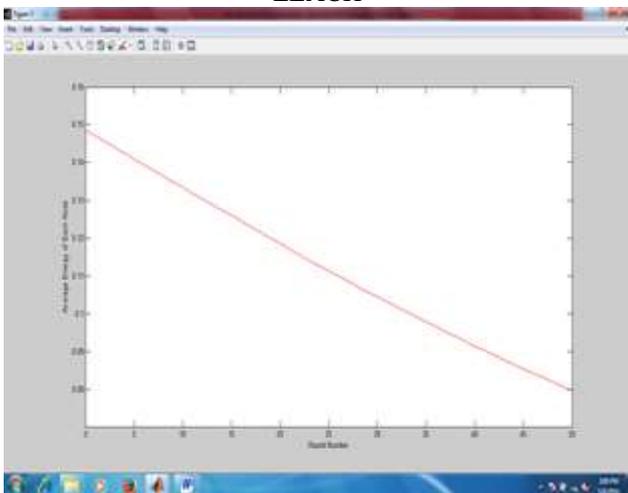


Fig. 9: Average energy of each node in the network

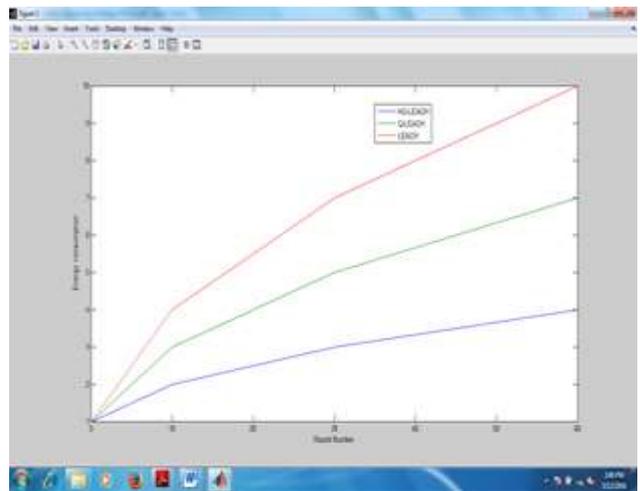


Fig. 10: Comparison Of LEACH, Q-LEACH And HG-LEACH

VIII. CONCLUSION

This work of thesis shows an energy efficient clustering algorithm based on LEACH for wireless sensor network. The proposed method will minimize the energy consumption of the sensor nodes. Energy efficiency is the major parameter in the design of protocols for WSNs as battery power of sensors is limited.

In this thesis, the functionality of Energy LEACH and Q-LEACH will be combined and in turn, resultant requirement of the energy would be minimized at very extent. Thus, the proposed schema would deliver the combined results of Energy LEACH and Q-LEACH protocols.

The proposed system will improve performance of Q-LEACH and Energy LEACH protocol by merging. So the energy efficiency will be improved. The proposed system will save the energy consumption. So, this will enhance the performance ratio in terms of energy consumption and life time of the sensor nodes.

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