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ENERGY EFFICIENT ROUTING MECHANISM BASED ON ANT COLONY OPTIMIZATION IN WIRELESS SENSOR NETWORKS

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***Abstract*— The applications of Wireless Sensor Networks are seriously constrained by energy supply. It is necessary to prolong the network lifetime. Energy efficient routing mechanism based on Ant Colony Optimization (ACO) in Wireless Sensor Networks is proposed. The 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 shows that the ACO routing protocol significantly improves the performance of the network.**

***Keywords*— wireless sensor networks, simulation results, ACO routing protocol**

I INTRODUCTION

Recent technological advancements in micro electronics and wireless communication technologies have enabled manufacturing of small, low cost, battery operated and multifunctional sensor nodes. These sensor nodes measure ambient condition in the surrounding environment that can be processed to reveal the characteristics of the phenomena occurring at the location where the sensor nodes are deployed. A large number of these sensor nodes are either placed carefully or randomly deployed over a geographical area and networked through wireless links to form a WSN. Each sensor node in WSN is capable of communicating with each other and the base station (BS) for the purpose of data integration and dissemination. WSN are used mainly in military, civilian and for industrial applications. WSNs applications in the military field include battlefield surveillance, intrusion detection, target field and imaging. However, WSN are now being used in many civilian application areas too, including environment and habitat monitoring, health applications, home automation and traffic control.

The node senses the data from the environment processes it and sends it to the base station. These nodes can either route the data to the base station (BS) or to other sensor nodes such that the data eventually reaches the base station. In most applications, sensor nodes suffer from limited energy supply and communication bandwidth. These nodes are powered by irreplaceable batteries and hence network lifetime depends on the battery consumption. Innovative techniques are developed to efficiently use the limited energy and bandwidth resource to maximize the lifetime of the network. These techniques work by careful design and management at all layers of the networking protocol. For example, at the network layer, it is highly desirable to find methods for energy efficient route discovery and relaying of data from the sensor nodes to the base station.

II RELATED WORKS

For industrial wireless sensor networks, it is essential to reliably sense and delivers the environmental data on time to avoid system malfunction [1]. In order to address the well-known curse of dimensionality problem and facilitate distributed implementation, the linear value approximation technique is used. A distributed energy allocation algorithm with a water-filling structure and a scheduling algorithm by an auction mechanism are obtained [2].

In Decentralized distributed Space Time Block Coding (Dis-STBC) system, the knowledge about the Channel State Information (CSI) is not available at the transmitter [3]. An Unobservable secure routing scheme offers complete unlink ability and content unobservability for all types of packets. This protocol is efficient as it uses a combination of group signature and ID based encryption for route discovery [4].

A new gradient based routing protocol for Industrial Wireless Sensor Networks (IWSNs) provides real-time data delivery by forwarding packets to its optimum forwarding node on the basis of two-hop neighbour information [5]. IWSN plays a vital role in creating a highly reliable and self-healing industrial system that rapidly responds to real-time events with appropriate actions. In addition, IWSN standards are presented for the system owners, who plan to utilize new IWSN technologies for industrial automation applications [6].

A path with lower energy cost is likely to be selected, because the probability is inversely proportional to the energy cost to the sink node. To achieve real-time delivery, only paths that may deliver a packet in time are selected. To achieve reliability, it may send a redundant packet via an alternate path, but only if it is a source of a packet [7].

The wide deployment of lower-cost wireless devices will significantly improve the productivity and safety of industrial plants while increasing the efficiency of plant workers by extending the information set available about the plant operations [8].

Neighbor-based Dynamic Connectivity Factor routing Protocol (DCFP) can dynamically test the status of the fundamental system without the intercession of a framework administrator based on a novel connectivity metric, while decreasing the RREQ overhead utilizing another connectivity factor [9]. Neighbor Coverage-based Probabilistic Rebroadcast (NCPR) protocol reduces routing overhead in MANETs and decrease the number of retransmissions so as to reduce the routing overhead [10].

Proposed ACO based energy efficiency approach

Energy Efficient routing mechanism based on Ant Colony Optimization (EEACO) in WSNs is proposed. The ACO routing protocol is composed of three phases: Neighbour Discovery phase, routing & data transmission phase and route maintenance.

Neighbour Discovery is initiated by the destination node. When the destination node receives an interest the node launches a neighbour discovery mechanism. Broadcast packets are flooded through the entire network until it reaches the source node to find all the routes from destination to source. This is when routing tables are built up. The destination node launches neighbour discovery mechanism. During this process broadcast packets are exchanged between the nodes.

The broadcast packets consist of the information of send time and receive time, and the packet delay equal to receive time subtract send time. Each intermediate node forwards the request only to the neighbors' that are closer to the source node than oneself and farther away from the destination node.

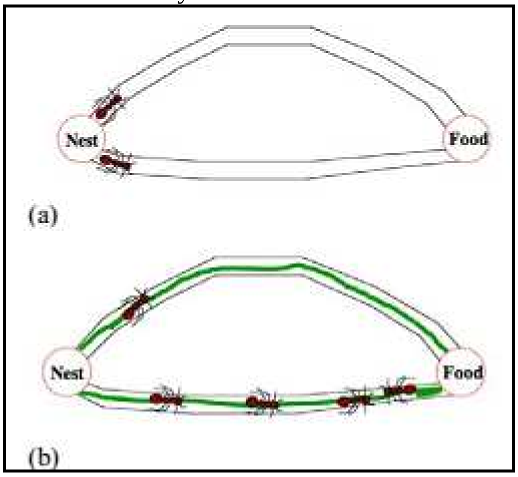

Figure 1: Ant colony optimization

In routing and data transmission, data is sent from source to destination, using the information from the earlier phase. This is when paths are chosen probabilistically according to the path delay, the node energy and the frequency a node acting as a router. Due to the choice of route is derived from the abovementioned parameters dynamically; therefore, the routing protocol has a very good adaptive performance. It can automatically adapt to the energy of each node of WSNs and pheromone changes to achieve dynamic routing choice in order to increase the network lifetime as long as possible.

Route maintenance phase is responsible for the maintenance of the path generated during the discovery phase. This phase basically helps in maintaining the route which has already been established during route discovery phase. As the topology of the network changes, it is required to refresh the route between the nodes. Once the path between source and destination is set up, it is up to the data packets to maintain the route. In such case, the path preference probability will automatically decrease and hence alternate routes can be used which are found during route discovery phase. The alternate routes are also periodically checked for their validity even though they are not currently used.

Performance Evaluation

The performance of the proposed scheme is analyzed by using the Network Simulator (NS2). The NS2 is an open source programming language written in C++ and OTCL (Object Oriented Tool Command Language). NS2 is a discrete event time driven simulator which is used to model the network protocols mainly. The nodes are distributed in the simulation environment. The simulation of the proposed scheme has 50 nodes deployed in the simulation area 900×900. The nodes are communicated with each other by using the communication protocol User Datagram Protocol. The traffic is handled using the traffic model CBR. The radio waves are propagated by using the propagation model two ray ground. All the nodes receive the signal from all direction by using the Omni directional antenna. The performance of the proposed scheme is evaluated by the parameters packet loss rate and throughput.

Packet Loss Rate

PLR is defined as the difference between the sent packets and received packets in the network per unit time as in equation 1.

$$PLR = \sum_{0}^{n} \frac{Number\ of\ Packets\ dropped}{Number\ of\ Packets\ Sent} \quad (1)$$

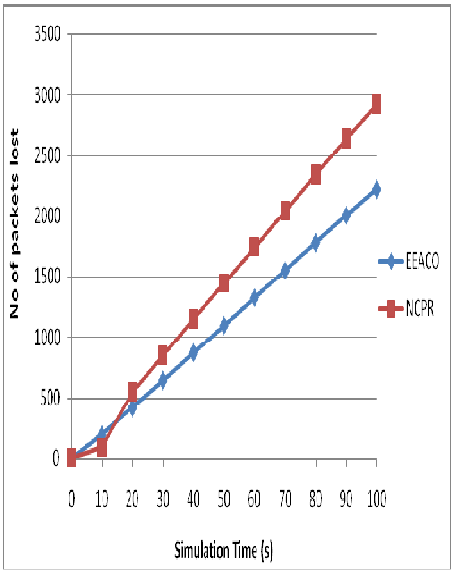

Figure 1: Packet Loss rate

Figure 1 shows the PLR of NCPR is greater when compared to that of EEACO. The number of nodes is increased when the number of packets dropped is increased.

Throughput

Throughput is defined as the data that can be transferred from source to the receiver in a given amount of time. Throughput is obtained using equation 2.

$$Throughput = \sum_{0}^{n} \frac{Number\ of\ Packets\ Received}{Time\ Taken} \quad (2)$$

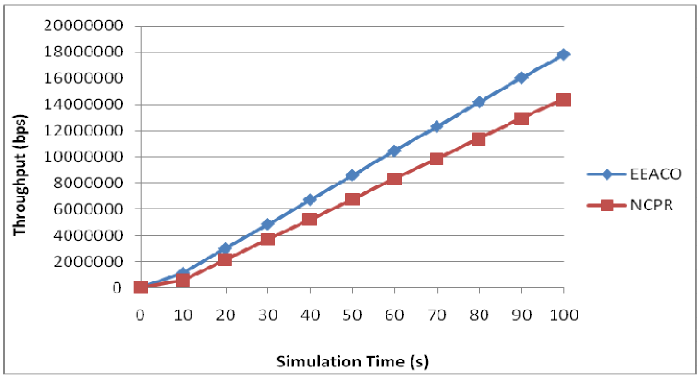

Figure 2: Throughput

It is observed from figure 2 that the number of packets received successfully for EEACO is greater compared to that of the NCPR.

III CONCLUSION

In this paper, we presented a new WSNs routing protocol by using ACO algorithm to balance the node power consumption and increase network lifetime as long as possible. The idea behind the protocol is simple using the lowest energy path always is not necessarily best for the long-term health of the network, because it would cause the optimal path quickly get energy depleted. The ACO approach considers 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. This is the significant difference between ACO routing and other traditional ACO routing algorithm.

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