Energy Efficient and Collision Aware Routing Algorithm for Wireless Sensor Networks

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ABSTRACT

Wireless sensor network (WSN) is a acquiring of sensor nodes that dynamically self-organize themselves into a wireless network without the utilization of any pre-existing infrastructure. Energy Efficient is a critical feature of wireless sensor networks, because sensor nodes run on batteries that are generally difficult to recharge once deployed. Clustering the sensor nodes using Energy Efficient Distributed Clustering algorithm to achieve these goal. In this work, an Energy Efficient Distributed algorithm based on Ant Colony Optimization Algorithm (EEDC-ACO) with Sleep Scheduling Multiple Target Tracking Algorithm to maximize the network lifetime. SSMTT algorithm, schedule the sensor node that will make them awake from sleep mode to active mode when needed. It improves the energy efficiency of sensor node as well as prolongs the network lifetime. In this proposed approach will provide optimal solutions in terms of efficient energy utilization and enhanced network lifetime.

Keyword : - *Wireless sensor network, Ant Colony Optimization, Clustering, Energy Efficient.*

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1. INTRODUCTION

A Wireless sensor network is a network consists of low-size and low-complex devices known as sensor nodes that may sense the environment and gather the data from the monitoring field and communicate through wireless links, the information collected is forwarded, through multiple hops to a sink. In WSN, the sensor nodes are deployed in a sensing area. The deployment of the sensor nodes is random. Each Sensor in WSN monitors its environment and also the objective of this network is to deliver some global data or an inference about the environment to an base station who could be located at the periphery of the network or they could be randomly connected to the sensor network. Each node of the sensor network consists of three schemes: the sensor subsystem that sense the environment, the process scheme that performs local computations on the sensed data, and also the communication process that is responsible for message transfer with neighboring nodes have limited sensing region, processing power, and energy, networking a large number of sensors gives rise to a reliable, and accurate sensor network covering a wider region. WSN collects local information, process them and send it to a remote base station. EEDC (Energy Efficient Distributed Clustering) protocol is the clustering protocol. It mainly consider residual energy as primary parameter and network topology features (e.g. node degree, distances to neighbors) are only used as secondary parameters to use to choose cluster heads, as a metric for cluster selection to achieve high energy efficiency and prolong network lifetime in large-scale WSN environments. In this proposed work, an Energy Efficient Distributed algorithm based on Ant Colony Optimization Algorithm (EEDC-ACO) with Sleep Scheduling Multiple Target Tracking Algorithm to maximize the network lifetime and also minimizes the network energy consumption. This proposed work form clusters with optimal cluster head.

2. RELATED WORK

Zhengmao Ye et al [1] propose that wireless sensor networks (WSNs) use battery powered sensor nodes for sensing, thus the energy efficiency is critical to extend the lifespan. The generalized Ant Colony Optimization (ACO) is applied to increase the reliable lifespan of sensor nodes with energy constraints. Each sensor node is modeled as an artificial ant and dynamic routing is modeled as ant foraging. The ant pheromone is released when an energy efficient channel from the source to sink is secured. Route discovery, data aggregation and information loss are modeled as the processes of pheromone diffusion, accumulation and evaporation. Each sensor node estimates the residual energy and dynamically calculates probabilities to select an optimal channel to extend the lifespan of WSNs.

Ying Lin et al [2] introduce that ant colony optimization (ACO) to solve combinatorial problems; this paper proposes an ACO-based approach that can maximize the lifetime of sensor nodes. This methodology is based on finding the maximum number of disjoint connected covers. Based on pheromone and heuristic information, each ants to find out the optimal path on the construction graph to maximize the number of connected covers. The pheromone value serves as a metaphor for the search experiences in building connected covers. The proposed approach has been applied to a variety of heterogeneous WSNs. The results show that the approach is effective and efficient in finding high-quality solutions for maximizing the lifetime of heterogeneous WSNs.

CherifaBoucetta et al [3] introduce that Power Aware Scheduling and Clustering algorithm based on Ant Colony Optimization (PASC-ACO). In the proposed approach, energy is saved by scheduling some nodes in the active state to generate data and keep network connectivity. Then, ACO algorithm is used for routing data packets in the network in order to minimize the energy wasted in transferring the redundant data sent by sensors in a densely deployed network. ACO scheme can play a significant role in the enhancement of network lifetime by selecting the optimum path to reach the base station. PASC-ACO achieves better performances in terms of lifetime by balancing the energy load among all the nodes.

XieHui et al [4] propose that efficient routing algorithm for large scale cluster-based wireless sensor networks. ACO approach consider not only the path delay but also the node energy and the frequency a node acting as a router to achieve a dynamic and adaptive routing, which can effectively balance the WSNs node power consumption and increase network lifetime as long as possible. Simulation results have shown the ACO routing protocol significantly improves the network lifetime.

Chi Lin, Guowei Wu et al [5] propose that DAACA consists of three phases: initialization, packets transmissions and operations on pheromones. In the transmission phase, each node estimates the remaining energy and the amount of pheromones value of neighbor nodes to compute the probabilities for dynamically select to next hop. After some rounds of transmissions, the pheromones values adjustments are performed, which take the advantages of both global and local merits for evaporating or depositing pheromones. Four different pheromones adjustment strategies which constitute DAACA family are designed to prolong the network lifetime.

3. THE NETWORK ENVIRONMENT

3.1 Network Model

A WSN consists of a large number of sensors randomly distributed in a given region. All nodes are homogeneous and the model is based on single sink node. Nodes have the same capabilities and initial energy level whereas the sink usually has sufficient resources, such as memory, processing capability and energy, to collect data and to manage the network.

3.2 Energy Model

Each time when n bits data are transmitted and the transmission distance is d, the energy consumption of the transmitter is:

$$E_t(n, d) = \begin{cases} E_{t-elec} \times n + \varepsilon_{fs} \times n \times d^2, d < d_o \\ E_{t-elec} \times n + \varepsilon_{amp} \times n \times d^4, d \geq d_o \end{cases} \quad (1)$$

E_{t-elec} Stands for the energy consumed by the transmitting circuit when 1 bit of data is transmit. The power amplification parameter ε_{fs} and ε_{amp} are relevant to the adopted energy consumption model of transmission. ε_{fs} Represents free space transmission and ε_{amp} multipath attenuation transmission. d_o is the boundary condition to differentiate two models, $d_o = \sqrt{\varepsilon_{fs}/\varepsilon_{amp}}$. When the transmission distance d is greater than d_o, the energy consumption of the transmitter will increase sharply with the transmission distance broaden. In the receiving end, the receiving circuit consumed the following energy when receiving n bits data:

$$E_r(n, d) = E_{t-elec} \times n \qquad (2)$$

4. PROPOSED APPROACH

In order to increase the network lifetime, in this propose work an energy efficient clustering algorithm based on ant colony optimization in WSN. Thus, combine clustering and scheduling with the Ant Colony Optimization. The objective of proposed work to realize dynamic clustering and scheduling the node.

4.1 Clustering technique

EEDC stands for Energy-Efficient Distributed Clustering method which considers energy and communication cost simultaneously. EEDC is an iterative grouping algorithm which utilizes residual energy of nodes and their communication cost to choose the best set as cluster head nodes. Nodes within the same cluster have to elect a cluster head. The lifetime of the network is divides into rounds.

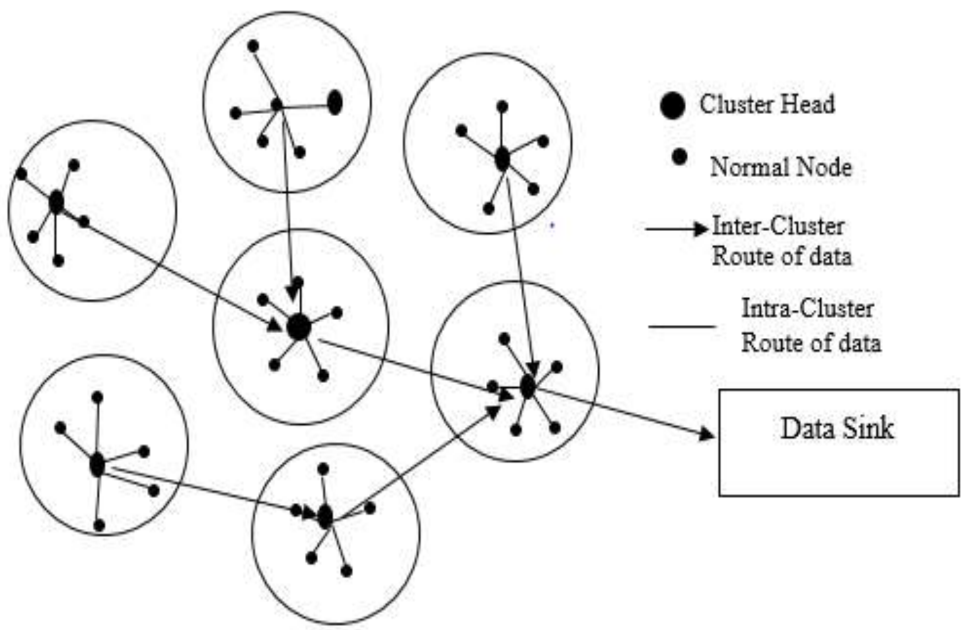

Fig-1: Intra-cluster and Inter-cluster communication in WSN

Each round initiates the selection of the CH, which is followed by the scheduling and the data transmission. During the cluster head selection phase, all nodes are active and which node has the maximum energy that node elect the cluster head. Cluster head gathering the data from their cluster member and then transfer data to a base station using relay node. It is a distributed, energy efficient clustering approach include two parameters such as sensor residual energy as a primary parameter and Intra-cluster Communication like node degree and node proximity as a secondary parameter.

The EEDC clustering operation is invoked at each node in order to decide if the node will elect to become a cluster head or join a cluster. A cluster head is responsible for two important tasks:

(i) Intra-cluster coordination: coordinating among nodes within its cluster.

(ii) Inter-cluster communication: communication between two cluster head.

Cluster head selection is based on the remaining energy and maximum energy of each node. The energy consumed per bit for sensing, processing, and communication is often known, and therefore remaining energy can be estimated. Intra cluster communication cost is considered as the secondary parameters. The secondary clustering parameter, intra-cluster communication value may be a function of (i) cluster properties, like cluster size, and (ii) whether or not variable power levels are admissible for intra-cluster communication. If the energy level used for intra-cluster communication is established for each node, then the cost can be proportional to (i) node degree, if the requirement is to distribute load among cluster heads, or (ii) 1/node degree, if the need to create clusters. This means that a node accompany the cluster head with minimum degree to disseminate cluster head load or joins the one with maximum degree to create dense clusters.

Each node performs neighbor discovery, and broadcasts its cost to the detected neighbor node. Each node sets its probability of becoming a cluster head, CHpro, as follows:

$$\text{CHpro} = \max\left(\text{cpro} \times \frac{\text{Eres}}{\text{Emax}}\right) \qquad (3)$$

Where, cpro is the initial percentage of cluster heads among m nodes, whereas Eres and Emax are the residual and the maximum energy of a node respectively. The value of Chpro is not allowed to fall below the threshold pmin (i.e. 10^{-4}).

4.2 To improve the energy efficiency of the sensor nodes

Energy efficiency is a critical feature of wireless sensor networks (WSN), because sensor nodes run on batteries that are generally difficult to recharge once deployed. Sensing and communications of sensor node are consuming more energy, therefore a proper power management and sensors scheduling is needed for maximized the network lifetime. To improve the performance of nodes in network and prolong the network lifetime, schedule the nodes in network and awake the sleep node when the object node or awake node wants to communicate and sensing the data in network. In wireless sensor network, sensor or node has two operation modes one is active mode and another is sleep mode. A sensor in active mode can done its function such as monitoring task and sleep node which are in idle mode not perform any task and it consume little energy. To better prolong the network lifetime and energy efficient of node, this paper proposed Ant Colony Optimization (ACO) technique and Sleep Scheduling Multiple Target Tracking Algorithm (SSMTT). By using both of this method the sensor node works better way.

4.3 To find the shortest path

A collection of asynchronous agents or ants produces partial solutions moving through different states of the problem. To find the shortest path between the each Cluster head to base station using Ant Colony Optimization algorithm. While moving they follow a decision policy which is based over two parameters namely trail and attractiveness. Each ant while moving incrementally produces a way out for the problem. When final solution is generated, the trail information of the components is altered by the ants by evaluating the solution which will influence the problem solving mechanism of future ants. Furthermore, there are two more mechanisms in an ACO algorithm: trail evaporation and daemon actions. Trail evaporation leads to decrease in trail value. To abstain unlimited growth of trails over specific component trail evaporation is used which decreases the trail value. As Energy is the major concern in WSN, ACO provides an optimized routing path i.e. minimum cost path for energy.

4.4 Basic Ant Based Routing for WSN

The ACO has been applied successfully on many combinatorial optimization problems. Implementation of AntNet algorithm can be described as follows,

1. A forward ant is launched from every node the network at specific instant of time with an aim of finding the path. To identify of each node that is visited is saved on a memory M_k and carried by an ant.

2. At node 'r' forward ant follows the similar probabilistic approach as in ACO for selecting next node:

$$P_k(r,s) = \begin{cases} \frac{[T(r,s)]^{\alpha}[E(r,s)]^{\beta}}{\sum_{\mu \epsilon M_K}[T(r,\mu)]^{\alpha}[E(\mu)]^{\beta}} & if\ s \epsilon M_k \\ 0 & otherwise \end{cases} \quad (4)$$

Where, E(s): Actual energy consumed by the node

α,β,μ: control trail and visibility parameters

P_k(r, s) is the probability of selection of particular path, T stores the pheromone information of path(r,s), E defines the visibility and is given by:

$$\frac{1}{\mathrm{C-E(s)}} \quad (5)$$

Where, C: Initial energy of node

E(s): Actual energy consumed by the node

3. Forward ant gets transformed to backward ant which updates the pheromone information.
4. Amount of pheromone which the ant drops is calculated at the destination by:

$$\nabla T_k = \frac{1}{\mathrm{N-fd_k}} \quad (6)$$

Where, N: Number of nodes

fd_k: Total number of node traversed by forward ant.

5. Backward Ant on reaching a particular node updates its pheromone information by:

$$T_{k(r,s)} = (1\text{-}\rho)\ T_k(r, s) + \nabla T_k \quad (7)$$

Where, ρ: parameter for trail evaporation.

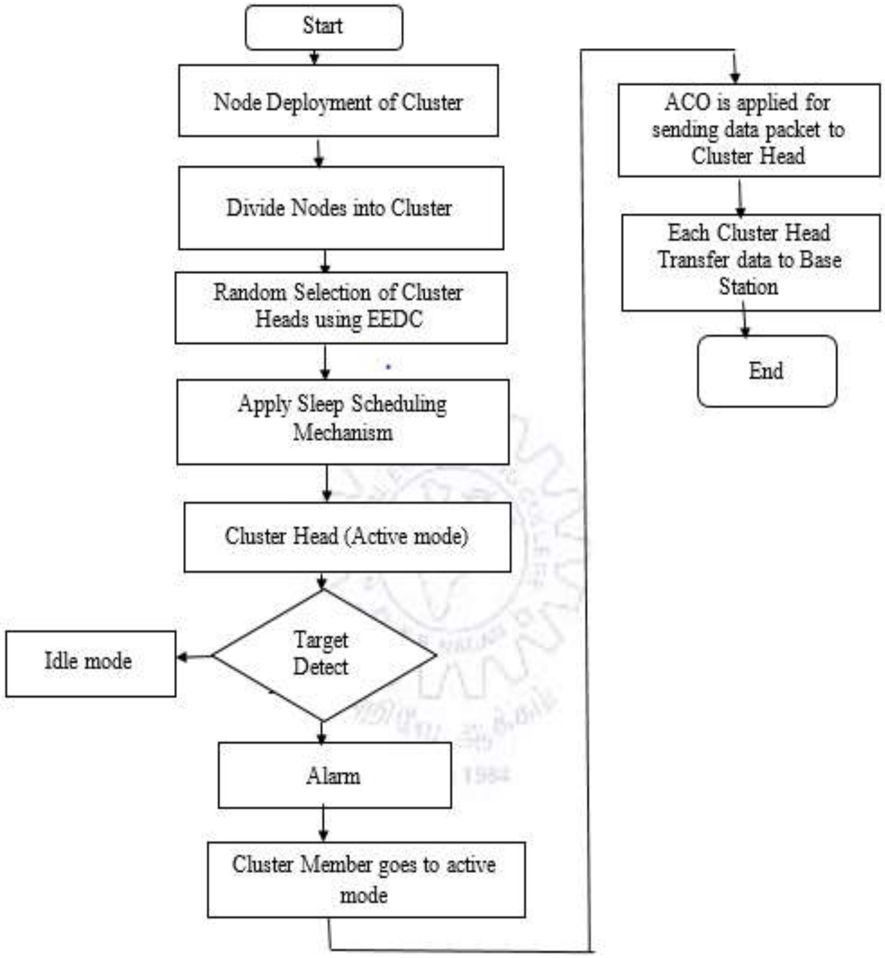

Fig- 2: Flow chart for Ant Colony Optimization with SSMTT Algorithm

6. When backward ant reaches the source node, this backward ant is eliminated.

4.5.1 Node Priority

Here, sensor nodes are classified into three types by taking the following two aspects into account:

Traffic load: Nodes in WSNs are disposed in harsh environments to complete the monitoring task. There are some nodes which have more monitoring events happen than others in their sensing region. So these nodes have more useful information to transmit than others. Therefore, this algorithm classify nodes in WSNs into two types by traffic load. Let T denote the load level of node. If the load of node is more than half of the channel capacity, T=0, otherwise T=1.

Traffic type: In WSNs, the multimedia data is more sensitive to delay than the scalar data. Therefore, this algorithm classify nodes into two types by traffic type. Let S denote the traffic type of node. If the data frame that nodes need to transmit is the real-time data, which has high demand for Qos, S=0, otherwise S=1. Let i denote the priority of node and this i is get from the formula: i=T+S.

Algorithm for Collision Avoidance:

Step1: Initialize the algorithm parameters.

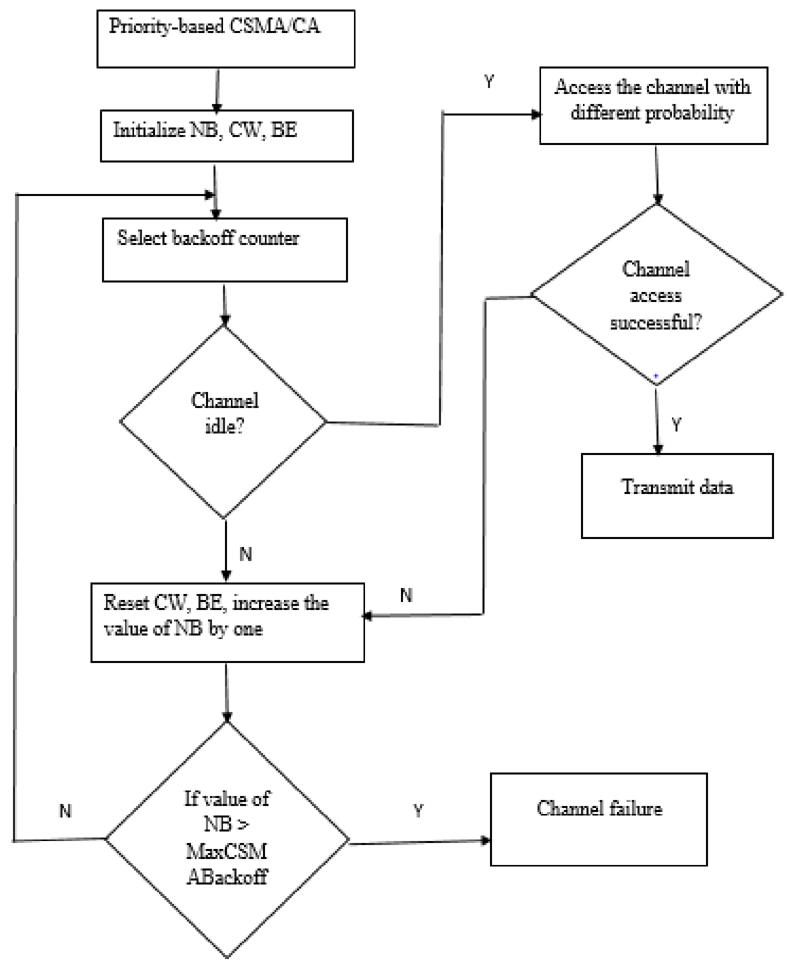

Fig-3: Flowchart for Collision Avoidance

Step2: Select a backoff counter value from the window.

Step3: When the value of backoff counter is zero, node performs CCA, assesses whether the channel is idle.

Step4: If the channel is accessed to be busy: the value of NB is increased by one, the value of BE is increased by one, the CW is set to different value for nodes with different priorities. If the value of NB is less than or equal to the maximum backoff times, the algorithm goes back to step 2; otherwise the algorithm terminated.

Step5: If the channel is accessed to be idle: if the value of CW is equal to zero, node with priority-0 accesses channel directly and transmits data frames.

5. SIMULATION AND RESULTS

5.1 Simulation study

The proposed scheme has been implemented in network simulator (NS2). Table 1 shows the parameter setting for simulation. Nodes are deployed randomly.

Table-1: Parameter settings for simulation

Parameter	Value
Simulation	NS-2.35
Maximum nodes in Network	100
Simulation Time	500 secs
Area of deployment	1000 * 1000 m^2
Initial energy of each node	2J
Transmission range	50m
Transmission energy	75µJ
Receiving energy	80 µJ

5.2 Results and Discussion

The proposed scheme is also evaluated by comparing it with the related LEACH and HEED schemes in terms of the energy consumption and routing overhead.

5.2.1 Energy consumption of the network

Chart 1 is plotted across the number of nodes and the total energy consumption of various nodes. The objective of the proposed schemes is to deal with selecting cluster head to the node with highest energy in the network.

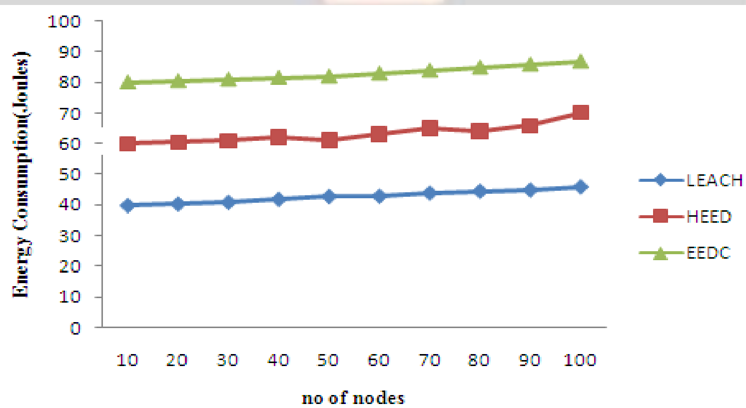

Chart-1: Energy Consumption

5.2.2 Network lifetime

Chart 2 shows the network lifetime as a varied number of nodes. The lifetime increases as the number of nodes grow. The proposed scheme achieved 90 percent of network lifetime.

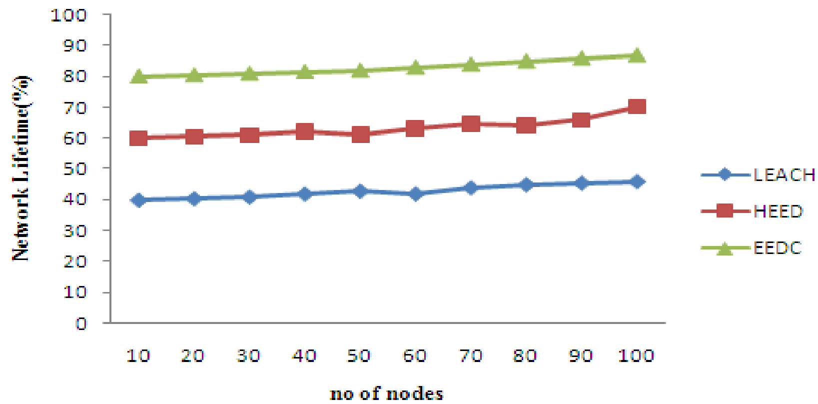

Chart-2: Network Lifetime

6. CONCLUSION

Energy Efficient is a critical feature of Wireless sensor networks, because sensor nodes run on batteries that are generally difficult to recharge once deployed. Sensing and communications of sensor node consume energy, therefore a proper power management and sensors scheduling is needed for maximized the network lifetime. An Energy Efficient Routing algorithm was proposed to find the shortest path and minimize the energy consumption of sensor nodes. The SSMTT algorithm schedules the sensor node and awakes the sleep node when needed. EEDC-ACO algorithm based on Sleep Scheduling Mechanism has been implemented. In the second phase, priority based CSMA/CA mechanism has been done. So overall network lifetime was maximized and energy consumption was minimized. In future, heterogeneous Wireless Sensor Network may be considered for testing application of the proposed EEDC-ACO Algorithm.

7. REFERENCES

[1]. Zhengmao ye, Habib Mohamadian, ''Adaptive Clustering Based Dynamic Routing of Wireless Sensor Network Via Generalized Ant Colony Optimization'', ELSEVIER Journal on Computer Networks, VOL.10,NO.2,PP.2212-667, 2014.

[2]. Ying Lin , Jun Zhang,, Henry Shu-Hung Chung,Wai Hung Ip, Yun Li ,Yu-Hui Shi, ''An Ant Colony Optimization Approach for Maximizing the Lifetime of Heterogeneous Wireless Sensor Networks'', IEEE TRANSACTIONS ON SYSTEMS, VOL. 42, NO. 3, PP.408-420, 2012.

[3]. CherifaBoucetta, HanenIdoudi, ''Ant Colony Optimization Based Hierarchical Data Dissemination in WSN'', IEEE TRANSACTION ON WIRELESS COMMUNICATION, VOL.13, NO.12, PP.782-787, 2014.

[4]. XieHui, Leila Azouzsaidane, ''Ant Colony Optimization Based Hierarchical Data Dissemination in WSN'', IEEE TRANSACTIONS ON WIRELESS COMMUNICATION, VOL.8, NO.15, PP.728-786, 2015

[5]. Chi Lin, Guowei Wu, Feng Xia, MingchuLi,Lin Yao, Zhongyi Pei, ' 'Energy efficient ant colony algorithms for data aggregation in wireless sensor networks'', ELSEVIER Journal on Computer and System Sciences, VOL.78, NO.5, PP.1686-1702, 2012.

[6]. Joon-Woo Lee, Byoung-Suk Choi,Ju-Jang Lee, ‘‘Energy-Efficient Routing Algorithm for Wireless Sensor Networks Using Ant Colony Optimization With Three Types of Pheromones’’, IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, VOL. 7, NO.3,PP.419-427, 2011.

[7]. FatemecMansourkiaie, Mohamed Hossam Ahmed , ‘’An Energy Efficient Routing algorithm using Ant Colony Optimization algorithm’’, IEEE SENSORS JOURNAL, VOL.16,NO.5,PP.1398-1411,2016.

[8]. Wen-Hwa Liao, Yucheng Kao, Ru-Ting Wu, ‘‘Ant colony optimization based sensor deployment protocol for wireless sensor networks’’, ELSEVIER Journal on Expert Systems with Application, VOL.38, NO.5, PP.6599-6605, 2014.

[9]. Rakhee, M.B.Srinivas, ‘‘Cluster Based Energy Efficient Routing Protocol Using ANT Colony Optimization’’, ELSEVIER Journal on Procedia Computer Science, VOL.89, NO.7, PP.124-133, 2016.

[10]. Amit Grover, Vishal Sharma, ‘‘A Modified ant colony optimization algorithm (mACO) for energy efficient wireless sensor networks’’, ELSEVIER Journal on International Journal for Light and Electron Optics, VOL.127, NO.9, PP.2169-217, 2016.