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Implementation of Energy Efficient Scheduling - Based Data Aggregation through Dynamic Routing in Wireless Sensor Networks

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ABSTRACT: Wireless Sensor Networks (WSNs) are networks that consist of sensors which are used to monitor physical or environmental conditions. The resources especially energy in WSNs are limited. Data sampled by sensor nodes have redundancy, data aggregation becomes an effective method to reduce amount of data that need to send to base station. Data Aggregation is the process of aggregating the data from distributed sensors to eliminate redundant transmission and provide fused information to the base station. The existing schemes, Attribute aware Data Aggregation (ADA) make the packets with the same attribute convergent for an efficient aggregation. ADA scheme is based on the concept of potential in physics and pheromone in ant colony. The overhead is that different depth values with respect to different sinks need to be maintained by nodes. In this paper to ensure the packets reach the sink at last Dynamic Scheduling (DS) is proposed. Dynamic Scheduling is implemented using the currently available information without the necessity of predicting the future.

KEYWORDS: Data aggregation, Redundancy, Potential, Packets, Transmission.

1 INTRODUCTION

Wireless Sensor networks (WSNs) constitute of small and low-cost sensors that gather and distribute the sensory data. They offer economical and effective solutions in a variety of fields; and their profound suitability to address mission critical problems that are common in health, transportation and military applications [1]. Most sensor network applications consist of one or more sink nodes which subscribe to specific data streams. The sink nodes are used to express the values of different applications such as the environmental temperature or the vibration of the building [2]. A WSN can sense a region and provide useful information about it by combining measurements reserved by individual sensor nodes and then routed over the wireless interface to a base station.

A base station provides a connection to the wired world where the collected data is processed, analyzed and presented to useful applications. But one of the important issues is energy consumption. So overcome this problem data aggregation technique is used. Data aggregation is the process of collecting data from different types of sensor nodes and provides fused data to the Base Station which is shown in fig 1. Data aggregation requires significant coordination between the sensor nodes because the packets to be aggregated must lie at the same node at the same time.

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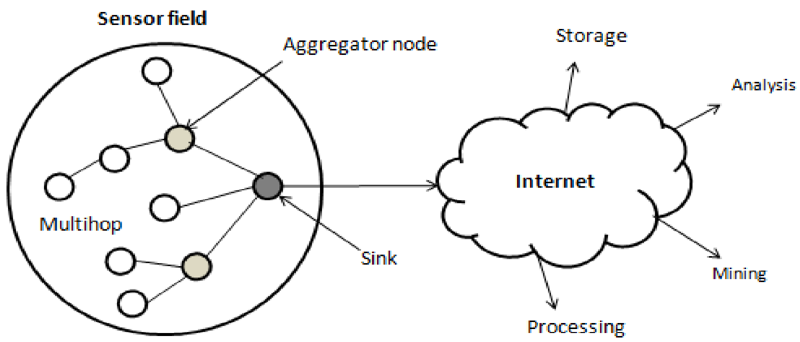

Fig.1. Architecture of Wireless Sensor Network

2 RELATED WORKS

Real-Time Query Scheduling (RTQS) [5], a novel approach to conflict-free transmission scheduling for real-time queries in wireless sensor networks. Timing Control Protocol [6] dynamically change the data aggregation period according to the aggregation quality. This protocol uses to phases. Setup phase distribute the parameters necessary for data aggregation. Data collection phase to reduce the control overhead.

Finding maximal non-conflicting transmission schedule set based on leaves and designed an algorithm with a latency bound explained by using Approximation algorithm [7]. Clu-DDAS [8] based on a novel cluster-based aggregation tree to avoid conflicting transmissions among neighboring clusters. Transmissions among different clusters are concurrent and conflicting free.

Contention-free Time Division Multiple Access (TDMA) [9] where nodes communicate on different time slots to prevent conflicts, offer several advantages for data collection as compared to contention-based protocols. They eliminate collisions, overhearing, and idle listening, which are the main sources of energy consumption in wireless communications.

Long-Lifetime and Low-Latency Data Aggregation Scheduling algorithm (L4DAS) [10] investigated the data aggregation problem and considered its latency and network lifetime for WSNs in scenarios of real-time and long-term applications.

3 MATERIAL AND METHODS

3.1 FORMATION OF POTENTIAL FIELDS

In this section, we describe how to construct the potential fields using depth and pheromone values on each node at the same time for balance the energy consumption. Combine the depth potential field and the pheromone potential field to form a hybrid potential field. Hybrid potential field ensure packets reach the sink as well as be more spatially convergent.

3.1.1 DEPTH POTENTIAL FIELD

Depth of the node is number of hops that it is away from the sink. Depth potential field force the packets along the shortest path.

$$Vd\ (d) = 1/\ d+1$$

Vd (d) - inverse proportional function of the depth

d=D (i) denotes the depth of node i.

3.1.2 PHEROMONE POTENTIAL FIELD

Pheromone potential field is constructed to gather the packets with the same attribute together. In WSNs the packets are treated as the ants leaving volatile pheromone at each passed node, a path selected by more packets will have more pheromone and can attract more packets with the same attribute.

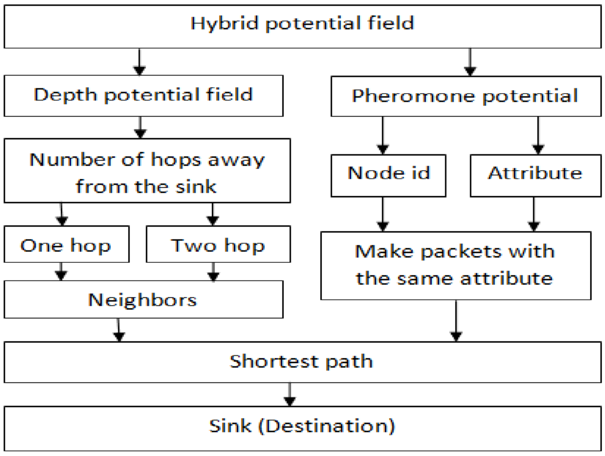

Fig. 2. Architecture for potential fields

Fig 2 shows the architectural design for potential fields. Each node can determine the number of hops that it is away from the sink. Depth is determined by using the depth value. The node has the lowest depth value considered as 1 which will be the next neighbor node. The different nodes have the same depth value which is not selected as the next neighbor node and also highest depth value is not selected. After the selection of neighbor node the pheromone potential field gathers and makes the packets with the same attribute along the shortest path. So the packets transmitted to the sink along the shortest path.

3.2 DYNAMIC SCHEDULING

In sensor networks the packets are received by different nodes. After receiving the packet the packets priority is checked based on the hop count of the packet and consequently sends it to the relevant buffer. Packet scheduling schemes can be classified based on the priority of data packets that are sensed at different sensor nodes in the buffer.

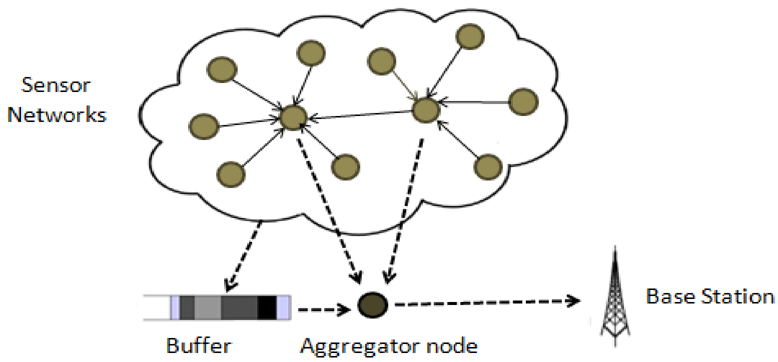

Fig.3. Buffer management in sensor networks

When a packet data arrives at the buffer of the scheduler, the packets priority is compared with the priority of the currently running data packet in the buffer which is shown in the fig 3. All types of data packets enter the buffer and are scheduled based on different criteria: type, priority, size, etc. Reward value is used to denote the important level of packets and process the most important and valuable packet first. Even two or more unimportant packets which just consume a small amount of energy, so like to process one important packet which may consume relatively larger amount of energy. Reward value is used to denote the priority level of packet.

A packet with a larger reward value means that this packet is more important. Therefore, the sensor nodes always accept the packets which have the highest reward value. Thus, we can guarantee that the most important packets can be processed first. Buffer acts as storage for the packets and works like to a queue. So consider a temporary buffer and multiple queue system in main buffer. First the input packet reaches the temporary buffer and then caters to different priority queues. We define different queues for different priority packets. For the first queue in the buffer, we push important packets first. Second queue is for normal packets.

3.2 DATA AGGREGATION

Data aggregation is an important paradigm for compressing data so that the energy of the network is used up efficiently. In aggregation mechanisms, the nodes aggregate received data and send aggregated result instead of raw data to sink, so the volume of the transmitted data is decreased.

Aggregation mechanism works as follow: each node senses data from the environment and receives other node's data, then aggregates these data, based on the aggregation function and transmits the aggregation result to the sink. Therefore aggregation decreases the data volume that is transmitted and this leads to less energy consumption. Also the aggregation process also decreases collision and retransmission delay [11].

Algorithm 1 Data aggregation using dynamic scheduling

Require: packet reaches aggregator
{
Store the packets in buffer
if (packet priority = Normal/Important) then
Forward packet to sink (no aggregation)
else
Wait for T Sec/Count M.
if (Time/Count reached) then
Apply aggregation
end if
end if
}//end aggregation phase

4 RESULTS AND DISCUSSIONS

We implement the ADA scheme with dynamic scheduling using the NS2 simulator to evaluate the performance. NS-2 is a discrete event network simulator built in Object-Oriented extension of Tool Command Language and C++. NS-2 can support a vast range of protocols in different layers. So using this, the data packets from different sensor nodes were transmitted to the sink node with minimum number of transmission. In this section we are verifying the data packets sent to the sink without any collisions. The proposed dynamic scheduling algorithm avoids the collision of data packets.

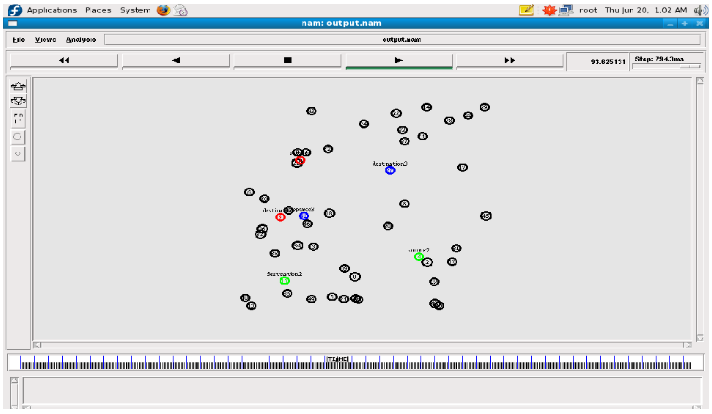

Fig.4. Formation of potential field

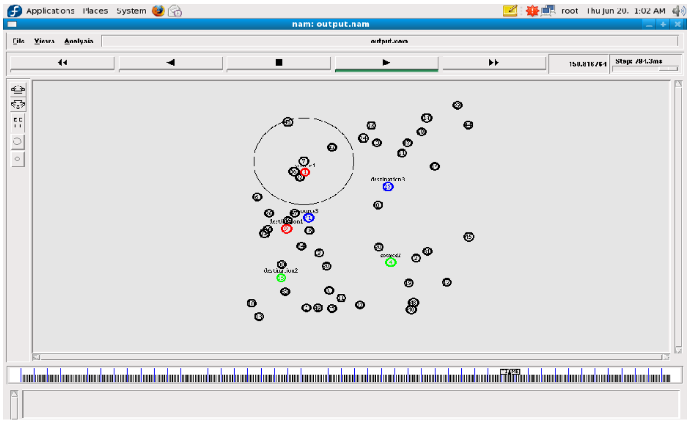

Fig.5. Perform dynamic routing

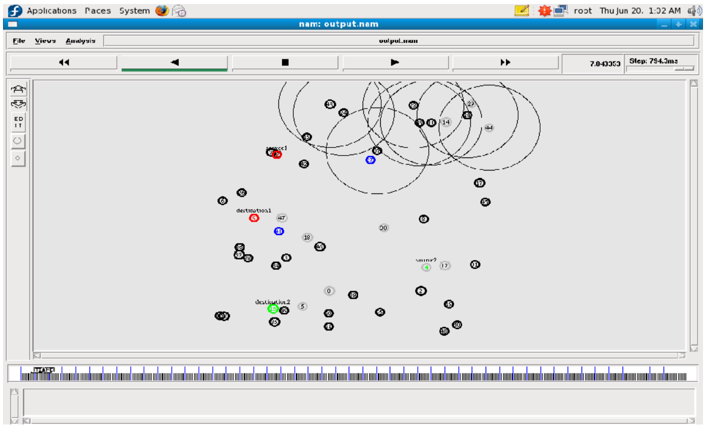

Fig.6. Result of data collection in different nodes

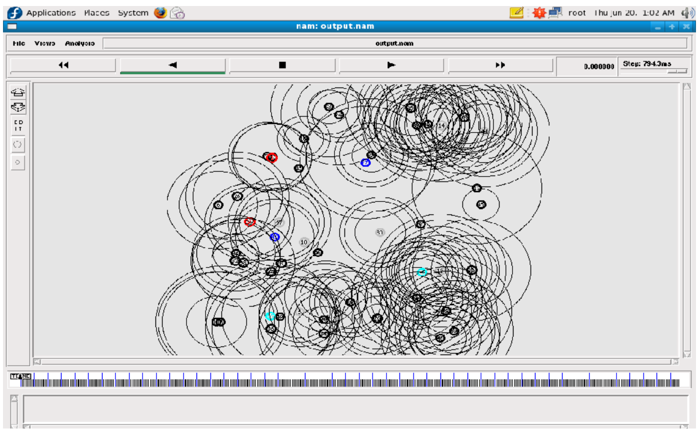

Fig.7. Scheduling the packets with data aggregation

4.1 PERFORMANCE METRICS

The design of sensor network is a challenge because many influencing factors such as fault tolerance, scalability, production cost, operating environment, network topology, hardware constraints, transmission media, power consumption and others have to be considered. The performance of the network is then measured based on quantifiable parameters called performance metrics.

4.1.1 LATENCY

Latency is defined as the delay involved in data transmission, routing and data aggregation. It can be measured as the time delay between the data packets received at the sink and the data generated at the source nodes.

4.1.2 ENERGY EFFICIENCY

The functionality of the sensor network should be extended as long as possible. In an ideal data aggregation scheme, each sensor should have expended the same amount of energy in each data gathering round. A data aggregation scheme is energy efficient if it maximizes the functionality of the network. If we assume that all sensors are equally important, we should minimize the energy consumption of each sensor. This idea is captured by the network lifetime which quantifies the energy efficiency of the network.

Fig 8 shows the performance of different approaches. Attribute Aware Data Aggregation(ADA) with Dynamic scheduling scheme performs better than the other approches.In this ADA scheme consumes only mimimum amount of energy by receiving minimum number of transmissions. Since the ADA scheme always attract the packets Since ADA always attracts the packets with the same attribute, the buffer in the node can receive the packets from application and finally provide the aggregated data to the sink along the shortest path.

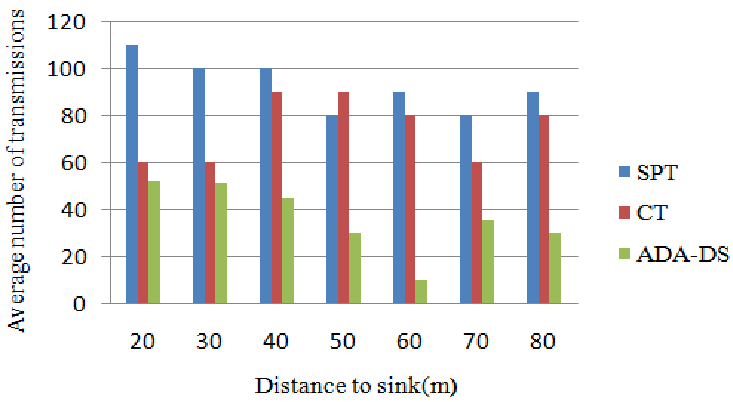

Fig. 8. Performance of different approaches

Latency is defined as the delay involved in data transmission, routing and data aggregation. It can be measured as the time delay between the data packets received at the sink and the data generated at the source nodes which are shown in figure 9.

Fig. 9. XGRAPH for Delay

5 CONCLUSION

The data aggregation is an effective mechanism to save limited energy in WSNs. Heterogeneous sensors and various applications likely run in the same network. To handle this heterogeneity, in this work, introduce the concept of ADA with Dynamic Scheduling which makes the packets with the same attribute as well as schedule the packets using buffer management. The buffer receive the important packets first based on the priority (i.e.) reward value. This scheme consumes less amount of energy by receiving minimum number of transmissions. The simulation experiments validate the effectiveness of our ADA with Dynamic Scheduling scheme and demonstrate that it also has some properties required by actual applications in WSNs, such as scalable with respect to network size and suitable for tracking mobile events and so on.

6 FUTURE WORK

Security is the major problem in wireless sensor network. Since there is more opportunity to hack the data because the aggregator node is compromised by attacker**.** To solve these problem packets from different sensor node were encrypted using encryption algorithms.

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