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Performance Improvisation For Longevity Maximization In Wireless Sensor Network : Performance Comparison Of LEACH ,PLEACH , EAMMH , LMACO

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Abstract : *Wireless sensor network (WSN) technologies are increasingly employed in recent years for monitoring purposes in various fields ranging from the engineering industry to our immediate home environments due to their ability to intelligently monitor remote locations at low cost. Maximization of longevity of wireless sensor networks is possible by using effective transmission strategy. An optimal-distance-based transmission strategy based on ant colony optimization is put forward to fulfill such a maximization aim. Clustering mechanism is one of the popular wireless sensor networks routing mechanisms, and it has proven to be an effective approach for organizing the network into a connected hierarchy .In proposed work, we have proposed a algorithm in order to increase the longevity of wireless sensor network . The simulations using MATLAB results shows that the network longevity have improved.*

Keywords *- Longevity maximization, Sensor nodes, Wireless sensor network, Clustering.*

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I Introduction

A wireless sensor network (WSN) consist of hundreds to thousands of low power multi-functional sensor nodes work in an unattended environment and have sense, computation and communication ability. The basic components of a node are a sensor unit, an ADC (Analog to Digital Converter), a CPU (Central Processing Unit), a power unit and a communication unit. Sensor nodes are micro-electro-mechanical systems (MEMS) that make a computable response to a change in some physical condition related to temperature and pressure. Sensor sense or compute the physical data of the area to be monitor [1].. Sensors nodes are of very small size, use extremely low energy, are operated in high volumetric densities and can be independent and adaptive to the environment. Wireless micro-sensor networks represent a new paradigm for extracting data from the environment. Conventional systems use large, expensive macro-sensors that are often wired directly to an end-user and need to be accurately placed to obtain the data. For example, the oil industry uses large arrays of geophone sensors attached to huge cables to perform seismic exploration for oil. These sensor nodes are very expensive and require large amounts of energy for operation. The most difficult resource constraint to meet is power consumption in wireless sensor networks. The use of wireless sensor networks is increasing day by day and at the same time it faces the problem of energy constraints in terms of limited battery longevity. As each node depends on energy for its activities, this has become a major issue in wireless sensor networks. The failure of one node can interrupt the entire system or application. Every sensing node can be in active, idle and sleep modes. In active mode, nodes consume energy when receiving or transmitting data. In idle mode the nodes consume almost the same amount of energy as in active mode. While in sleep mode, the nodes shutdown the radio to save the energy. Energy constraints end up creating computational and storage limitations that lead to a new set of architectural issues. A wireless sensor network platform must provide support for a suite of application-specific protocols that drastically reduce node size, cost, and power consumption for their target application.

In wireless sensor networks, the only source of life for the nodes is the battery. Communicating with other nodes or sensing activities consumes a lot of energy in processing the data and transmitting the collected data to the sink. In many cases (e.g. surveillance applications), it is undesirable to replace the batteries that are depleted or drained of energy [2]. Many researchers are therefore trying to find energy-aware protocols and

algorithms for wireless sensor networks in order to overcome such energy efficiency problems as those stated above. The memory management and the resource management in wireless sensor network is done by operating

Systems specially designed for WSNs. Now routing is the major issue in WSNs and this is under network layer issues for sending the data from sensor nodes to sink. Various routing protocols and algorithms for wireless sensor networks are Sensor protocols for Information via Negotiation (SPIN) , Rumor Routing , Direct Diffusion , Low Energy Adaptive Cluster Hierarchy (LEACH), Threshold Sensitive Energy Efficient Sensor network protocol (TEEN),Geographical and energy aware Routing(GEAR), Sequential Assignment Routing(SAR), etc. Amongst them Low-energy adaptive clustering hierarchy protocol is widely used in wireless sensor network, because this protocol dissipates the energy in low level. When the battery power is drained in these devices/nodes then the network cannot be used and all the nodes spend most of the energy while transmitting the data. Therefore ,to increase the longevity of the network, each node has to do only minimal work for transmitting the data. Here all the nodes are grouped into the clusters, and in each cluster one of the nodes is assigned as a Cluster Head (CH). CH collects the data from the surrounding nodes and passes it to the sink. Usually, initial assignment of CH is random and the role of CH is rotated for every fixed duration so that each node will act as a CH at least once in its lifespan. Low-energy adaptive clustering hierarchy algorithm has two phases. They are set up phase and steady state phase. Setup phase is used to choose a CH and steady state phase is used to maintain the CH during the transmission of data.

As a swarm intelligence method, ant colony optimization (ACO) [15] has gained popularity in recent years and has been successfully applied to a large range of combinatorial optimization problems, such as data transmission in wireless sensor networks. An energy-efficient ant-based routing algorithm (EEABR) was presented in [16], in which forward ants and backward ants are defined, and the ant chooses a path according to the actual energy level of nodes and the distance traveled by the forward ant. Based on ant colony optimization, a dynamic and reliable routing protocol (DRRP) was proposed in [17], in which the ant chooses a path according to the energy level of the nodes and the total number of nodes visited by the ant. In [18], an ant colony optimization routing algorithm named ASW was introduced to reduce energy consumption. In this routing algorithm, the distance to the sink and the energy consumption of the path are used to select paths by the ant. Another energy-aware ant colony algorithm (EAACA) was proposed to extend the network longevity [19]. In such a routing algorithm, the next neighbor node of the routing is chosen according to the distance to the sink, the residual energy of the node, and the path of the average energy. An ant colony optimization -based transmission scheme named the unity of MPEE and MPEB (UMM) was presented in [20], in which energy efficiency and energy balancing have been simply considered for longevity maximization of WSNs.

This work focuses on analyzing the optimization strategies of routing protocols and algorithms with respect to energy utilization of sensor nodes in Wireless Sensor Network (WSNs). In this paper , we have considered Low-energy adaptive clustering hierarchy protocol as reference and used the ant colony optimization algorithm to increase the longevity of wireless sensor network.

II Proposed Work

We present performance improvisation for longevity maximization of wireless sensor network to achieve our goal on the basis of the ant colony optimization.

To achieve the energy depletion minimization for the nodes with maximal energy consumption throughout a network, we propose a „global optimal transmission distance acquirement scheme‟ by designing a network longevity maximization approach. This scheme further helps to extend the network longevity

2.1 The proposed transmission strategy

As shown in the fig.1, we consider a wireless sensor network where nodes are evenly deployed on a disk with a radius R centered at the sink. M disjoint concentric coronas divide this disk. An arbitrary wedge subtended by an angle Θ is also considered. This is partitioned into M sectors, which are denoted as Ω1 , Ω2 ,……. Ω M by its intersection with M concentric coronas. Suppose each node generate the particular bits of data per second and having the initial uniform energy. This type of sector division can be called as a clustering technique which has some advantages such as more robustness and more scalability [21], [22]. Such a sector division can also be regarded as an effective method of achieving the load balancing with non-uniform clustering manner and this is because of different sizes of sector distribution.

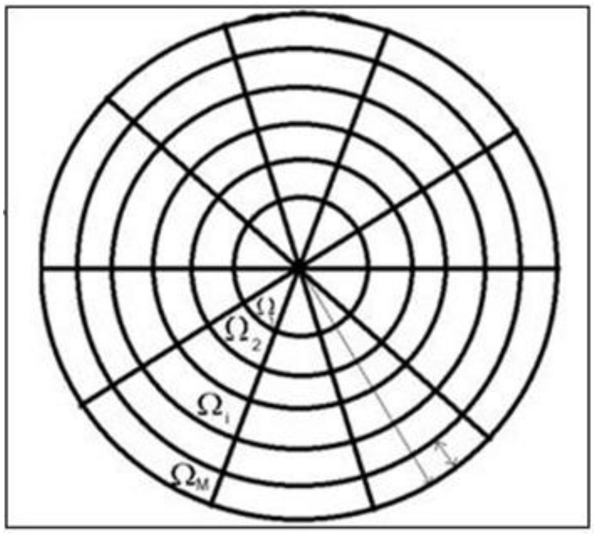

Figure 1: Network model

To seek an optimal transmission distance for nodes of each sector is our goal. There is an ant on the every sector initially; After that, every ant moves from a sector to another towards the sink according to a specific probability, as shown in Fig. 2 .

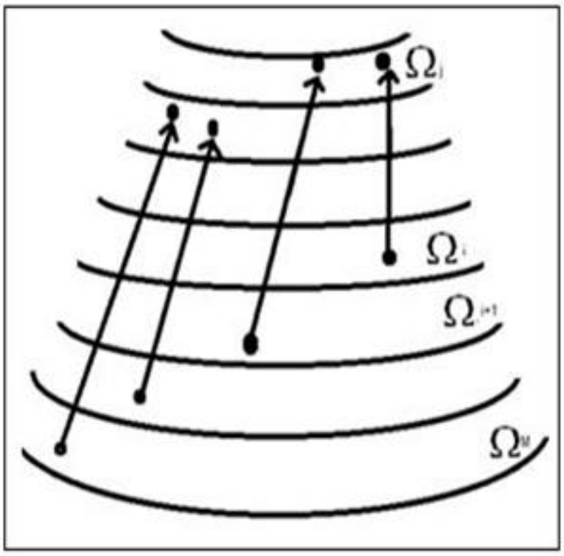

Figure 2: The moving mode of ants

In order of the largest to the smallest number of the sector, these ants move one after another. Generally, every ant moves after the ant of the adjacent outer sector has completed its trip, the ant on the most outer sector moves firstly. When any ant moves only one hop, it has finished its full work. A corresponding path is created by an ant when it moves from Ω i to sector Ω j towards the sink and whose distance is, d . “d” is the transmission distance of the nodes in sector Ω i , path is transmission route of this sector. Thus, the routing abstraction is the moving of ant. The solution that is the transmission distance of the nodes for all sectors have been obtained when all the ants completed their task of moving. The best solution is updated and reserved after several iterations.

2.2 Flow chart of proposed algorithm

The flow chart of proposed algorithm LMACO (longevity maximization using ant colony optimization) is as follow :

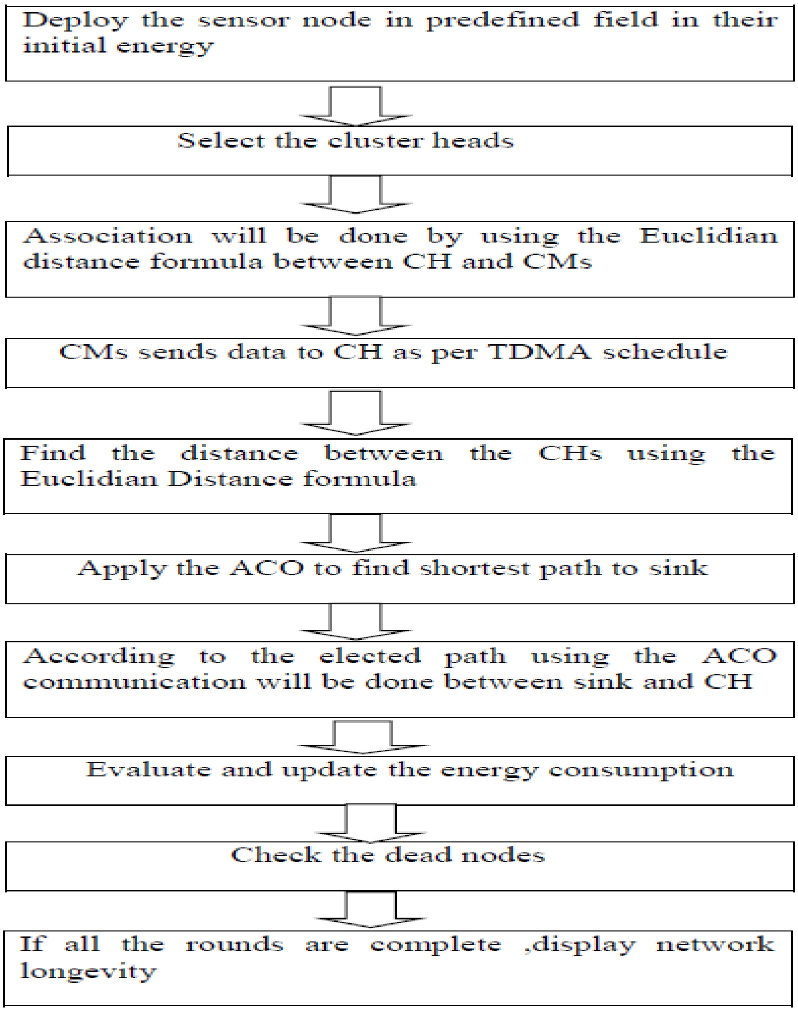

Figure 3: Flow chart of proposed algorithm

2.3 Optimization Algorithm ACO

The proposed strategy decomposes the sensor network into numerous segments hence called clusters, and cluster heads are chosen in every cluster. Then, ACO based data aggregation come in action and collects sensing information directly from cluster heads by utilizing short distance communications. The cluster-head nodes should be spread throughout the network, as this will minimize the distance the non-cluster-head nodes need to send their data. A sensor node chooses a random number, r, between 0 and 1. Let a threshold value be

$$\mathbf{T\ (n):\ T\ (n) = p/\ (1\text{-}p \times (\ r \bmod [1/p]\ )\ )} \qquad \textbf{..eq (1)}$$

If this random number is less than a threshold value, T (n), the node becomes a cluster-head for the current round. The threshold value is calculated based on the above given equation where P is the desired percentage to become a cluster-head, r represent the current round, and G represents the set of nodes that have not been selected as a cluster-head in the last (1/P) rounds. After the nodes have elected themselves to be cluster-heads, it broadcasts an advertisement message (ADV). Each non-cluster-head node determines to which cluster it belongs by choosing the cluster-head that requires the minimum communication energy. Member nodes will send data to their CHs as per TDMA schedule. Euclidian distance formula is used to find the distance between the cluster heads. Ant Colony Optimization algorithm is then used to find the shortest path to send data from CHs to the sink. The steps of algorithm to find the shortest path using ant colony optimization are as follow :

Step1: Initialize CHs as ants combined with sink as Destination.
Step2: Going of virtual ant depends on the amount of pheromone on the CHs distances.
Step3: The first step in ACO could be the trail collection between neighboring clusters ,some synthetic ants (CHs) are simulated from the CHs to the sink.
step4: The ahead ants are choosing the following CH randomly for initially taking the data from the length matrix and the ants who are successful in achieving the sink are updating the pheromone deposit at the edges

visited by them by an amount (CL), where M is the sum total journey period of the ant and D a constant price that is adjusted in line with the fresh problems to the perfect value.

Step5: The following set of the ants can now study on the pheromone deposit feedback left by the formerly visited successful ants and will soon be guided to follow along with the quickest path.

Step6: When someone ant walks from CHi to CHj, the chance in the selection principle for a simple ant is:

$$P_{i,j} = \frac{(\tau_{i,j})^{\alpha} + (\eta_{i,j})^{\beta}}{\Sigma(\tau_{i,j})^{\alpha}(\eta_{i,j})^{\beta}}$$

…eq (2)

where Γi,j represents the amount of pheromone deposit from CHi to CHj ; ηi,j is the trail visibility function that is equivalent to the reciprocal of the energy distance between CHi and CHj; α is the parameter to adjust the amount of pheromone Γi,j ; β is a parameter to adjust the heuristic visibility function ηi,j.

Step7 : if the link between two CHs exists , then

Pi,j will be updated

else

Pi,j= 0.

end

Step8: Evaluate the distance between the cluster head i and cluster head j.

Step9: P values will be updated by all the ants which have reached the sink successfully.

Step10: Phermone evaporation (ρ) on the edge between CHi and CHj is implemented .

Step11: CHs not chosen by artificial ants , the amount of P decreases exponentially.

Step12: Every moment of time ,t ={ 1,2,3,4,…,n} . all the ants will, after n iteration find the solution and leave the P .

Step13: If ant k has passed some edge between the CHs ,it will leave P which is inversely proportional to with the total length of all the edges ant k has passed from the starting CH to the Sink .

Step14: Now the path with best P value (minimum distance) is selected to communicate data between CHs and sink.

End

Based upon the elected path the communication will be done between sink and the cluster heads. Then, energy consumption will be evaluated and updated by using following formulas

i. $\boldsymbol{W(i).E = W(i).E - ((Txenergy + EDA) * (K) + efs * K * (d2)): ifd < do}$

ii. $\boldsymbol{W(i).E = W(i).E - ((Txenergy + EDA) * (K) + amp * K * (d4)) : ifd > do}$

..eq(3)

where, W(i).E is the energy of ith node, EDA is effective data aggregation, Tx energy is the transmitter energy, k is the packet size, efs represents the free space and amp is the multipath, do is the minimum allowed distance.

III Experimental Results

As already discussed, energy efficient WSN deployment is not an easy task due to large number of parameters, i.e., energy parameters and cluster head selection then their data transmission procedure. MATLAB version R2013a programming platform is used for coding of algorithm using ACO algorithm.

The MATLAB simulation tool is used for simulation purpose. It evaluates the performance of the proposed algorithm (LMACO) on the following metrics i.e. network longevity, residual energy (average remaining energy), and number of dead nodes. Network longevity of a network is the time when last ever node die in the network. The network longevity , residual energy (average remaining energy) of the proposed algorithm (LMACO) is significantly improved. Due to random deployment of the sensor network there exist variation in network longevity whenever simulation is run. But when compared to available protocols and algorithms, it is found that the network longevity of the proposed technique is consistent and maximized than available well-known protocols and algorithms.

3.1 Simulation Environment

The proposed algorithm (LMACO) for low energy consumption of nodes in wireless sensor network has been simulated using MATLAB. During simulation an assumption has been made that the system and the channel used are ideal with no attenuation and no channel noise. All the factors that can degrade the system performance are ignored. Various parameters used for the simulation are given in Table 1 . These parameters are standard values used as benchmark for WSNs.

Table 1: Experimental Setup

Parameter	Value
Area(x,y)	100m*100m
Sink(x,y)	1.5*xm,0.5*ym
Nodes(n)	200
Probability(p)	0.2
Initial Energy(Eo)	0.1
Transmitter energy	50nJ/bit
receiver energy	50nJ/bit
Free space(amplifier)	10nj/bit/m^2
Multipath(amplifier)	0.0013pJ/bit/m^4
a (energy factor between normal and advanced nodes)	1
Maximum number of rounds	100
Message size	4000 bits
m (fraction of advanced nodes)	0.0
Effective Data aggregation	5nJ/bit/signal

3.2 Network Longevity

Network longevity is define as the time for the first node or a certain percentage of sensor nodes to run out of power or it is the time interval from the start of operation of the sensor network until the death of the first alive node. The overall network longevity depends on the longevity of each sensor node. Network instability occurs as soon as the first node dies in the network .

Table 2 : Network Longevity

Number of Dead Nodes	Total Number of Nodes in Sensing Area of 100m*100m			
	Nodes = 50	Nodes = 100	Nodes = 150	Nodes = 200
Number of Dead Nodes in Case of LEACH Protocol	35	68	99	129
Number of Dead Nodes in Case of PLEACH Protocol	30	64	92	122
Number of Dead Nodes in Case of EAMMH Protocol	29	62	80	112
Number of Dead Nodes in Case of The Proposed Algorithm Using ACO	19	54	73	108

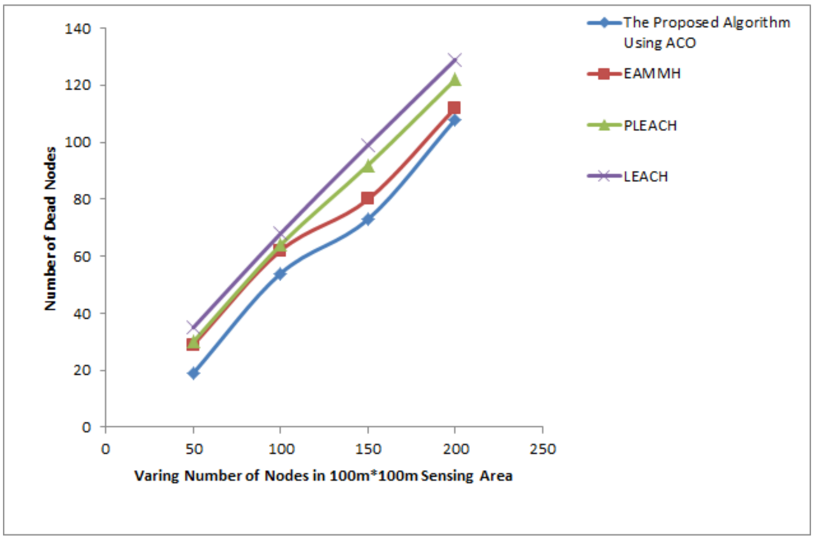

Figure 4 : Number of Dead Nodes for Varying Number of Nodes in 100m*100m sensing Area

The number of dead nodes can demonstrate the balance of energy consumption in the network. In figure 4, x-coordinate represents the varying number of nodes in 100m*100m sensing area and y-coordinate shows the number of nodes which died . It is clear from the figure that the proposed algorithm using ACO (LMACO) outperforms LEACH, PLEACH ,EAMMH protocols in terms of the number of dead nodes. Figures 4 represent the comparison of the proposed algorithm (LMACO) and LEACH, PLEACH ,EAMMH protocols for the number of dead nodes against the varying number of nodes 50,100,150 and 200 nodes respectively. From figure 4 it is observe that, at start when total number of nodes are 50,the number of dead nodes with the simulation of LEACH ,PLEACH, EMMAH protocols are almost as comparable to number of dead nodes in the proposed algorithm (LMACO) .However as the number of nodes increase, it is observe from figure 4 that the proposed algorithm (LMACO) results in lesser number of dead nodes after the completion of 100 rounds when compared to LEACH, PLEACH , EAMMH protocols.

3.3Analysis of Results

From figure 4 it is observed that as the time progress ,the proposed algorithm (LMACO) lose energy as the number of round increases . It is also observed from figure 4 that once the node reaches the value of zero it is no longer functional and is deemed as dead node. From figure 4 it is observed that the numbers of dead nodes for the proposed algorithm (LMACO) also get lesser as the number of total nodes increase when compared to

LEACH , PLEACH, EAMMH protocols.

From the simulation it is observed that the nodes which are far away from the sink are the one which run out of the energy more quickly than the rest which are nearer to the sink. This is due to the fact that the nodes or the cluster head which are farther from the sink have to dissipate large amount of energy to send the information as

they will have to travel longer distance when compared to the ones which are nearer. The reason why the proposed algorithm (LMACO) performs better than LEACH , PLEACH , EAMMH is that the proposed algorithm uses ACO algorithm to find out shortest paths for communication which will help make the network survive for a longer time. LEACH protocol on the other hand has a direct hop communication with the Cluster

Head and then to the sink. Even though LEACH, PLEACH , EAMMH employs Multi-hop mechanisms, the proposed algorithm (LMACO) with the usage of Multi-path and hierarchical routing parameters and ACO algorithm can perform with much better energy efficiency than LEACH, PLEACH ,EAMMH in cases where more number of nodes are involved.

Analysis of results conclude that proposed algorithm which uses the ACO to find out the shortest path for the communication between cluster heads and sink increases the longevity of the wireless sensor network.

IV Conclusion And Future Scopes

In this paper, the problem of network longevity maximization in the wireless sensor networks is investigated, and on the basis of the ant colony optimization an optimal-distance based transmission strategy is proposed. A algorithm was proposed to achieve high throughput and increases the network longevity. Throughput was analyzed by calculating the number of dead nodes verses round number for varying sensing area and by calculating average energy of each node verses round number for varying sensor area .The

performance analysis using MATLAB shows that longevity of wireless sensor network increases as compared to the already existing algorithms and protocols.
The future scopes of proposed transmission strategy are as follow :
1.In this proposed work single sink node is used, thus for the improvement multiple sink nodes can be used. Multiple sink nodes increases the complexity of routing algorithms.
2. Sink node used is dynamic in nature, thus for further research prospects the static sink node can be assumed.
3. Research can be done by implementing other algorithms on WSN.
This type of simulation is iteration based. However for future work this simulation can also be implemented using another techniques or models.

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