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Wireless Sensor Network Protocol with PEGASIS (GA) to Enhance the Network Lifetime

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ABSTRACT

This paper discusses the need for energy-efficient communication in wireless sensor networks and identifies the key energy dissipation sources as well as countermeasures to ensure a long lifetime of the network. In remote and dangerous settings, wireless sensor networks can collect trustworthy and reliable information and can be used in national defence, military affairs, industrial control, traffic management, medical care, smart home, etc. The sensor whose resources are reserved is low-cost and relies on the battery to supply energy, so it is necessary to use its power efficiently for routing. In this research work, first we use the greedy chain to implement the LEACH and PEGASIS Protocol and then we use the Genetic Algorithm to construct the data routing chain, which uses its parameters of crossover and mutation and finds an optimised data collection routing route. For the same number of nodes, the Genetic Algorithm increases the network lifespan. Simulations are performed and, on the basis of energy consumption and number of rounds, the effects of PEGASIS and Genetic Algorithm are compared with each other.

KEYWORDS: *wireless sensor network, Routing Protocol, Leach, Pegasis protocol, Genetic Algorithm, Energy efficiency etc*

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INTRODUCTION

In communication and sensor networks, the Wireless Sensor Network (WSN) plays the most important role and is also becoming a very important part of wireless sensor networks. There are a large number of sensor nodes in the wireless sensor network that are used for collecting data under different conditions. In different applications ranging from home to industry and from medical to military, wireless sensor networks are applied. Most network applications for[1] wireless sensors need some form of self-configuration and automatic functionality. The key problems in wireless sensor networks are the creation of routing protocols capable of using the smallest amount of energy required by different communication protocols[2].

Routing in Wireless Sensor Networks

Routing is a method of forming a route between sources with a destination at the request of data transfer. The network layer is typically used in WSNs to enforce the routing of incoming data. It is understood that[3] the source node does not hit the sink directly, usually on multi-hop networks. Therefore, their packets have to be relayed by intermediate sensor nodes. The resolution is given by the efficiency of routing tables. These contain node choice lists for any given destination of a packet. The role of the routing algorithm is the routing table, along with the assistance of the routing protocol for its construction and maintenance.

ROUTING PROTOCOLS IN WIRELESS SENSOR NETWORK

Routing protocols are essentially classified into following categories, which are:-

Mobility-based Protocols

In WSNs, mobility introduces new challenges to routing protocols. Sink mobility requires energy-efficient protocols to ensure the transmission of data to mobile sinks originating from source sensors.

Multipath-based Protocols

There are two routing samples in view of the transmission of data between the source sensors and the sink: single-path routing, multipath routing. In single-path routing, the shortest path for each source[4] sensor delivers the data to the sink. Each source sensor finds the first 'k' shortest paths to the sink in multipath routing and splits its load uniformly among these paths.

Heterogeneity-based Protocols

There are two types of sensors in this type of sensor network architecture: line-powered sensors have no energy constraints, battery-powered sensors have insufficient lifetime, and can therefore use their usable energy efficiently by reducing their data transmission and processing potential.

Location-based Protocols
Sensor nodes are named by means of their locations in location-based protocols. The distance of position information sensor networks between two unique energy consumption nodes can be determined.

Hierarchical Protocols
Clustering is an energy-efficient communication protocol in the hierarchical Clustering protocol that can be used by the sensors to circulate their sensed data to the sink.

Data Centric Protocols
Data is delivered from source sensors to the sink in data-centric protocols, as the source sensors circulate. Their data to the sink; some form of aggregation can be done by intermediate sensors on the data originating from several source sensors and the aggregated data can be sent into the[5] sink. Due to lower transmission needed to transmit the data from the sources to the sink, this process will result in energy savings.

LEACH
LEACH is the first network protocol that uses hierarchical routing for wireless sensor networks to increase the life time of network. All the nodes in a network organize themselves into local clusters, with one node acting as the cluster-head. All non-cluster-head nodes transmit their data to the cluster-head, while the cluster-head node receive data from all the cluster members, perform signal processing functions on the data (e.g., data aggregation), and transmit data to the remote base station. Therefore, being a cluster-head node is much more energy-intensive than being a non-cluster-head node. Thus, when a cluster-head node dies all the nodes that belong to the cluster lose communication ability.

LEACH incorporates randomized rotation of the high-energy cluster-head position such that it rotates among the sensors in order to avoid draining the battery of any one sensor in the network. In this way, the energy load associated with being a cluster-head is evenly distributed among the nodes. Since the cluster-head node knows all the cluster members, it can[6][7] create a TDMA schedule that tells each node exactly when to transmit its data. In addition, using a TDMA schedule for data transfer prevents intra-cluster collisions. The operation of LEACH is divided into rounds. Each round begins with a set-up phase when the clusters are organized, followed by a steady-state phase where several frames of data are transferred from the nodes to the cluster-head and onto the base station. Hierarchical protocols are defined to reduce energy consumption by aggregating data and to reduce the transmissions to the Base Station. LEACH is considered as the most popular routing protocol that use cluster based routing in order to minimize energy consumption.

Low Energy Adaptive Clustering Hierarchy (LEACH) protocol is a TDMA based MAC protocol. The principal aim of this protocol is to improve the lifespan of wireless sensor networks by lowering the energy consumption required to create and maintain Cluster Heads. LEACH Protocol is a typical representative of hierarchical routing protocols. It is self-adaptive and self-organized. LEACH protocol uses round as unit, each round is made up of cluster set-up stage and steady-state stage, for the purpose of reducing unnecessary energy costs, the steady stage must be much longer than the set-up stage.

Advantages
- Outperforms conventional routing protocols
- LEACH is completely distributed, requiring no control information from the base station
- Nodes do not need global topology information

Disadvantages
- Nodes must have data to send in the allotted time
- Perfect correlation is assumed, which might not be true always

PEGASIS
PEGASIS is Power-Efficient Gathering in Sensor Information Systems. PEGASIS form open chain staring from node which is farthest from Base Station .PEGASIS assume that global information is available. This algorithm uses greedy algorithm for chain construction. Before first round of communication chain formation is done. During formation of chain care must be taken so that nodes already in chain should not revisited .When a node die then chain is reconstructed by bypassing that node. In data gathering cycle each node forms a[8] data packet of its own in network. For each data gathering cycle leader is elected among all nodes in network. Each node in network receives a data packet and fuses it with its own data and forwards it to other neighbouring node. PEGASIS uses a simple token passing approach which is initiated by leader to start data transmission from ends of chain.

GENETIC ALGORITHM
The Genetic Algorithm is a heuristic search algorithm focused on natural selection and evolution principles. Genetic algorithms are evolutionary algorithms (EA) that use genetic operators, such as mutation, selection and crossover, to solve optimization problems. In a genetic algorithm, the candidate solution (fitness value) is created by developing a population of chromosomes. The chromosome population is generated randomly.

Results and Discussion
The work performed requires applying the PEGASIS protocol. The protocol is implemented using the traditional PEGASIS implementation form, Greedy Chain. The Genetic Algorithm is then used to execute it. From the farthest node from the base station, the greedy chain initiates the creation of the chain. The next node, at a smaller distance from the others, is picked. So the inter-nodal distances are determined and the nodes are chosen. During this process, the distances start to increase towards the end of the chain, resulting in further dissipation of energy. All simulations were performed on an area of 100m*100m and nodes were distributed randomly in this field. Using 100 nodes, the implemented protocol PEGASIS is simulated. PEGASIS uses a greedy approach and a Genetic Algorithm to construct the chain. Each node has an initial energy level that is the same.

1. First energy is .5

Protocol	10	20	30	40	50	60	70	80	90
LEACH	1500	1560	1610	1700	2000	2250	2310	2450	2650
PEGASIS	2260	2320	2360	2420	2460	2500	2570	2630	2740
PEGASIS (GA)	2930	2990	3225	3420	3500	3610	3790	4250	4800

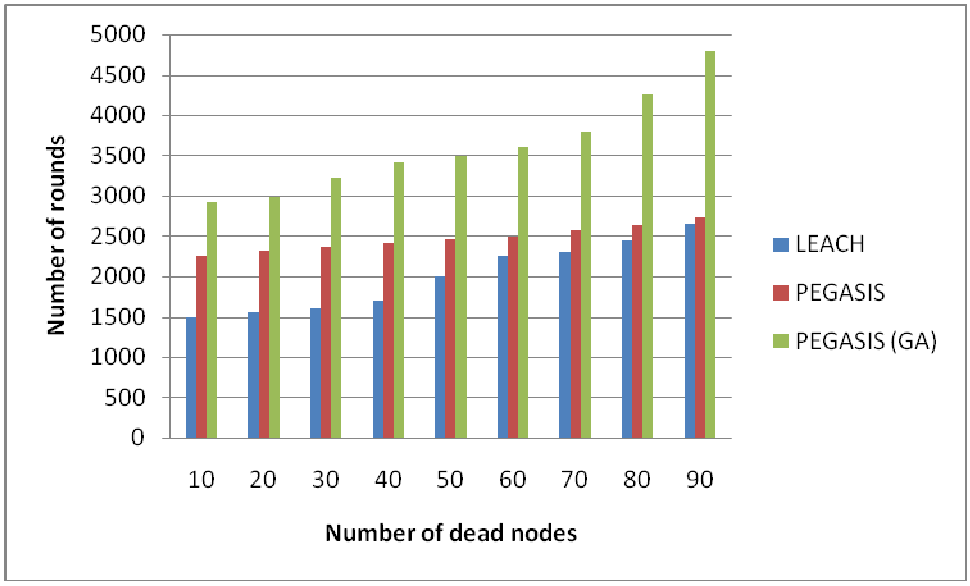

Fig.1: LEACH, PEGASIS, PEGASIS(GA) comparison when energy .5

2. Energy is .25

Protocol	10	20	30	40	50	60	70	80	90
LEACH	670	710	760	790	920	1000	1150	1230	1340
PEGASIS	1100	1160	1180	1197	1205	1240	1255	1320	1520
PEGASIS(GA)	3000	3110	3350	3400	3510	3590	3860	4200	4480

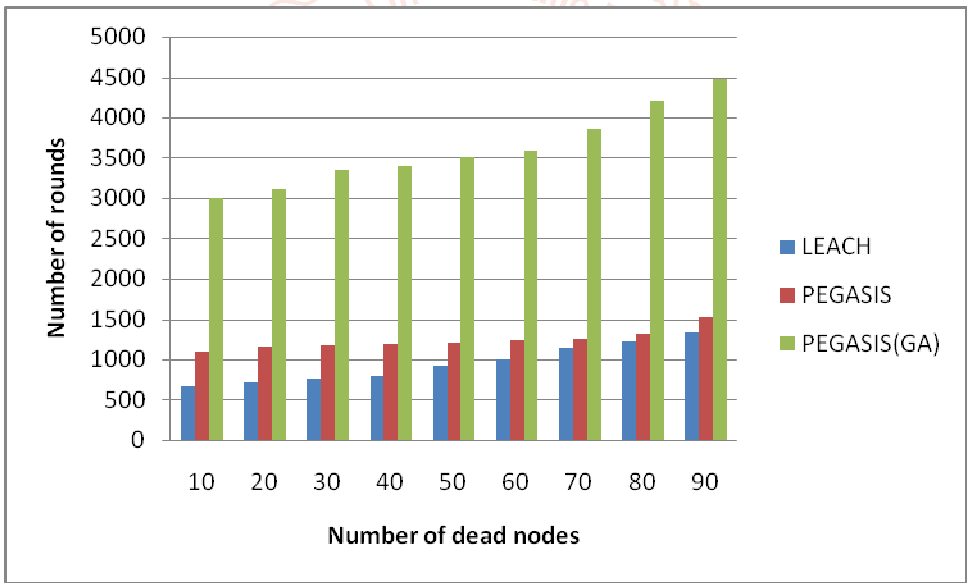

Fig.2: LEACH, PEGASIS, PEGASIS (GA) comparison when energy .25

Conclusion

We have introduced a new protocol for WSN routing operations in this research paper. The protocol is accomplished by optimising routing paths using the GA algorithm, providing efficient multi-path data transmission to obtain secure communications in the event of node faults. We aimed to preserve the full network life time, while effectively achieving data transmission. In terms of data collection and network lifespan, our analysis was completed to assess the efficiency of the Genetic algorithm, LEACH and PEGASIS protocol. In addition, it is concluded that the overall performance of the Genetic algorithm is higher in terms of data collection than PEGASIS.

Future Work

Other optimization algorithms such as particle swarm optimization (PSO), artificial bee colony algorithm (ABO) to get optimised or shortest path should investigate potential changes to the gathering mechanisms for further improvements in reliability.

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