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Mobile Agent Driven Time Synchronized Energy Efficient WSN

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Abstract: ***Wireless sensor networks (WSNs) are used for applications like continuous monitoring purposes. In such a network routing is one of the major challenging issues for communication between the communicating hosts. Communication takes place between a pair of nodes in a conventional wireless sensor networks. The main objective in sensor network is to acquire the data from every node and transmit it to the sink node. In this sparse network since the number of nodes are large in number, hence number of packets are extreme. To minimize such huge volume of packets we need a time synchronizing effort between the nodes which further depends upon prior information like energy which is calculated through Mobile agents. For every aspect of planning, managing, securing a network involves determining when actually an event occurs. Hence Time synchronization is important in sensor network. Energy consumption must be reduced during the Time Synchronization of the WSN to improve the lifetime of the network using a powerful single mobile agent. The electricity of sensor nodes in wireless sensor networks is very limited, so it is an important research topic to deploy the sensor nodes and cooperate with an efficient routing algorithm for extending the network lifetime.***

Keywords: wireless sensor network (WSN), Mobile agents, Time synchronization

1. Introduction

Wireless sensor network consists of large number of battery powered sensor nodes and one or more base stations. Sensor nodes have limited memory and processing power. Sensor nodes sense the data and transmit it through the network to its Base station. User can get the data from the sensor nodes through the internet from the Base station. Such WSN are used in environmental monitoring, military applications such as battlefield surveillance etc. Now a day's such networks are used in many industrial and consumer applications, such as machine health monitoring, industrial process monitoring and control and so on.

Sensor networks have widely applicable in agricultural monitors and warehouse inventory management. In order to understand the scientific phenomenon it is necessary to collect numerous measurements of an event in any geographic region. Hence WSN plays a significant role in such situation where there is often no substitute for observations made firsthand within the region of interest. In WSNs a number of probe devices are distributed throughout a geographic region to observe local scientific conditions. In addition to sensors, probes are equipped with computational resources for in-network data processing, as well as wireless transceivers for communication with neighboring probes.

Time synchronization is a process of bringing the entire sensor node's local clock time to a common notion of time. To know the order of events that has sensed by the sensor nodes Time synchronization in WSN is required, and for data fusion Time synchronization is required. The main goal of time synchronization in WSN is to achieve the accuracy of the information collected from different sensor nodes. In any computer network every aspect of securing, managing, planning a network involves determining when actually an event occurs hence time synchronization is critical. To increase the lifetime of the network the energy conservation is one of the main issues in WSN. Various time synchronization schemes are already implemented to provide efficient time synchronization among the sensor nodes in the network.

Many existing synchronization schemes rely on the clock information from GPS (Global positioning system) which requires high power receiver and it is not cost efficient. A Mobile Agent (MA) is a type of software agent which consist of program code and the program execution state. This mobile agent travels from one place to other place in the network for the time synchronization of the sensor nodes. For synchronization of the sensor network, the mobile agent must cover the whole network in any fashion for proper synchronization and it should be able to synchronize the whole sensor nodes in the network. When the sensor nodes receive this timing information from mobile agent the sensors nodes will get synchronize with reference to the mobile agent UTC.

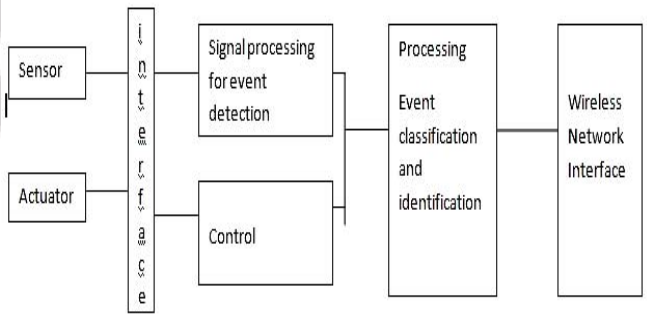

Figure 1: The Architecture of a Sensor Node

In sensor networks, the architecture of a node is highly dependent on the purpose of the deployment. But a

generalized architecture can be shown as in Figure. Each node consists of a sensor, processor, and radio for communication, battery, and memory.

2. Literature Survey

In [1] proposed Time Synchronization using Pair wise Broadcasting and how to choose the "appropriate" sensors aiming at reducing the number of PBS message exchanges while allowing every node to synchronize. This selection problem is shown to be NP-complete, for which the greedy heuristic is a good polynomial-time approximation algorithm. Nevertheless, a centralized algorithm is not suitable for wireless sensor networks. Therefore distributed heuristic algorithm is developed allowing a sensor to determine how to synchronize itself based on its neighborhood information only.

In [2] proposed three methods to achieve global synchronization in a sensor network: a node-based approach, a hierarchical cluster based method, and a fully localized diffusion-based method.

In [3] proposed the synchronization requirements of future sensor networks and present an implementation of low power synchronization scheme, post-facto synchronization.

In [4] proposed energy efficient time synchronization algorithm for deployment of Underwater Wireless Sensor Network (UWSN) for the purpose of monitoring phenomenon. This paper describes a prototype of a synchronization protocol which is suitable for UWSN considering the effects of both propagation delay and movement.

In [5] proposed the definition and basic concepts of time synchronization, and the related work is summarized in brief.

In [6] proposed a novel scheme for clock synchronization in sensor networks which is a combined idea of passive clustering and diffusion based asynchronous averaging algorithm for clock synchronization.

In [7] proposed a (breadth first search) BFS based synchronization algorithm to achieve energy efficiency in Wireless sensor network.

3. Problem Statement

Time synchronization is critical because every aspect of securing, managing, planning a network involves determining when actually an event occurs. Time synchronization in WSN plays a significant role in reducing the energy consumption within the nodes and thereby increases the lifetime of the network. Mobile Agent Driven Time Synchronized Energy Efficient which will be Energy and Cost efficient to improve the lifespan of the network.

4. Methodology

The energy required for the time synchronization must be small in WSN to improve the lifespan of the network using a powerful single mobile agent. Our work tries to decrease the energy consumption during the time synchronization process. A Mobile Agent (MA) is a type of software agent which consist of program code and the program execution state. Mobile agent carries the timing information attached with UTC (Universal Coordinated Time). The mobile agent traverses inside the network for the synchronization of the sensor nodes.

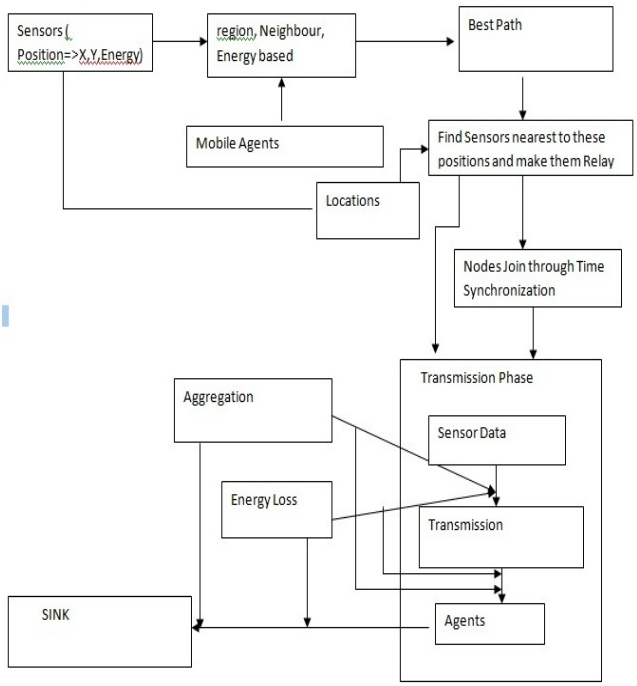

Figure 2: Block diagram

In our proposed scheme, our work tries to decrease the energy consumption during the time synchronization of the WSN to improve the lifespan of the network using a powerful single mobile agent. The mobile agent traverses inside the network for the synchronization of the sensor nodes. Some assumptions have been made for our proposed scheme:

a) A powerful mobile agent which will not fail during the entire synchronization process is use for the synchronization process of the WSN.
b) The path of the mobile agent covers the entire network in any fashion for proper synchronization of the sensor nodes.
c) Propagation delay between the mobile agent and the sensor nodes which are in its range are very small.

Proposed System is the more controlled architecture for data transmission for sensor network. In the proposed system, nodes obtain the path till the sink. However the paths are energy efficient paths which are accumulated through the nodes that have higher energy in correspondence to their neighbor. The energy efficient paths lasts for longer period of time as the intermediate nodes are capable of transmitting and forwarding data for a longer period of time. The sink first

generates agents. Agents are just like any other packets but comprises of active objects which has a life time and capability to exchange message. Agents traverse through the network and synchronize the nodes that they go through. This process is further modified such that each node knows the time instance when it has to transmit.

Even if a node has acquired data, it waits for the time period and then transmits. Hops at different levels are given different time stamp. Hence probability of packet collision is minimum as no two nodes transmits and receive at the same time. The sink also can tune it's receiver to different paths according to synchronization achieved. Hence packet loss is minimum along with low delay. The only drawback of the method is that number of control packet is more due to number of agent packets. In order to minimize this drawback we provide lifetime to the generated agents such that they don't traverse too long in the network in order to avoid prolonged and duplicate agents.

The following equation shows the energy consumed when sending a signal to a distance d by the node.

$$\text{Energy consumption} = \begin{cases} \varepsilon_{fs} \times d^2, \text{if } d \le d_0 \\ \varepsilon_{tr} \times d^4, \text{if } d > d_0 \end{cases}$$

Using d0 as a threshold, if the transmission distance is shorter than d0, a free-space propagation model is used to calculate the consumed energy.

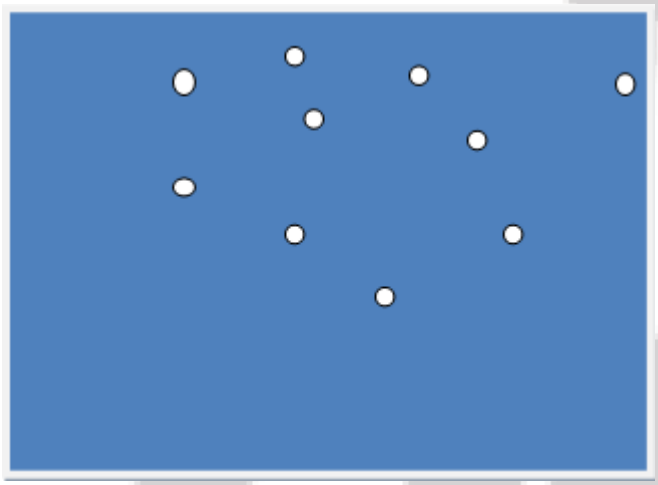

Figure 3: Sensor nodes deployed in sensor network

Figure 3 depicts a sensor network deployed over a geographical area in which the sensor nodes are randomly placed and static in nature. After deployment, a mobile agent traverses the sensor network broadcasting the timestamp messages to the sensor nodes which are in its coverage range. Mobile agent carries the time stamp message carrying the timing information. Mobile agent travels inside the network to synchronize the entire sensor network. The timestamp message contains the timing information of the mobile agent. Any node receiving the timestamp message will synchronize its local clock time with respect to the mobile agent time. When the node receives the time stamp message and gets synchronize, Boolean flag is set to true. When this node again receives the time stamp message then it will not synchronize again. Hence the number of synchronization process gets reduced to unity.

The Mobile agent has got a life time. The life time of the mobile agent is very small, such that it carries the fresh data in the network for synchronization. The nodes when they receive the mobile agent, it checks for the expiry life time of the mobile agent. If the life time of the mobile agent has expired then the node will not synchronize. If the life time of the mobile agent is not expired then the node will gets synchronized, and forwards the mobile agent to the next nodes in the network. This will continue till all the nodes get synchronized. The mobile agent will be broadcasting its timestamp messages for every "t" secs which is set by according to the coverage range of the mobile agent, size of the network and density of the sensor nodes in the network. The mobile Agent must cover the entire network in any fashion such that all the nodes get synchronized in the sensor network. The time taken by the mobile agent to travel from one node to another must be very small. Thus the delay must be small.

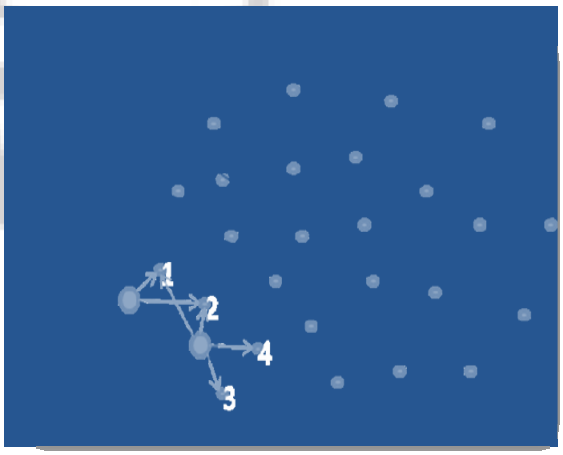

Figure 4: Synchronization process of sensor nodes

Sink node generates the mobile agent which carries the timing information and sends it to its nearest nodes to synchronize the nodes. A tree topology is used to synchronize the entire network. The propagation delay to send mobile agent from one node to another node is very small.

5. Simulation Results and Analysis

We simulate Time synchronization using a mobile agent using Gossiping in OMNET++ 3.3pl. For the experiment, the random networks of different number of Nodes are varied as an input is used in an area of (500 x 500). Simulation time is set to 1000sec. And packet size of 512 byte long.

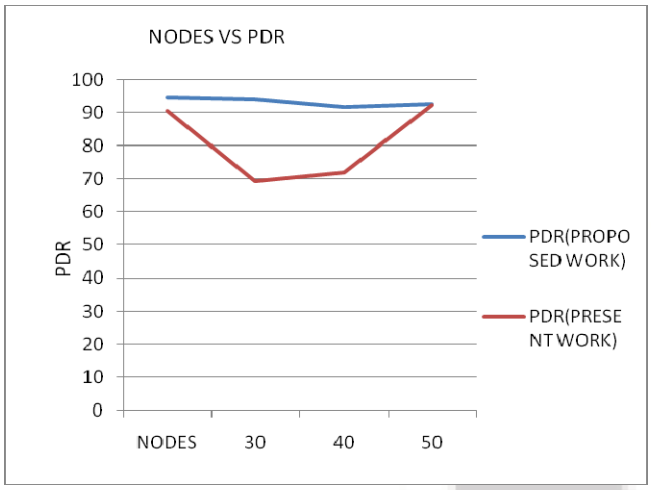

Figure 5: Nodes V/S Packet Delivery Ratio

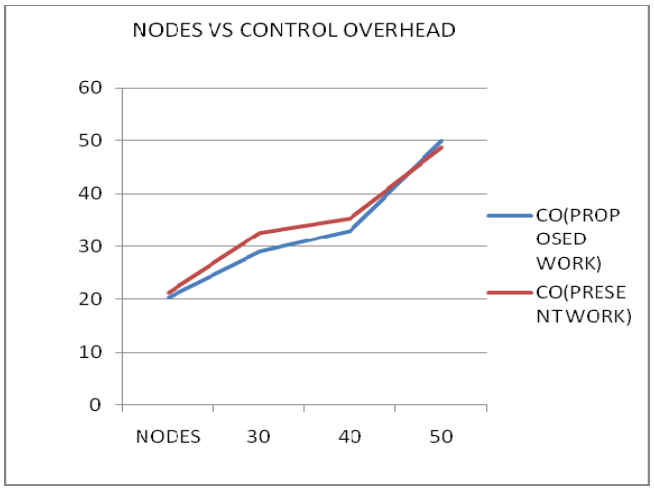

Figure: 8 Nodes V/S Control Overhead

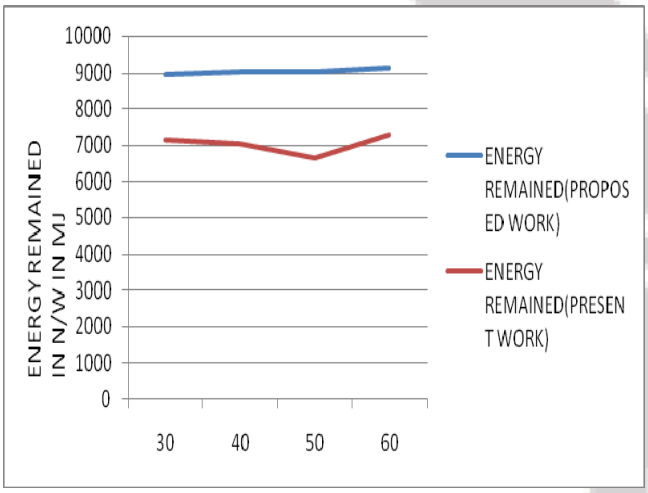

Figure 6: Nodes V/S Energy Remained In the Network

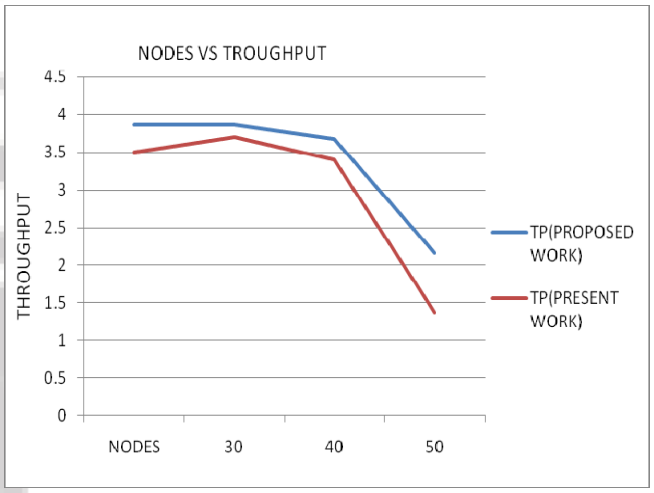

Figure 9: Nodes V/S Throughput

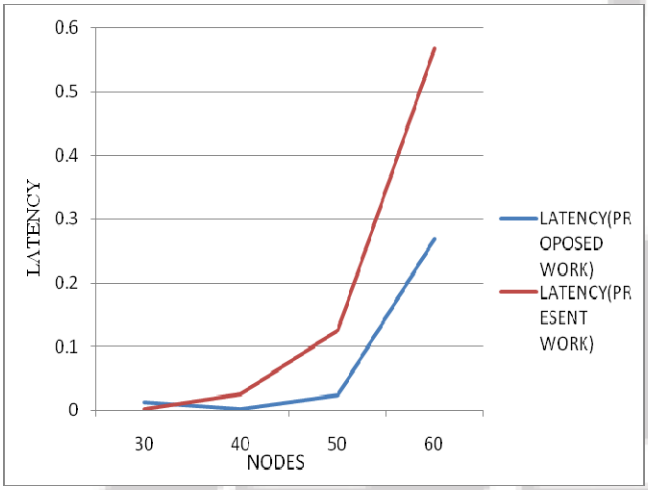

Figure 7: Nodes V/S Latency

6. Conclusion

In this paper, we proposed a Time synchronization scheme using a mobile agent which helps us to reduce the energy consumption to a great extent of the sensor nodes by optimizing the required number of transmissions to achieve time synchronization. The energy remaining in the network is comparatively high. Delay in the network is very small. So, we can conclude that our proposed scheme reduces the total amount of energy consumption for the synchronization of the sensor nodes thereby increasing the lifespan of the network.

7. Future Scope

This technique can be further investigated on various time synchronization schemes in sparse network. It also includes implementing the algorithms in real sensor network using mobile agents

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