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GENETIC ALGORITHM FOR ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORK

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Abstract: *This study proposes a genetic algorithm-based (GA-based) adaptive clustering protocol with an optimal probability prediction to achieve good performance in terms of lifetime of network in wireless sensor networks. The proposed GA-based protocol is based on LEACH, called LEACH-GA herein, which basically has set-up and steady-state phases for each round in the protocol and an additional preparation phase before the beginning of the first round. In the period of preparation phase, all nodes initially perform cluster head selection process and then send their messages with statuses of being a candidate cluster head or not, node IDs, and geographical positions to the base station. As the base station received the messages from all nodes, it then searches for an optimal probability of nodes being cluster heads via a genetic algorithm by minimizing the total energy consumption required for completing one round in the sensor field. Thereafter, the base station broadcasts an advertisement message with the optimal value of probability to the all nodes in order to form clusters in the following set-up phase. The preparation phase is performed only once before the set-up phase of the first round. The processes of following set-up and steady-state phases in every round are the same as LEACH. Simulation results show that the proposed genetic-algorithm-based adaptive clustering protocol effectively produces optimal energy consumption for the wireless sensor network.*

Keywords: *genetic algorithm, optimal probability, lifetime, WSN, LEACH.*

I. Introduction

Recently WSN became an essential part of many application environments that are used in military and civilians. The key applications of WSN are habitat monitoring, target tracking, surveillance, and security management [1] [2]. The application of WSN consists of small sensor nodes that are low-cost, low-power and multi-functional. These small sensor nodes communicate within short distances. Since energy consumption during communication is a major energy depletion factor, the number of transmissions must be reduced to achieve extended battery life[3] [4].Cluster-based approaches are suitable for continuous monitoring applications [5], [6]. For instance, Heinzelman et al.[6] describe the LEACH protocol, which is a hierarchical self organized cluster-based approach for monitoring applications. The data collection area is randomly divided into several clusters, where the numbers of clusters are pre-determined. Based on time division multiple access (TDMA), the sensor nodes transmit data to the cluster heads, which aggregate and transmit the data to the base station. Bandyopadhyay and Coyle [5] describe a multi-level hierarchical clustering algorithm, where the parameters for minimum energy consumption are obtained using stochastic geometry. Hussain and Matin [7], [8] propose a hierarchical cluster based routing (HCR) protocol where nodes self-organize into clusters and each cluster is managed by a set of associates called head-set. Using round-robin technique, each associate acts as a cluster head (CH). The sensor nodes transmit data to their cluster heads, which transmit the aggregated data to the base station. Moreover, the energy-efficient clusters are retained for a longer period of time; the energy-efficient clusters are identified using heuristics-based approach. We improve the HCR protocol by using a Genetic Algorithm (GA) to determine the number of clusters, the cluster heads, the cluster members, and the transmission schedules. Jin et. al [9] have also used GA for energy optimization in wireless sensor networks. In their work, GA allowed the formation of a number of pre-defined independent clusters which helped in reducing the total minimum communication distance. Their results showed that the number of cluster-heads is about 10% of the total number of nodes. The pre-defined cluster formation also decreased the communication distance by 80% as compared with the distance of direct transmission.

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Ferentionoset. al [10] extended the attempts proposed by Jin *et. al*[9] by improving the GA fitness function. The focus of their work is based on the optimization properties of genetic algorithm. However, we use GA to determine the energy efficient clusters and then cluster heads choose their associates for further improvement. Finally, to increase the overall performance, simple heuristics are used to retain a few energy efficient clusters for a longer duration than the other ones.

Paper organization

The rest of the paper is organizes as: in section II proposed work will be discussed. In section III pseudo code will be describes, in section IV results will be discussed, in section V finally conclusion will be reviewed.

II. PROPOSED WORK

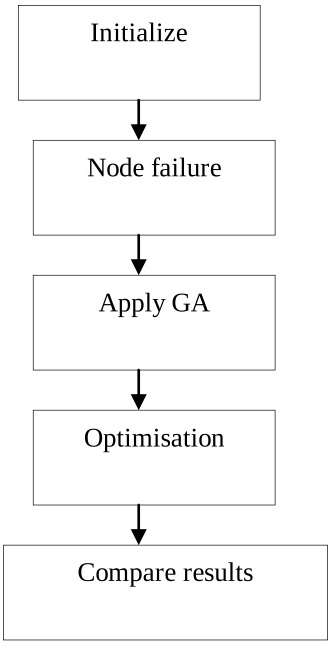

Figure. 1: Flowchart of Proposed Method

Step-1 Initialize
Step-2 If node failure occurs then apply GA
Step-3 Procedure of GA

Initialization :	Many individual solutions are randomly generated to form the population.
Selection :	Individual solutions are selected through fitness based process where fitter solutions are selected.
Reproduction :	Second generation population of solution are generated through genetic operators. They are: Crossover & Mutation. Process continues until a new population of solution is generated
Termination :	Process of reproduction is repeated until a termination condition has been reached. Conditions for termination are: 1. A solution is found that satisfies minimum Criteria. 2. Fixed No. of generations reached. 3. Allocated budget reached. 4. The highest ranking solution fitness is reached. 5. Manual inspections. 6. Combination of above

Step-4 After optimization, find out the performance

III. PEUDO CODE

BEGIN

1: Specify the probability (*pset*), number of nodes (n);
2: Einit(s)=E0, s=1,2, …, n;

(I) PREPARATION PHASE

1: **if** (Einit(s)>0 &rmod(1/pset)≠0) **then** //pset can set≥0.5
2: r←random(0,1) and compute T(s); //given by (1)
3: **if** (r < T(s)) **then**
4: CCH{s}=TRUE; //node s be a candidate CH
5: **else**
6: CCH{s}=FALSE; //node s not be a candidate CH
7: **end if**
8: **end if**
9: SendToBS(IDu, (xu,yu), CCH(u)) ← All nodes send messages to BS;
10: GAinBS(*popt*) ← Optimal probability is determined;
11: BC (*popt*) ← BS broadcasts a message back to all nodes;

(II) SET-UP PHASE

1: **do** { //repeat for r rounds
2: r←random(0,1);
3: **if** (Einit(s)>0 &rmod(1/popt)≠0) **then**
4: compute T(s); //given by (1)
5: **if** (r < T(s)) **then**
6: CH{s}=TRUE; //node s be a CH
7: **else**
8: CH{s}=FALSE; //node s not be a CH
9: **end if**
10: **end if**
11: **if** (CH{s}=TRUE) **then**
12: BC (ADV) ← broadcast an advertisement message;
13: Join(IDi); //non-cluster head node i join

into the closest CH
14: Cluster(c); //form a cluster c;
15: **end if**

(III) STEADY-STATE PHASE
1: **If** (CH(s)=TRUE) **then**
2: Receive(IDi, DataPCK) //receive data from members;
3: Aggregate(IDi, DataPCK) //aggregate received data;
4: TansToBS(IDi, DataPCK); //transmit received data;
5: **else**
6: **If** (MyTimeSlot=TRUE) **then**
7: TansToCH(IDi, DataPCK); //transmit sensed data;
8: **else**
9: SleepMode(i)=TRUE; //node i at a sleep state
10: **end if**
11: **end if**
12: } // one round is completed
END

IV. RESULTS

Parameters	WSN	WSN with GA
Throughput	85%	95- 96%

Table-1 Results

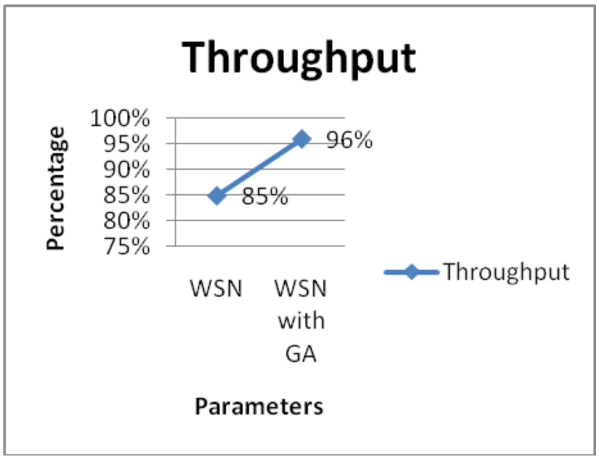

Figure.2 Performance Evaluation

V. CONCLUSION

In this thesis we considered a well known protocol for wireless sensor networks called LEACH protocol which is the primary and the most imperative protocol in wireless sensor network which uses cluster based propagation technique. Followed by an overview of LEACH protocol implementations, then we proposed a fusion of LEACH protocol involving Genetic algorithm (GA). From the simulation results, we found that throughput is enhanced using GA by 95-96%.

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