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# Energy Efficient Chaining Protocol for Wireless Sensor Networks

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***ABSTRACT-*** *Energy Efficiency for wireless Sensor Network is an issue now days due to resource constraints on sensor nodes. Actually each node need different amount of energy to transmit the data because base station is located at variable distance from nodes in the network. The hierarchical protocols like LEACH, PEGASIS and HEED provide solution to energy regarding problems. Sometimes these protocols not provide a best solution or optimal solution. In this paper we have proposed a protocol for enhancing the network lifetime by proving shortest path to nodes. To achieve this design objective we have applied PEGASIS (Power Efficient GAthering in Sensor Information System) with ACO (Ant Colony Optimization) to form a data gathering chain and an efficient shortest path to the base station. In this scheme the each node communicates with a close neighbor only and sends data to that neighbor. This helps to reduce the power consumption during transmission.*

***Keywords:*** *Heterogeneous network, optimization, Power Management, Quality of service, Shortest Path.*

## I. INTRODUCTION

Numbers of nodes are deployed in the large area of wireless sensor network. Wireless network plays very important role in communication and sensor network also becoming very crucial part of wireless networks. In wireless sensor network there is large number of sensor nodes are used for gathering data in various situations. Wireless sensor network applied in different applications ranging from home to industry and from medical to military. Most of sensor network applications need some form self-configuration and automatic functionality [1]. Some major issues in wireless sensor networks are developing such as routing protocols which is capable in consume minimum energy. Some communication protocols are proposed. In this paper some of these issues are described. Maintaining the lifetime of wireless sensor network is most important goal in sensor network research. Sensor networks are deal with sensitive data, so there also need some security consideration. There is few architectures overviewed and routing protocol suitable for Wireless sensor network. Wireless sensor networks are highly distributed networks of small lightweight nodes that are arranged over large area. Sensor node has capability of sensing, first it sense the data and process that data. After processing it route that data to base station through a communication medium. Ad hoc networks are also wireless networks. Ad hoc network lead to some differences. Such as sensor network has a large number of nodes. Due to more prone to failure, energy drains rapidly. They have no unique global IDs.There are some design issues and challenges*:*

- Managing the communication in heterogeneous network is basic challenge in self-managed or self-organized system because communication protocols play important role in network communication.
- Wireless sensor network require different infrastructure and protocol stack that is implemented using automatic computing.

Some design factors for wireless sensor network are scalability, fault tolerance, power consumption and sensor network architecture (that may be layered or clustered). Wireless sensor network (WSN) is widely used in different applications such as Area Monitoring, Environmental Monitoring, Industrial Monitoring, Water Monitoring etc [2].

## II. SENSOR NETWORK TOPOLOGY

To achieve quality of service (QOS) is the basic issue in communication network. Quality of service can be classified as bit error rate, packet loss, transmission power and in terms of economic cost of transmission. Topology affects network features such as validity, capacity and latency. The choice of network topology based on the installation environment, economic consideration and application to maintain the quality of service. To make a single-hop network every sensor node is directly communicate with another node and multi-hop network may form an arbitrary graph. Basic network topologies are: mesh topology, ring topology, star topology, fully connected topology. Topology maintenance is a challenging task. There are number of nodes that are inaccessible and unattended, these nodes are prone to frequent failures. Hundred to several thousand nodes are

spread to sensor field. Spreading large number of nodes require careful handling of topology maintenance [3]. There are three phases for topology maintenance:

- Deployment and pre-deployment phase

Sensor nodes can be placed one by one or in massive amount in sensor field. This can be done by dropping from plane, delivering in a rocket or missile or placing one by one either by human or by robot.

- Post-deploying phase

The topology changes due to change in sensor nodes, reasons may be position, available energy, task dynamics and malfunctioning.

- Re-deployment of additional nodes phases

Due to changes in task dynamics additional sensor nodes can be re-deployed. Additional nodes lead to re-arrange the network

## III. POWER MANAGEMENT

Energy consideration should be in mind when creating infrastructure. Multi-hop routing will consume lower energy than direct communication. Direct routing performs well if nodes were very close to the sink. Now days the use of Wireless Sensor Network (WSN) has arisen extremely. The main requirement of wireless sensor network is to extend the network lifetime and energy efficient routing, data gathering and aggregation protocols that representing large-scale environment. Hierarchical clustering protocols have been used for energy efficient routing in wireless sensor networks. In WSN, the sensor nodes have a limited processing, and storage capabilities and transmission range, as well as energy resources also limited. Routing protocols maintain the routes in the network and ensure reliable multi-hop communication under limited resources. WSNs use clustering for achieving scalable and efficient communications. Clusters are organized and select a cluster head for each cluster. Cluster head nodes have great importance in these network topologies because these nodes are communication and coordination hubs [3].

Wireless sensor networks are spreading over large area. WSNs play very important role in our life, provide us information even from those situations which are inaccessible by human being also. Now a day's lots of new inventions are take place to overcome limitation of sensor network. Sensor network consist of various nodes scattered in large area or even in small area. Structure of sensor nodes is based on requirements. There are some constraints on sensor network. Especially on power that is main function or we can say backbone of wireless sensor network. There are some routing protocols used to manage energy problems like LEACH, PEGASIS etc. hierarchical protocols are good to save energy during transmission. LEACH is clustering algorithm it is helpful for energy-Efficient routing. But there are some problems in LEACH like random rotation of cluster head. That led to use of more energy. Another algorithm PEGASIS is used for same purpose. But it mainly forms a chain that sends data to base station and restrict random rotation of cluster-head as in LEACH. PEGASIS need dynamic topology adjustment since a sensor node needs to know about energy status of its neighbor in order to know where to route its data, such topology adjustment can introduce overhead for highly utilized networks [4].

Clustering helps to overall system measurability, lifetime and energy efficiency in sensor networks. Hierarchical routing is an efficient way to lower the energy consumption within a cluster by performing data aggregation and fusion to decrease the number of transmitted messages to base station [5].

PEGASIS overcome these problems as there is no any rotation of cluster head. But PEGASIS need dynamic topology adjustment since a sensor node needs to know about energy status of its neighbor in order to know where it route its data. Such topology adjustment can introduce more overhead [6].

## IV. VARIOUS ROUTING PROTOCOLS IN WSN

- **Data centric Protocols**

These are query based and depend on appointment of desired data to eliminate extra transmission. Some Data centric protocols are: Flooding, Spin, Direct diffusion, EAD.

- **Hierarchical protocols**

In order to save energy and for reduction in data hierarchical protocols cluster the heads for aggregation. It is more efficient for habitat monitoring. These include: LEACH, PEGASIS, HEED

- **Location based**

These use position information pass the data to desired region rather than entire network. These include: MECN, SMECN, GEAR

- **PEGASIS (Power Efficient gathering in sensor information system)**

PEGASIS is used to overcome the problems of LEACH protocol. It works as form chains of sensor nodes. The data is gathered and moves from node to node, aggregated and sent to base. Each sensor node transmits and receives from a neighbor and only one node is selected from that chain to transmit data to base station. The chain constructs in a greedy way. PEGASIS avoids cluster establishment as in LEACH, and use only one node in chain for the transmission of data to base station instead of using multiple nodes. The construction phase in PEGASIS, all the sensor nodes have global knowledge about the network, especially about the position of nodes. When any node fails due to low battery power, the chain is constructed in the same way just bypassing the failed nodes. In each round a randomly chosen node from the chain will transmit the aggregated data to base station. It reducing per round energy consumption compared to LEACH [7].

- **ACO (Ant Colony Optimization)**

The original idea comes from observing the development of food resources among ants. Which describe the ability of ants and they find the shortest path between a food source and the nest. Earlier ACO is used as routing for sensor node. In 2006 ACO was firstly introduced Ant-aggregation-algorithm using ACO for optimal data aggregation in WSN. In ACO algorithm random searching for the destination is needed in early iterations. There is a chance of dead lock occurrence as Ants travel in cycle [8]. The Ant Colony Optimization algorithm runs in two phases:

1. Forward Pass: In forward pass the route is constructed by a group of ants. An Ant searches a route to the destination randomly, and then Ant searches the nearest point of previously discovered route. There are number of iteration before an Ant can find a correct path with a reasonable length.
2. Backward Pass: In Backward pass every Ant starts from sink node and travel back to source node by following the path discovered in the forward pass [8].

## V. PROPOSED CHAIN FORMATION BY IMPROVED PEGASIS WITH ACO

Table 1 shows distance travelled by different nodes 20, 30 and 50. With the help of chain formation in PEGASIS 20 nodes travel total distance is 1916 and with the help of chain formation in improved PEGASIS with ACO, it is reduced to 1776. When there are 30 nodes chain formation travel distance 1954 but with PEGASIS and ACO it travel 1637. Like when there are 50 nodes in network PEGASIS travel 2000 and PEGASIS with ACO travel 1666. In this way these results verify that when we combine PEGASIS with ACO, it will reduce the total distance travelled by nodes. When sensor nodes travel less, it will lead to use less power and save energy.

Table.1. Distance travelled by nodes with chain formation

| Number of nodes | Distance travelled with chain formation in PEGASIS | Distance travelled with chain formation by improved PEGASIS with ACO |
|---|---|---|
| 20 | 1916 | 1776 |
| 30 | 1954 | 1637 |
| 50 | 2000 | 1666 |

Fig1 shows the chaining formation with PEGASIS of 100 nodes in a network. Fig2 show the chaining of PEGASIS using ACO when there are 100 nodes. Total distance covered by 100 nodes in a network is 3238. In ACO a number of artificial ants provide a solution to optimization problem. They exchange their information on their quality through their communication scheme. PEGASIS is used to form the chain among the sensor nodes and each node receives and transmits to neighbor. ACO utilize both local information and information about good solutions obtained in past while constructing new solution.

Fig 3 shows the alive nodes in the network and plots those nodes in the work. After that ACO helps to find distance between nodes and calculate the shortest path. That shortest path is used to transmit the data. In this way this leads to use less energy to transmit data.

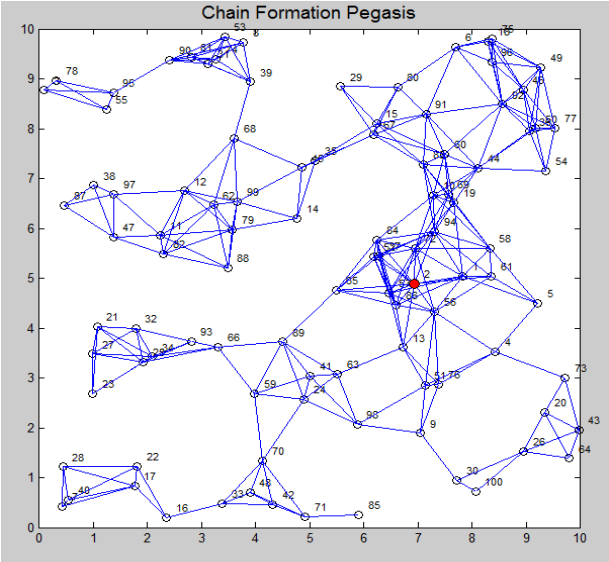


Fig.1.Chain formation with PEGASIS Algorithm

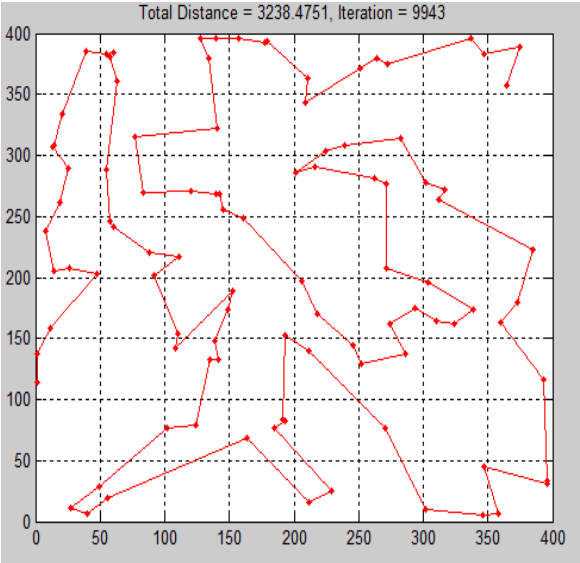


Fig.2.Chain formation by improved PEGASIS with ACO

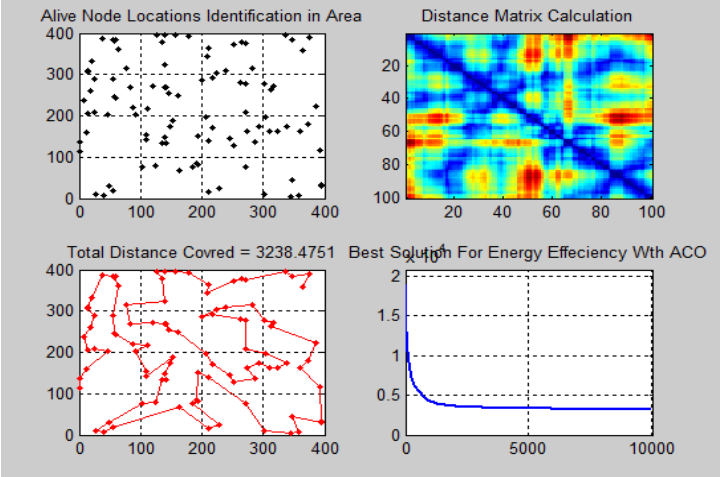


Fig.3. Best result of chaining by improved PEGASIS with ACO

## VI. CONCLUSION

To combine PEGASIS with ACO is proved to be the best algorithm to minimize the power consumption in wireless sensor networks. ACO (Ant Colony Optimization) is energy optimization technique that finds the shortest path. PEGASIS is routing algorithm that is based on chaining. It forms a chain of nodes and transmits data towards base station. When we combine these two techniques they provide better way to utilize the resources and take minimum distance to travel the network. ACO find the shortest path and PEGASIS form the chain to that shortest path. In this way they lead to travel minimum distance. It is concluded that for a wireless sensor network energy is very crucial because sensor use battery power for transmission of data. There are number of protocols used to extend the life time of sensor. When we combine PEGASIS with ACO it also uses less energy to transmit data and extend the life time of sensor.

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