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Improvement in LEACH protocol based on the Genetic Algorithm

Rajanbir Singh Bhattal
M.Tech Student, ECE Department,
Surya World Group of Institutes

Pallavi Chandel
ECE Department,
Surya World Group of Institutes

***Abstract*— Wireless Sensor Networks is a collection of nodes organized into cooperative network that uses a large number of routing algorithms. One important protocol, LEACH protocol is discussed in this paper. The parameters involved in this protocol are discussed and improved using an optimization technique, that is genetic algorithm approach.**

Keywords—Wireless Sensor Networks; Low Energy Adaptive Clustering Hierarchy (LEACH); Cluster Head (CH);Genetic Algorithm (GA)

I. INTRODUCTION

Wireless Sensor Networks (WSNs) is a collection of nodes organized into cooperative network that have sensing, calculation and wireless transportation capabilities. Each node consists of microcontrollers, CPUs or DSP chips, may contain many types of memories (program, data and flash memories), RF transceiver, power source, sensors and actuators. The figure 1 shows the structure of WSN.

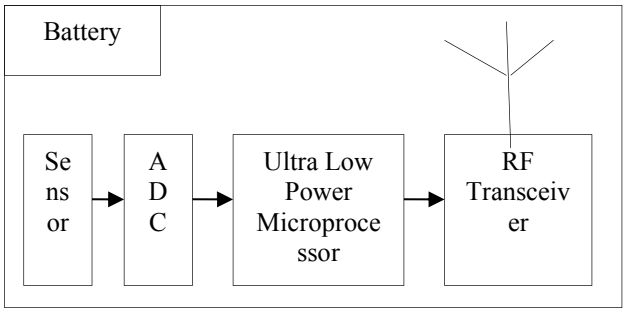

Fig. 1 Structure of WSN

The main issues of WSN are reliability, security, voids, real time, congestion etc. Numerous routing protocols have been mainly designed for WSNs where the throughput and energy consumption are main issues. LEACH protocol is the main clustering routing protocol in WSNs which is able to deal out energy indulgence evenly all over the sensors. The goal of the LEACH algorithm is to support a spatiotemporal communication service with a neccesary delivery LEACH along the sensor network, so that end-to-end delay is proportional to distance between the source and destination. The two stages of the protocol are setup phase and steady phase. In setup phase, each node decides independently if it will become a CH or not. This election probability is based on the earlier time a node has been elected as a CH. The node that hasn't been a CH for long time is more likely to elect itself than other nodes that have been CHs recently. Each CH inform their neighbour nodes with an advertisement message that it has become CH. Non-CH nodes choose the advertisement message with the strongest received signal strength. The member nodes then inform to the chosen CH that they have become a member of that cluster using a "join message" which consists of their identifications. After this phase, the each CH knows the number of member nodes and their identifications. Based on the number of member nodes of the cluster, the each CH creates a TDMA schedule and broadcasts it to its cluster members. In Steady-state phase, data are conveyed from the nodes to the cluster head and then to the Base Station (BS).

The main limiting factor in LEACH protocol is energy. The important operations in WSN are gathering of data and forwarding of it. The main cause of it is energy consumption. It can also be considered that it is secure transmission of data in LEACH protocol. All nodes send their data to their CHs, hence CH can be the target for intruder. In case of public key methods data from nodes need to be decrypted at CH since CH needs original data on which it can perform aggregation. So, it is required that new LEACH protocol is to be developed in which data is transmitted in confidential way with least energy consumption and no need to decrypt data at CH [1-4].

II. LITERATURE SURVEY

M. Heinzelman, et.al [5] uses a clustering algorithm for sensor networks known as Low Energy Adaptive Clustering Hierarchy (LEACH). It outlines clusters by means of a distributed algorithm, where nodes create self-directed judgments exclusive of any federal control. It assembles the nodes in the network keen on clusters and prefers one of them exactly as the cluster head. The procedure of LEACH is separated into rounds. Every round start on through a setup phase after the clusters is controlled, pursued by a steady-state phase when data are conveyed from the nodes to the cluster head and on to the Base Station (BS).
Zytoune et al. [6] present a Stochastic Low Energy Adaptive Clustering Hierarchy protocol (SLEACH), which out

performs LEACH when the appeal in gun ruffled data is the smallest amount or the highest value in a region. SLEACH employs the similar method planned in LEACH for shaping of clusters. One time the clusters are shaped, the cluster head transmits in its cluster a data message including its measurement pretentious the relevant value. The nodes having the majority important data barely send their messages towards the cluster-head.

M. Bani Yassein, A. Al-zou'bi, Y. Khamayseh, W. Mardini [7] presents a new version of LEACH protocol, the cluster encloses; CH (accountable only for conveyance data that is acknowledged from the cluster members to the BS), vice-CH (the node that will turn into a CH of the cluster in crate of CH dies), cluster nodes (congregation data from surroundings and throw it to the CH). In the novel leach, the CH is forever on getting data from cluster members, summative these data and then sends it to the BS that may be positioned far away from it. The CH will expire earlier than the other nodes in the cluster as its action of getting, sending and overhearing. When the CH pass away, the cluster will become ineffective.

Nguyen Duy Tan, Longzhe Han, Nguyen Dinh [8] presents an effective way to improve the LEACH protocol according to them . In their approach they presented cluster-based LEACH routing protocol for greater energy efficiency in a WSN. In the proposed routing protocol, we consider the residual energy and geometric distance between candidate nodes and the BS to select CH nodes. It is clear that the CH node closer to the BS will consume less energy than other nodes.

Pragati and Rajender Nath [9] widens the approach of the LEACH protocol from the wireless sensor network to the mobile adhoc network . He adds the TORA protocol in this architecture and tries to compare the performance of the TORA PROTOCOL with the competitive environment of the LEACH protocol. The approach is appreciable but the problem with this approach is that some things are configured according to their working ability. The leach protocol works fine with WSN network but putting the LEACH protocol in the ADHOC network would not be that much effective as compared to the LEACH protocol in the WSN environment.

Alisha Gupta [10] says that WSN has been an active research area over the past few years. However, the salient limit is energy. Due to this limitation, it is quite important to design a routing protocol for WSN so that sensing data can be transmitted to the receiver securely and efficiently and at the same time energy consumed must be minimum. Hence there is a need to develop a confidentiality scheme for energy efficient Leach protocol (hierarchical clustering protocol) using homomorphic encryption.

III. IMPLEMENTATION

As already mentioned, LEACH is the first hierarchical cluster-based routing protocol for WSN that divides the nodes into clusters, in each cluster a devoted node with additional privileges called CH is accountable for creating and manipulating a TDMA (Time division multiple access) calendar and sending collective data from nodes to the BS where these data is required using CDMA (Code division multiple access). Remaining nodes are cluster members. This protocol is separated into two rounds, every round consists of two phases setup phase and steady phase. Setup phase involves advertisement and cluster setup phase while the steady phase involves schedule creation and transmission of data.

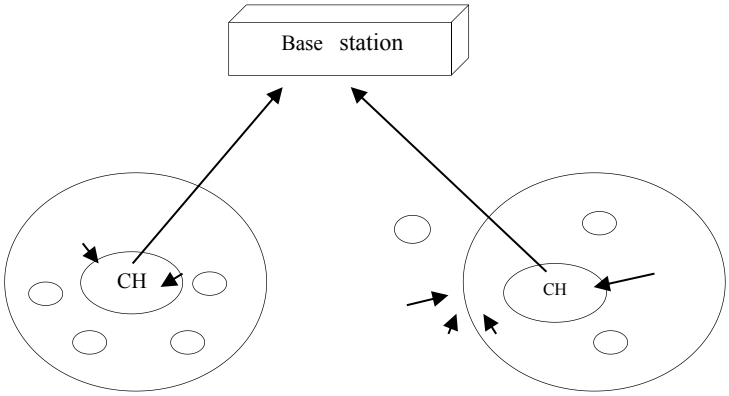

Fig. 2 LEACH Protocol [7]

The initial uniform energy of the nodes is taken to be 0.5 joules. Each sensor node initially has the ability to transmit data to any other sensor node or directly to BS. The sensor nodes are stationary. Moreover, the packet size is same for all nodes having a minimum packet size of 2000 kbit. All the nodes have their own IDs. A node belongs to only one cluster, but it can change its cluster affiliation during each round. It was assumed that the sensor nodes are scattered all over the field. Then, Genetic Algorithms is applied for the optimization process. A second generation population of solutions is generated from those selected through a combination of crossover and mutation. Pair of parent solutions are selected for breeding from the earlier pool selected. New parents are selected for each new child, and the process continues until a new population of solutions of appropriate size is generated.

These processes ultimately result in the next generation population of chromosomes that is different from the initial generation. Generally the average fitness will have increased by this procedure for the population, since only the best organisms from the first generation are selected for breeding, along with a small proportion of less fit solutions. These less fit solutions ensure genetic diversity within the genetic pool of the parents and ensure the genetic diversity of the subsequent generation of children.

It is worth tuning parameters such as the mutation probability, crossover probability and population size to find reasonable settings for the problem class being worked on. A very small mutation rate may lead to genetic drift . A recombination rate that is too high may lead to premature convergence of the genetic algorithm. A mutation rate that is too high may lead to loss of good solutions unless there is

elitist selection. This generational process is repeated until a termination condition has been reached.

IV. RESULTS

The figure 3 shows multi-hop transmissions and single-hop transmission in the clusters that is proposed for measurement of power utilization.

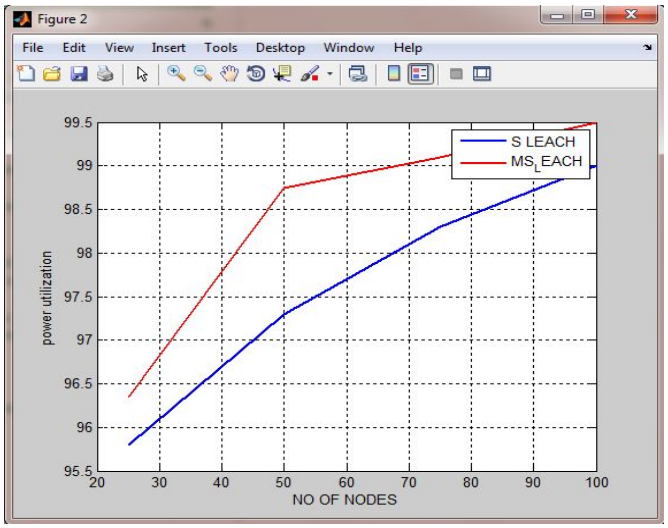

Figure 3 Power versus no. of nodes for S leach and MS leach

The figure 4 shows multi-hop transmissions, single-hop transmissions, enhanced version of hop transmission in the clusters to measure power utilization.

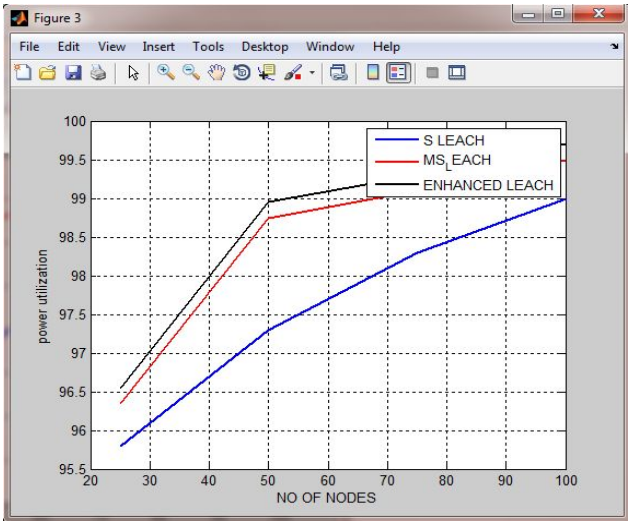

Figure 4 Power versus no. of nodes for S leach, enhanced leach and MS leach

Average normalized routing load is the ratio of the total number routing control packet to data packet received at BS. Above figure shows the routing load versus packet per second. It is sometimes an advantage for energy efficiency to run the algorithm with large values of r. This will limit the average number of CHs and thus the number of costly data transmissions to the base station. RL with MS-LEACH has been decreased as packet per second increases.

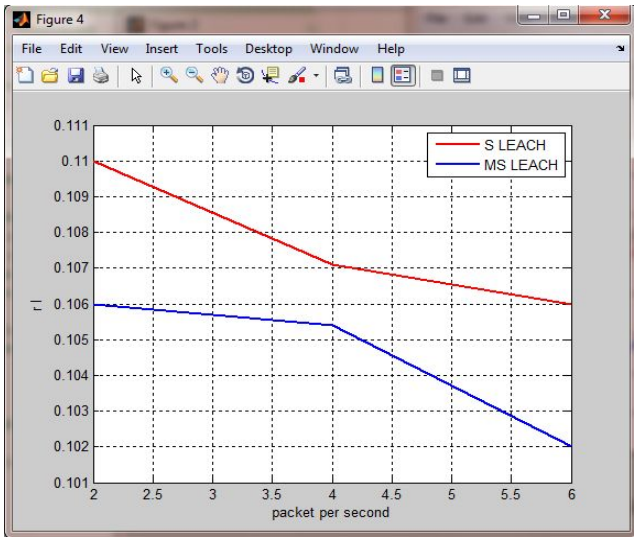

Figure 5 Average normalized routing load (rl) versus packet per second for s leach and MS leach

The figure 6 shows the routing load versus packet per second for s, ms, enhanced leach protocol. It is sometimes an advantage for energy efficiency to run the algorithm with large values of r. This will limit the average number of CHs and thus the number of costly data transmissions to the base station. As normalized routing load with E-LEACH has been decreased as packet per second increases as compare to MS-LEACH and S-LEACH. So in these protocols, for enhanced version. we get the optimized results.

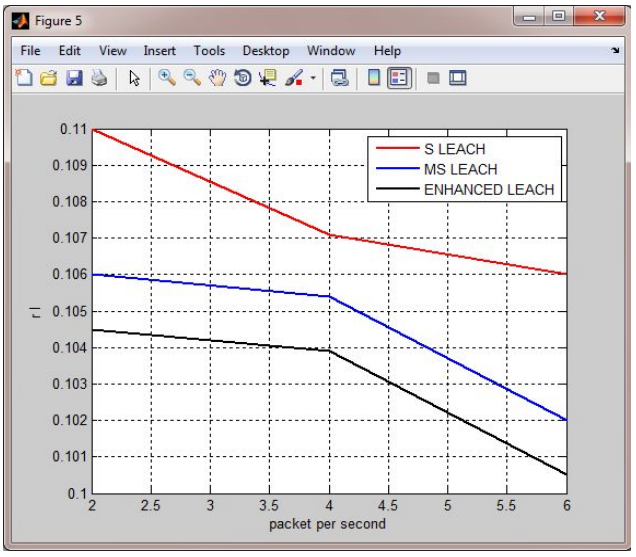

Figure 6 Average normalized routing load (r1) versus packet per second for s leach, enhanced leach and MS leach

V. CONCLUSION

In this, a GA based approach is used for the LEACH protocol implantation. It improves the path finding capability of the leach protocol in WSN. It finds the best path which has less complexity, low data traffic and minimum loss. Due to these contributions of GA, the network becomes more energy efficient and reliable. It is concluded that the proposed method shows result more effective in terms of power utilization and routing load as compared to S-LEACH and MS-LEACH. In addition to it, network is secured using the AES algorithm.

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