

Review of Various Enhancements of Modified LEACH for Wireless Sensor Network

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Abstract— Wireless sensor network depends on the nodes have limited energy, memory, computational power, range and it is important to increase energy efficiency by saving the battery power so as to extend of the life time of the given wireless sensor network deployment. In wireless sensor network, data is measured by node and same is send to base station at regular interval. Clustering sensor nodes is an effective technique in wireless sensor network. Different protocols are used for energy consumption in which Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is the first hierarchal cluster based routing protocol successfully used in the wireless sensor network. In this paper, various enhancements used in the original leach protocol are studied.

Key words: Wireless sensor networks, sensor node, LEACH, cluster head

I. INTRODUCTION

In wireless sensor network technology has provided the availability of sensing various types of physical and environmental conditions. A wireless sensor network consists of a large number of sensor nodes that co-operatively monitors a specific region of interest. Typically, a sensor node is a small hardware device consisting of a processing, a sensing unit, a communication unit and a power unit that is used for sensing, data processing and communication purpose. Figure 1 shows the schematic diagram of sensor node component. Sensor nodes are usually scattered in a sensor field, which is an area where the sensor nodes are deployed Sensor nodes co-ordinate among themselves to produce high quality information about the physical environment.

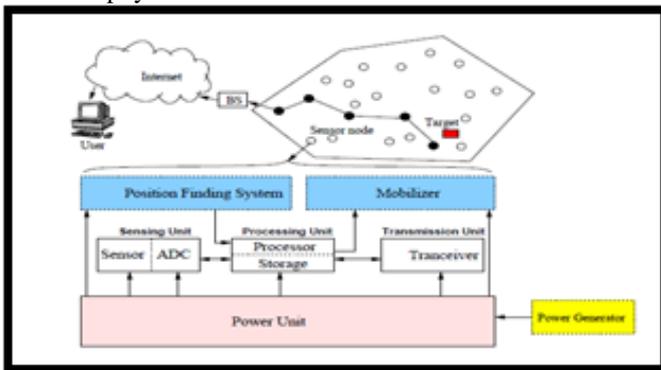


Fig 1

Each of these scattered nodes has the capability to collect and route data either to other sensor or back to an external base station. A base station may be fixed node or a mobile node capable of connecting the sensor network to an existing communication infrastructure or to the internet where a user can have access to the reported data.

In order to enhance the network lifetime in wireless sensor network, the routing protocol is a major issue. There are two competing objectives in the design of wireless

sensor network. The first objective is the capability to exchange the large amount of the node station. The second constraining objective is minimizing the energy consumption.

II. RELATED WORK

This section represents the existing work related to the wireless sensor network. Mainly of the routing protocols have been proposed for wireless sensor networks. Routing in the wireless networks are categorized into 3 types based on the structure of the network. They are Flat Routing, Hierarchical Routing and Location Based Routing. In Flat Routing all the nodes of the network performs the same functionality and work together to collect the data and routing to the destination. Hierarchical routing, also known as cluster-based routing considered as a two layer architecture where one layer is engaged in cluster head selection and the other is responsible for routing. A cluster head in hierarchical routing is the node which is responsible for collecting data from other nodes in the cluster, aggregating all data and sending the aggregated data to the base station. LEACH is the foremost algorithm in these hierarchical and in the past decades several variants of LEACH have been employed to achieve energy efficiency [1]

In LEACH protocol, the sensor nodes are combined together and form a local cluster. Among all sensor nodes one node acts as a cluster head inside the local cluster. A randomized rotation technique a cluster head is used by this protocol whose main aim is to distribute the energy load equally among all the sensors in the network which ultimately gives result of a longer life to the node's battery. The major role of cluster head is to collect data from their respective clusters and aggregate those collected data and finally sent to the base station. In this manner, LEACH enable scalability and robustness for dynamic network and incorporates data fusion into the data gathering process to reduce the amount of data to be transmitted.

The operation of LEACH is divided into two phases and these phases are further divided in same sub-phases. Each LEACH round begins with a set-up phase and a steady state phase. Set up phase is used to choose a cluster head and steady state phase is used to maintain the cluster head during the transmission of data. The structure of the cluster of nodes in a wireless network is given in the following Fig 2.

LEACH is a protocol that tends to reduce energy consumption in a wireless sensor network. However, LEACH uses single-hop routing in which each sensor node transmits information directly to the cluster-head or the sink. Some of the limitations of LEACH routing protocol are,

- Cluster heads sends aggregated data to the base station in single hop manner so consumes lot of energy.

- Distribution of the cluster head is not uniform. Some of the clusters may have cluster head at the edge of the cluster.
- Cluster heads are predefined typically taken as 5% or 10% of total deployed nodes.

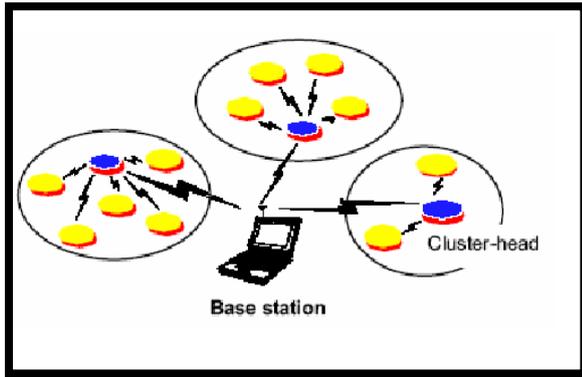


Fig 2

III. MODIFIED ALGORITHMS FOR LEACH

M. BaniYassein, A. Al-zou'bi, Y. Khamayseh, W. Mardini [2] presented an overview of LEACH protocol implementations, then proposed a new version of LEACH protocol called V-LEACH protocol. From the simulation results, number of conclusions can be made. The first: number of messages created by the V-LEACH is less than the messages created by the original LEACH. The second: if messages created by the new version are less that means the network energy remaining using V-LEACH is more than the remaining network energy using the original LEACH. That means the new version of LEACH outperforms the original version of LEACH protocol.

Ben Alla, Ezzati Abdellah, Abderrahim Beni Hssane, Moulay Lahcen Hasnaoui [3] presented IB-LEACH, an extension of the LEACH, which improves the stable region of the clustering hierarchy and decrease probability of failure nodes using the characteristic parameters of heterogeneity in networks. In these networks some high energy nodes called NCG nodes (Normal node or Cluster Head or Gateway) become "cluster heads" to aggregate the data of their cluster members and transmit it to the chosen "Gateways" that requires the minimum communication energy to reduce the energy consumption of cluster head and decrease probability of failure and this increase the lifetime of the network. Simulation results shows that the IB-LEACH achieves better performance in this respect, compared to SEP and LEACH in both heterogeneous and homogenous environments. In this paper it is supposed that nodes called NCG nodes are distributed randomly and fixed.

Vivek Katiyar, Narottam Chand, Gopal Chand Gautam, Anil Kumar [4] presented Improvement in LEACH Protocol for Large-scale Wireless Sensor Networks In this paper an improvement in LEACH protocol has been proposed to overcome the shortcoming i.e. existence of very large and very small clusters in the network at the same time. This leads to the decrease in lifetime of WSNs. In this paper, it proposes and analyzes a new energy efficient clustering protocol (FZ-LEACH) that eliminates the above problem by forming Far-Zone. Far-Zone is a group of sensor

nodes which are placed at locations where their energies are less than a threshold. The simulation results and analysis show that proposed FZ-LEACH algorithm outperforms LEACH in terms of energy consumption and network lifetime. Simulation results prove the improvement in the performance in the original LEACH protocol in terms of energy dissipation rate and network lifetime. It is found that FZ-LEACH protocol saves around 30% energy of sensor network in comparison to LEACH.

D. Mahmood, N. Javaid, S. Mahmood, S. Qureshi, A. M. Memon, T. Zaman [5] presented MODLEACH. MODLEACH tends to minimize network energy consumption by efficient cluster head replacement after very first round and dual transmitting power levels for intra cluster and cluster head to base station communication. In MODLEACH, a cluster head will only be replaced when its energy falls below certain threshold minimizing routing load of protocol. Hence, cluster head replacement procedure involves residual energy of cluster head at the start of each round

Bilal Abu Bakr, Leszek Lilien [6] presented A Quantitative Comparison of Energy Consumption and WSN Lifetime for LEACH and LEACH-SM. Extending the period of operation (lifetime) of wireless sensor networks (WSNs) is one of the most critical issues. Their limitations are caused by limited energy resources. To achieve WSN lifetime extension, we propose the LEACH-SM protocol, which modifies the prominent LEACH protocol by providing an optimal energy-saving spare management, including spare selection. LEACH-SM extends WSN lifetime while maintaining the minimum required coverage throughout the WSN lifetime. Other features of LEACH-SM are: spare selection at the beginning of its operation (allowing sensor nodes in all clusters to make their primary/spare decisions in parallel), reducing transmission of redundant data to cluster heads, and maintaining scalability by using only local information.

Lu Jianyin [7] presented Simulation of Improved Routing Protocols LEACH of Wireless Sensor Network, this paper introduces compression ratio, takes the surplus energy of nodes as a pivotal factor in cluster-head node selection, proposes an improved algorithm of the optimal number of cluster heads with the minimum energy consumption and provides the computational formula for obtaining the optimal number of cluster heads, and proves by mathematical reasoning and by simulation experiments. The improved algorithm is a success in terms of balancing energy consumption of the system and prolonging the network life cycle, thus leaving the network more of robustness

Suyog Pawar, Prabha Kasliwal [8] presented Design and Evaluation of En-LEACH Routing Protocol for Wireless Sensor Network. This paper takes into account the assumption in LEACH i.e. each sensor node contains equal amount of energy which is not valid in real scenarios. Enhanced LEACH protocol (En-LEACH) has been adaptable to handle non-uniform energy distribution characteristic of a dynamic sensor network. En-LEACH is more effective; producing high level information about the environment in an energy-efficient way. En-LEACH is able to handle non-uniform energy distribution of sensor nodes which is an important characteristic of a dynamic sensor

networks. In En-LEACH, cluster-head depending upon energy left in the node, all cluster members are kept informed about the status of their cluster-head, since the probability of failure of cluster head is high during data transmission phase. This provision is missing in LEACH protocol. Hence it is bound to perform better than LEACH

Ningbo WANG, Hao ZHU [9] presented an Energy Efficient Algorithm Based on LEACH Protocol. In this paper, effectiveness of LEACH protocol is analyzed in extending the lifetime for energy-constrained wireless sensor networks. An improved protocol LEACH-R is proposed based on LEACH protocol. LEACH-R improves the selection of cluster-head and proposes to choose relaying node compare to LEACH. Residual energy of the nodes is considered during selection of cluster-head, possibility of low energy nodes being selected as cluster-head is reduced. Based on both residual energy and distance to base station, relaying node is chosen from cluster heads to become the relay node between base station and other cluster-heads. The simulation result suggests LEACH-R protocol could balance network energy consumption and extend the network life cycle more effectively and proves the improvement in the performance in the original LEACH protocol in terms of energy dissipation rate and network lifetime. It is found that LEACH-R protocol saves around 20% energy of sensor network in comparison to LEACH.

Hongqin Liu, Shaochuan Wu [10] presented Improvements of LEACH Protocol in Wireless Sensor Networks. This article analyzes the mechanism of clustering in LEACH protocol and presents improved approaches based on energy of sensor node and the distance between the node and the base station, then compares their performances. Two improved protocols: LEACH-E and LEACH-ED are presented in this paper. LEACH-E considers residual energy of nodes in phase of cluster head selection and LEACH-ED takes into account both the residual energy of nodes and the distance between the base station and nodes. Results of simulation indicate that the improved protocols can balance the network load and prolong the network lifetime.

Shuo Shi, Xinning Liu and XuemaiGu [11] presented an Energy-Efficiency Optimized MAX_LEACH for Wireless Sensor Networks. MAX_LEACH is a cluster algorithm in which cluster heads are randomly selected from the nodes with energy above the average, and the simulated annealing algorithm is utilized to find the optimal solution with better position to reduce the energy loss of cluster heads. It provided an energy-efficiency optimized MAX_LEACH through a modified model of the cluster head energy consumption considering retransmission and acknowledgment, and the secondary simulated annealing algorithm is utilized to get a better solution.

Geon Yong Park, Heeseong Kim, HwiWoonJeong, and Hee Yong Youn [12] presented A Novel Cluster Head Selection Method based on K-Means Algorithm for Energy Efficient Wireless Sensor Network. In this paper we propose an efficient cluster head selection method using K-means algorithm to maximize the energy efficiency of wireless sensor network. It is based on the concept of finding the cluster head minimizing the sum of Euclidean distances between the head and member nodes. This is mainly due to effective selection of the CHs such that the distances

between the CH and the member nodes become minimal. We have proposed to group the sensor nodes into several clusters by using K-means algorithm in this paper.

IV. CONCLUSION

In wireless sensor network, energy is an important issue. So designing energy efficient protocol is very important. In this survey, the advantages and limitations of various enhancements of modified LEACH were discussed. Each version of LEACH was implemented to solve some limitations of original LEACH algorithm like delay, stability, uniform distribution of cluster heads, multi-hop routing and optimal cluster head selection.

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