Ant Swarm Based Mobile Sink Data Aggregation With Token System For Reserved Forest Monitoring Application

P.Paruthi Ilam Vazhuthi, Dr.S.P.Manikandan

Abstract: Wireless sensor networks are the collection of tiny and compact devices are deployed in the particular area for monitoring some parameters. Forest monitoring, habitat monitoring, industrial monitoring and structural monitoring are the trending applications in sensor networks. However due to scarcity of limited resources such as memory, transmission range, Bandwidth and Battery power, life time improvement of the sensor network is the major problem facing by the researcher. To get better life time of the sensor network, mobile sink is used in the reserved forest monitoring application. A novel Ant swarm approach is proposed for data aggregation through mobile sink to prolong the life span and reduce the overhead of sensor network. For better enhancement of lifetime of individual entity in the sensor network for forest monitoring, Drones can be used to carry the sink node for data aggregation. Mobile sink node is continuously transmitting the tokens to the sensor node within the coverage area of sink node. Sensor nodes send the sensed data with its node identity after arrival of token message from the sink. When the sink node is out of transmission range from any sensor node then the sensed data is forwarded with neighbor node continuously and check whether the sink node is in transmission range or not. By using the concept of ant line walking, data aggregation is done with minimal overhead and better lifetime improvement in WSN. Simulation results show that the proposed method enhance the network performance in terms of different performance evaluation metrics. The life time is improved with 30 to 40% when compared with various existing mobile sink data aggregation approach.

Index Terms: Mobile sink, Network lifetime, Ant Swarm, Data aggregation, Forest monitoring, Overhead.

1 INTRODUCTION

Wireless sensor network is self-organizing network and consists of spatially distributed sensor nodes which perform sensing, processing, storing and communication. Physical conditions and environmental conditions can be monitored by the various parameters like temperature, vibration, pollution, motion, sound etc. Energy and Bandwidth resources are very limited constrained in sensor network as shown in figure 1. Therefore the data gathering from the sensor node is quite difficult without compromise the overhead to enhance the life time of the network [9]. In few scenarios, Sensor node is ready with limited battery that is difficult to put back in high density forest environment. Hence the battery backup in the node is the important factor for lifespan of the network. Commonly the sensor nodes are ready with transceiver for communicating purpose, signal-processing circuits, and microcontrollers for processing the sensed information [1]. To increase the lifetime of the sensor network, clustering among the nodes plays major role in the network. Hierarchical routing protocols such as LEACH, APTEEN, and HEED take the minimum energy consumption by WSN [1].

In forest monitoring sensor network, Humans are unable to interfere into the forest for collecting the sensed data in each node and for replacing the battery in the sensor node. In existing method, all the sensor nodes are transmitting the sensed parameters to the sink in multihop fashion[5]. Hence the network consumes more overhead in terms of transmission power, Bandwidth, Power usage in each node entity. To reduce control overhead and prolong the lifetime of sensor network, Clustering of nodes are framed. In Highly densed forest areas, nodes coverage is the challenging one for data gathering [10]. Usually, the sensor nodes are deployed randomly through aircraft over the sky[11]. Sometimes the network may have worst coverage among the nodes, then the data routing from sensor node to sink is also complicate. In order to overcome this challenge, sink can be used to collect information by moving one point to another point. Drone can be used to carry the sink node in this application, so that drastic reduction of overhead will be achieved and network life time may be increased [12]. In this proposed Ant Swarm approach, Data gathering can be done through sending tokens to the sensor nodes. If any node left the transmission rage of mobile sink node then it forwards to neighbor node and check the tokens received from the sink. If the neighbor node is in the transmission range of sink then it sends their own sensed information and the data received from the previous node.

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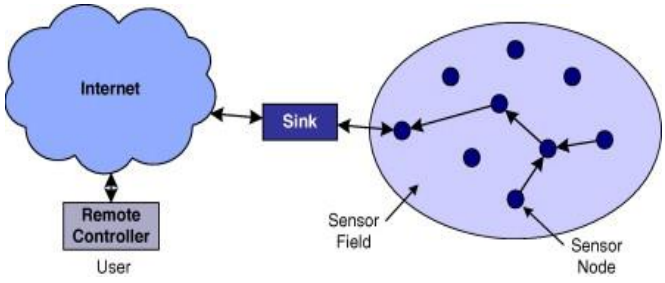

Figure 1. *Sensor Networ*

2 ANT SWARM APPROACH

Many routing protocols were proposed for routing the sensed information from sensor node to sink. Normally Route discovery and route maintenance process were take place in all existing routing protocols. Some energy may consume for the mentioned process and some energy for data transmission in the sensor network. Most of the routing protocols find the shortest route from the sensor node to sink with high cost and more overhead [7]. To reduce the overhead and energy consumption by the node, an Ant Swarm based routing is proposed through the behavior of ant species. Ants are social insects. They generally travel large distances in search for food. In absence of any maps or navigation aids, they have to rely on other mechanisms to find their way around. The ants walk in a line because they follow the scent left behind by the leader. Here the ant scent is considered as tokens from the mobile sink node. Based on the availability of tokens in the neighbor sensor nodes then transfers the information to the sink node. The ant-based routing approach the communication between sensor nodes is required based on such assumption. However the sink node is the responsible to collect sensor data from the network through multihop or single hop communication. Instead it is important to build generic algorithms that somehow can be adapted to some application requirements and at the same time prolong the network lifetime as long as possible. The lifetime of a sensor network can be measured based on generic parameters, such as the time when half of the sensor nodes lose their transmitting capability, or through specific metrics of each application[14].

3. RELATED WORKS

Many Researchers have proposed numerous schemes deals with the better utilization of Mobile Sink for effective data gathering in sensor network. In this research study [2], two novel algorithms are proposed based upon reinforcement learning to solve hot spot problem and it saves about 40% of battery power in wireless sensor network. First Reinforcement learning based clustering algorithm (RLBCA) to create head among the sensor node and second is on-demand mobile sink traversal (ODMST) algorithm is to collect data from the entire sensor nodes. Here mobile sink is used to store the request messages from cluster heads in a routing table and visits accordingly. In [3], EEABR uses a colony of artificial ants that travel through the WSN looking for paths between the sensor nodes and a destination node, FANT and BANT are the agents used for data collection in this system. The cost and overhead of using this method is quite more due to routing from sensor node to sink node. In [4], Mobile Sink based inter- and intra-cluster routing algorithms are proposed. Its objective is resolving the unbalanced energy consumption of Cluster Head and balance the energy consumption between the nodes which improves the coverage time of the network as shown in figure 2. In all the related works[8], control overhead is more in the algorithms which consumes some energy. To avoid the overhead and enhancing the life time of the network, mobile sink with token system is proposed by the ant swarm approach [6].

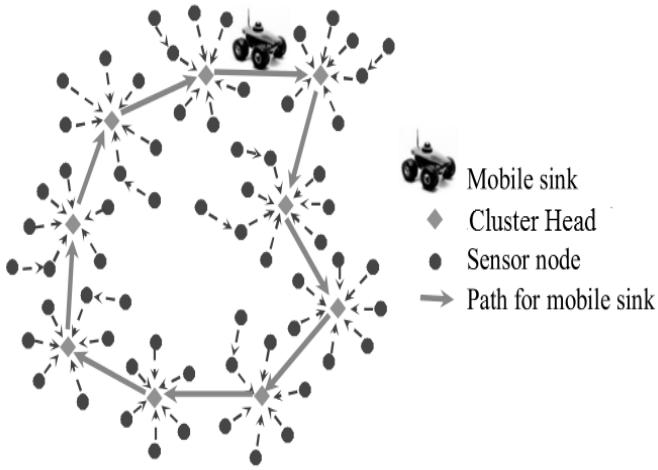

***Figure 2**. Sensor Network with mobile sink*

4. PROPOSED ALGORITHM

The basic idea of the proposed algorithms is as follows. We first initialize the parameters as shown in the table 1. This proposed methodology is inspired from the behavior of ant walking in line. This paper is mainly focused mobile sink data collection for reducing cost, overhead and energy consumption to enhance the life time of the sensor network. The Mobile sink (MS) is in mobility for collecting the data from the sensor node. After start moving by the Mobile sink, the SN is allowed to transmit the tokens to all Sensor Nodes (SN) when it is in coverage area of the Mobile Sink (MS) node. All the sensor nodes will be in sleep state if no activity takes place, this can be carried out for improving the life time of the network. When the SN is in transmission range of MS, sensor nodes are switched to active state, it collects the parameters and appends its node ID with sensed data then it transmits to the MS as shown in the Algorithm 1. As explained in the algorithm 2, Mobile Sink node moves randomly with the speed of above 2m/s. the sensor node coverage area of MS will be changed frequently within send back the sensed data the mobile sink. Thus the sensor is in detection range of MS, therefore SN forwards the data to the neighbor node which is also received token from the Mobile sink. The node discards the packet received from the previous node, if the node does not receive any tokens from the MS. The neighbor node forwards the sensed data with previous node sensed information to the MS when the new neighbor is in transmission range of MS. Node information such as Node ID is added into the sensed data packet before transmit to the new neighbor node. Hence the nodes sensed data is forwarded based on the availability of tokens received from the MS [13]. If the Node received the previous nodes data packet with 4 or 5 hops different nodes. Then the Node increases the transmission power then the transmission power may be increased from 40m to 80m. hence the sensor node easily find the transmission range of Mobile sink node through follow the MSs token having senor nodes.

TABLE 1
SIMULATION PARAMETERS

Parameter	Value
Target area	220 x 220 m^2
Number of SNs	100-200

Initial energy of SNs	2J
Communication range of each SN	20–40 m
Speed of mobile sink	2 m/s

Algorithm1:
Sending tokens to MS (Mobile Sink) covered Sensor Nodes (SN)

1. Initialize all parameters
2. MS starts to move
3. Sends token continuously by MS
4. For j=1:M
   (M denotes the nodes in Coverage area of SN)
5. If M<Coverage (SN is in coverage area of MS
6. then
7. If SN detects token, goes to Active state
8. Else retain in Sleep state
9. end
10. End if
11. End

Algorithm2:
Ant based Routing for data gathering

1. Initialize all parameters
2. Mobile Sink node starts moving from the origin randomly
3. For j=1:M
   (M denotes the nodes in Coverage area of SN)
4. then
5. If M = Transmission Range
   (if SN is in the transmission range of MS)
6. Then Receives token (Sensor node receives tokens)
7. Send the sensed data to MS with token and its ID= Q
8. Else
9. M= Detection Range
   (SN is in transmission range of MS)
10. Then send Q to neighbor M
    (Send the sensor node information to its neighbor when it is not in transmission range of Mobile sink)
11. Neighbor nodes forward further if the nodes receive token message from sink node
12. Continues the process until MS stops sending tokens
13. end
14. end if

In this paper the performance analysis of Ant Based Routing algorithm with token based (ABRT), Energy Efficient Ant Based Routing algorithm (EEABR), is done using Network Simulator(NS2).

5. PERFORMANCE ANALYSIS

The proposed system is analyzed with 100 sensor nodes as show in the figure 3. Based on the application the scalability of the sensor nodes may change. Performance analysis is done with comparing EEABR protocol by number of sensor nodes Vs Network life time. The network lifetime is highly reduced around 100 to 200 nodes as shown in figure 5. Analysis is done between Number of sensor nodes Vs life time as shown in figure 5. The lifetime of the network work is reduced drastically above 100 nodes are deployed in the region. The network is stable around 100-140 nodes is deployed. As shown in the figure 6 the performance analysis between Packet delivery time Vs network energy consumption, network energy consumption is less when compared to EEABR. For Packet delivery time Vs network energy consumption as shown in figure 7. The energy consumption is decreased gradually when the packet delivery time is increased due to increase of many nodes. For Number of sensor nodes Vs network energy consumption as shown in figure8. Energy consumption is considerably less around 100-140 nodes.

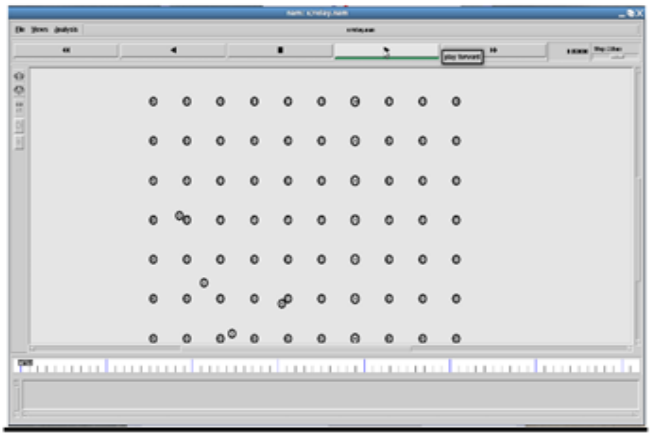

***Figure 3**. Network with 100 nodes*

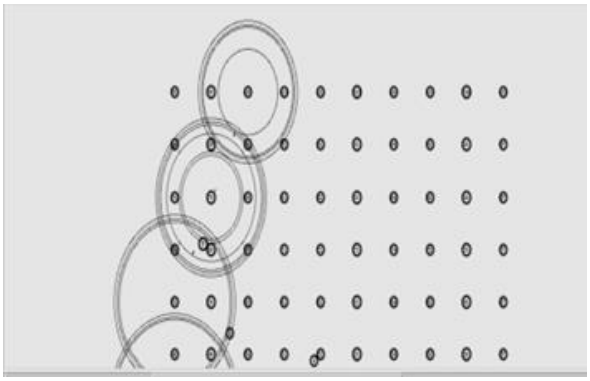

***Figure 4**. Data routing to MS with token based*

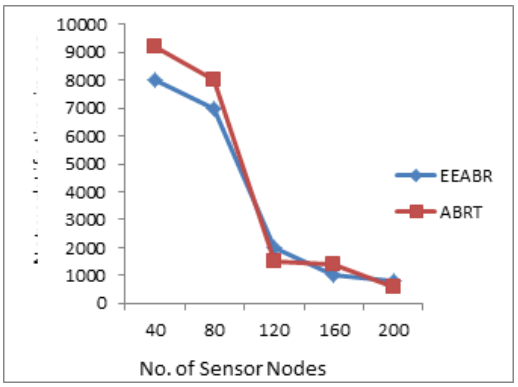

***Figure 5.** Number of sensor nodes Vs life time*

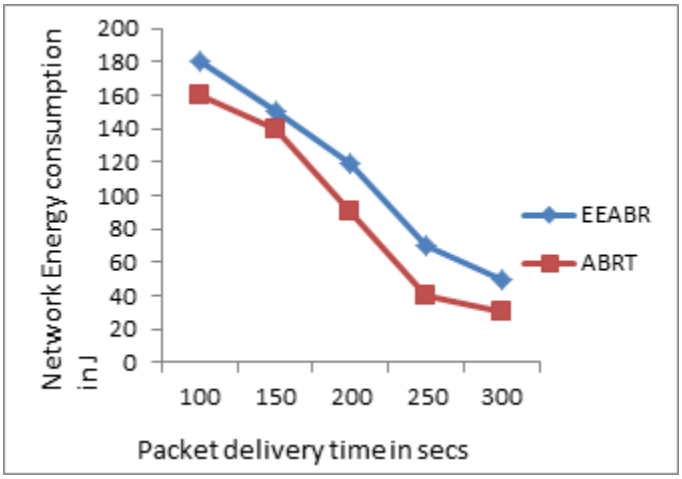

***Figure 6**. Packet delivery time Vs network energy consumption*

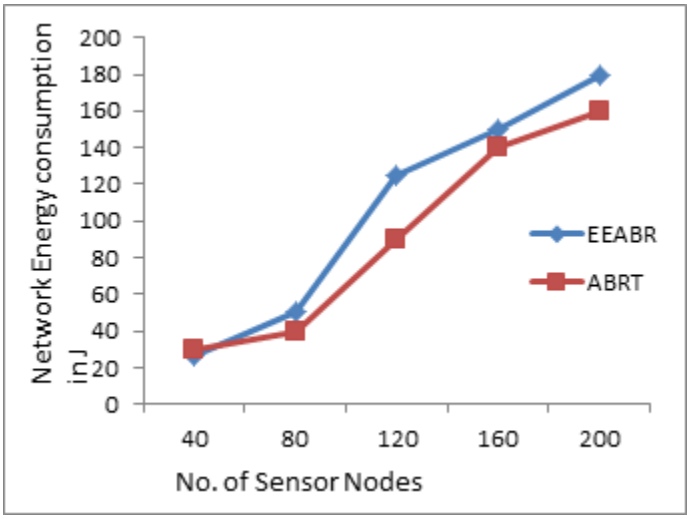

***Figure 7**. Number of sensor nodes Vs network energy consumption*

6. CONCLUSION

In this paper Ant Swarm based Mobile Sink Data Aggregation with Token System is evaluated and its performance is compared with the existing algorithm Basic EEABR using NS2 simulator. The main purpose of this paper is to minimize the overhead and increase the life time of the network. This proposed approach uses light weight data routing concept to find routing paths between the sensor nodes and the sink nodes through the tokens received by the sensor nodes. The experimental setup produced good results in different scenarios. The performance is degraded for EEABR protocol for metrics: minimum- energy, overhead and Energy efficiency are considered. The network life time is increased up to 30 % when compared to the existing protocols.

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