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Reducing Network Delay in an Energy Efficient Wireless Sensor Networks

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Abstract : *Millions of sensors are deployed to monitor the smart grid. They consume huge amounts of energy in the communication infrastructure. Therefore, the establishment of an energy-efficient protocol for sensor nodes is challenging and urgently needed. Recently the research focus on a promising routing scheme in wireless sensor networks (WSNs), is shifting towards duty-cycled WSNs in which sensors are sleep scheduled to reduce energy consumption. Energy-balanced clustering routing protocol based on task separation in wireless sensor networks. In this scheme, the network is firstly divided into clusters by using global information. And each of them has the same number of sensor nodes so as to balance the energy consumption of intra-cluster. Furthermore, task separation, the tasks of traditional single cluster head are separated and achieved by two cluster heads respectively, is proposed to reduce the traffic burden for single head. This protocol is mainly proposed for delay minimization and energy efficiency in wireless sensor networks (WSNs). In this protocol, the performance is measured by the network simulator-2. The simulation results are provided to demonstrate the increase the network efficiency in WSN.*
Keywords - *Quorum time slot adaptive condensing protocol, energy efficiency, Network delay Minimization, Mobile Sink, and Wireless Sensor Networks.*

I. Introduction

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor ne

twork node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding.

Routing

Multihop routing is a critical service required for WSN. Because of this, there has been a large amount of work on this topic. Internet and MANET routing techniques do not perform well in WSN. Internet routing assumes highly reliable wired connections so packet errors are rare; this is not true in WSN. Many MANET routing solutions depend on symmetric links (i.e., if node A can reliably reach node B, then B can reach A) between neighbors; this is too often not true for WSN. These differences have necessitated the invention and deployment of new solutions. For WSN, which are often deployed in an ad hoc fashion, routing typically begins with neighbor discovery. Nodes send rounds of messages (packets) and build local neighbor tables. These tables include the minimum information of each neighbor’s ID and location. This means that nodes must know their geographic location prior to neighbor discovery. Other typical information in these tables include nodes’ remaining energy, delay via that node, and an estimate of link quality. Once the tables exist, in most WSN routing algorithms messages are directed from a source location to a destination address based on geographic coordinates, not IDs. A typical routing algorithm that works like this is Geographic Forwarding (GF).

In GF, a node is aware of its location, and a message that it is “routing” contains the destination address. This node can then computes which neighbor node makes the most progress towards the destination by using the distance formula from geometry. It then forwards the message to this next hop. In variants of GF, a node could also take into account delays, reliability of the link and remaining energy. Another important routing paradigm for WSN is directed diffusion. This solution integrates routing, queries and data aggregation. Here a query is disseminated indicating an interest in data from remote nodes. A node with the appropriate requested data responds with an attribute-value pair. This attribute- value pair is drawn towards the requestor based on gradients, which are set up and updated during query dissemination and response. Along the path from the source to the destination, data can be aggregated to reduce communication costs. Data may also travel over multiple paths increasing the robustness of routing.

Node Localization

Node localization is the problem of determining the geographical location of each node in the system. Localization is one of the most fundamental and difficult problems that must be solved for WSN. Localization is a function of many parameters and requirements potentially making it very complex. For example, issues to consider include: the cost of extra localization hardware, do beacons (nodes which know their locations) exist and if so, how many and what are their communication ranges, what degree of location accuracy is required, is the system indoors/outdoors, is there line of sight among the nodes, is it a 2D or 3D localization problem, what is the energy budget (number of messages), how long should it take to localize, are clocks synchronized, does the system reside in hostile or friendly territory, what error assumptions are being made, and is the system subject to security attacks? For some combination of requirements and issues the problem is easily solved.

However, they do not require extra hardware on every node. Several early localization solutions include centroid and APIT. Each of these protocols solves the localization problem for a particular set of assumptions. Two recent and interesting solutions are Spot- light and Radio Interferometric Geolocation. Spotlight removes most of the localization code and overhead to a centralized laser device. Spotlight requires line of sight and clock synchronization. Radio interferometric geolocation uses a novel in-network processing technique that relies on nodes emitting radio waves simultaneously at slightly different frequencies. This solution is subject to multi-path problems in some deployments and can require many messages. Both of these recent solutions provide a high accuracy in the cm range.

Aim Of The Paper

The main aim of this paper is to improve energy efficiency for reducing network delay in wireless sensor network. This is achieved by task separation, where the tasks of traditional single cluster head is separated and achieved by two cluster heads respectively to reduce the traffic burden of single cluster head. The main objective is delay minimization and energy efficiency which is achieved by two geographic-distance based connected-k neighbourhood sleep scheduling algorithms. This paper combines geographic routing, handling of dead ends, MAC, awake-asleep scheduling and back-to-back data packet transmission for achieving an energy-efficient data gathering mechanism.

II. Literature Review

The recent availability of small, inexpensive low-power GPS receivers and techniques for finding relative coordinates based on signal strengths, and the need for the design of power efficient and scalable networks provided justification for applying position-based routing methods in ad hoc networks. A number of such algorithms were developed recently. This tutorial will concentrate on schemes that are loop-free, localized, and follow a single-path strategy, which are desirable characteristics for scalable routing protocols. Routing protocols have two modes: greedy mode (when the forwarding node is able to advance the message toward the destination) and recovery mode (applied until return to greedy mode is possible). We shall discuss them separately. Methods also differ in metrics used (hop count, power, cost, congestion, etc.), and in past traffic memorization at nodes (memory-less for memorizing past traffic). Salient properties to be emphasized in this review are guaranteed delivery, scalability, and robustness.

In the absence of location errors, geographic routing - using a combination of greedy forwarding and face routing - has been shown to work correctly and efficiently. The effects of location errors on geographic routing have not been studied before. In this work we provide a detailed analysis of the effects of location errors on the correctness and performance of geographic routing in static sensor networks. First, we perform a micro-level behavioral analysis to identify the possible protocol error scenarios and their conditions and bounds. Then, we present results from an extensive simulation study of GPSR and GHT to quantify the performance degradation due to location errors. Our results show that even small location errors (of 10% of the radio range or less) can in fact lead to incorrect (non-recoverable) geographic routing with noticeable performance degradation. We then introduce a simple modification for face routing that eliminates probable errors and leads to near perfect performance.

We propose a decentralized algorithm to calculate the control signals for lights in wireless sensor/actuator networks. This algorithm uses an appropriate step size in the iterative process used for quickly computing the control signals. We demonstrate the accuracy and efficiency of this approach compared with the penalty method by using Mote-based mesh sensor networks. The estimation error of the new approach is one-eighth as large as that of the penalty method with one-fifth of its computation time. In addition, we describe our sensor/actuator node for distributed lighting control based on the decentralized algorithm and demonstrate its practical efficacy.

This paper addresses an approach to estimating the location of a mobile node based on the range measurements of Cricket sensor network (CSN), where the coordinates of the mobile node are calculated via the method of trilateration. There are, in general, two kinds of obstacles to be tackled and overcome in CSN: One is noisy distance measurements, and the other is the low data rates of Cricket sensors. To overcome these problems, we propose a fusion prediction-based interacting multiple model (FPB-IMM) algorithm. The FPB-IMM algorithm utilizes multiple position measurements produced by trilateration and a self-tuning algorithm; it takes advantage of these multiple measurements to minimize the effect of noisy measurements and the low data rates by modifying a cycle of IMM with fusion prediction. The experimental results demonstrate that the proposed algorithm outperforms existing algorithms such as the Kalman filter and the conventional IMM.

III. System Analysis

EXISTING SYSTEM

For a data-gathering WSN, the network is generally disabled under the following two situations. One is that all the sensor nodes exhaust their energy and die. The other is that the base station can not receive any data in a data period due to the energy hole partitioning the network, even if there are still a large number of alive nodes in the outer region of the energy hole.

ISSUES OF EXISTING SYSTEM

- Create Energy hole problem
- Create Network Delay

PROPOSED SYSTEM

In this paper, we propose to improve Energy Efficiency for reducing network delay in Wireless Sensor Network. In this scheme, the network is firstly divided into clusters by using global information. And each of them has the same number of sensor nodes in order to balance the energy consumption of intra-cluster.

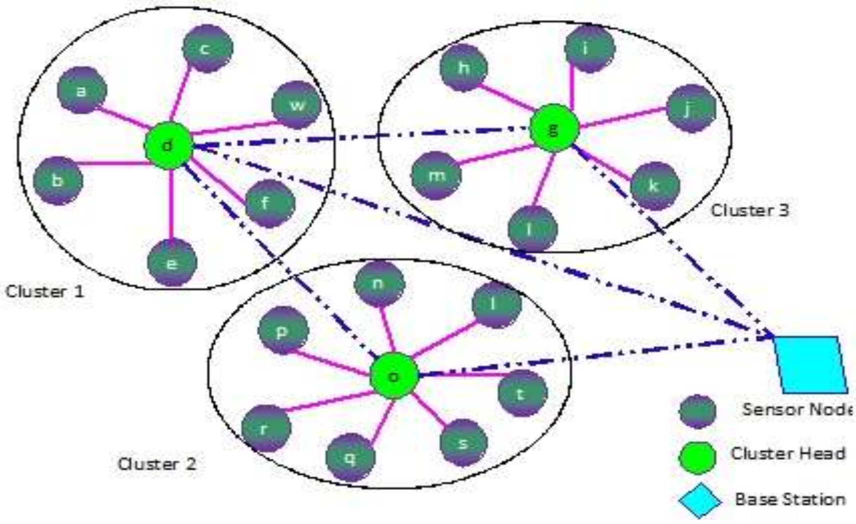

Fig 1. Architecture Diagram

In succession, task separation, the tasks of traditional single cluster head are separated and achieved by two cluster heads respectively, is proposed to reduce the traffic burden for single cluster head. Then, we explore an energy-efficient and reliable inter-cluster routing algorithm, which considers comprehensively three factors: residual energy, distance and available buffer space of nodes. Thus minimizes both the energy consumption and network delay in WSN.In this paper, we focus on two geographic-distance based connected-k neighborhood (GCKN) sleep scheduling algorithm- s. The first one is the geographic-distance based connected-k neighborhood for first path sleep scheduling algorithm. The second one is the geographic-distance based connected-k neighborhood for all paths sleep scheduling algorithm.

Advantages

- Reduce network Delay
- Avoid Energy hole problem and Improve network life time.

IV. Design And Implementation

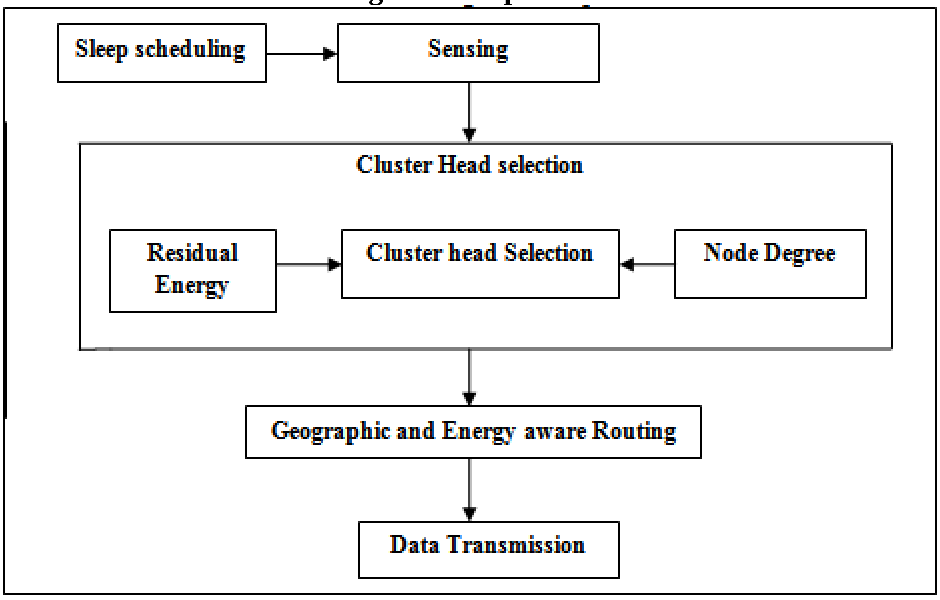

Fig 2. Block Diagram

CLUSTER FORMATION

The sensor nodes obtain their current location by using Global Positioning System (GPS). Cluster based routing in WSN has been investigated to realize the network scalability and maximizes the lifetime of the network. Clustering is defined as the process of choosing a set of Wireless Sensor Node to be cluster heads for a given WSNs. In this paper the sensor nodes are formed the clusters by node distance.

CLUSTER HEAD SELECTION

Selection of cluster head mostly affects WSNs. CHs occasionally collect aggregate and forward data to the base station. The electing cluster head based on the quality factor that is evaluate node degree and residual energy.

SLEEP SCHEDULING

Normal sensors can dynamically change states between asleep and awake. The basic mechanism for sleep scheduling is to select a subset of nodes to be awake in a given epoch while the remaining nodes are in the sleep state that minimizes power consumption, so that the overall energy consumption can be reduced.

GEOGRAPHIC AND ENERGY AWARE ROUTING

Recently geographic routing is an inviting approach in large scale WSNs because it does not require global topology of the WSNs. The basic idea of geographic routing is greedy routing. Specifically, each packet is tagged with the coordinates of its destination, all nodes know their own coordinates, and a node forwards the packet to its neighbor that is geographically closest to the destination.

A sensor node making routing resolution based on the geographic position of itself and its energy. The sensors forward the data to the neighbor, which is closest to the base station. This is reduces the average hop count and energy dead problem.

DATA TRANSMISSION

The data transmission stage contain 3 main activities that is

- Data gathering
- Data aggregation
- Data sending

At sensing period, all sensor nodes are send data to their cluster heads,which in turn receive the data from cluster members instead of the cluster heads check the redundant data and eliminate them. Finally combine the original data. The cluster heads transmit the aggregate data to the base station.

V. Simulation Analysis

THROUGHPUT

The fundamental goal of the application requirements is to maximize the throughput. Throughput is the rate at which information is sent through the network. The network lifetime can be defined as the time at which the first node death in the network occurs. The first node death in the network can seriously affect the connectivity and coverage of the network, such that the network cannot fully play its due role. Therefore, as in the network lifetime is defined in this paper as the time at which the first node death occurs. Suppose Ei is the energy consumption of node i. The maximization of the network lifetime can be expressed by the following formula:

$$Max\ (T) = \min \max_{0<i\leq n} E_i$$

…(1)

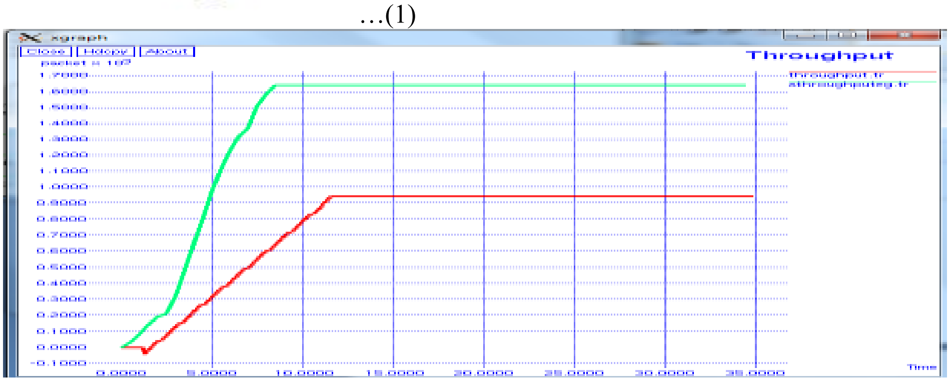

Fig 3. Throughput

DELAY

The delay, which is denoted by D, refers to the difference between the time at which the event report packet is generated and the time at which it is transferred to the sink. Denoting the delay of data that pass through the i th hop as d_i, the end-to-end delay minimization can be expressed as

$$Max\ (D) = \min \left(\sum_{i \in route} d_i \right)$$

…(2)

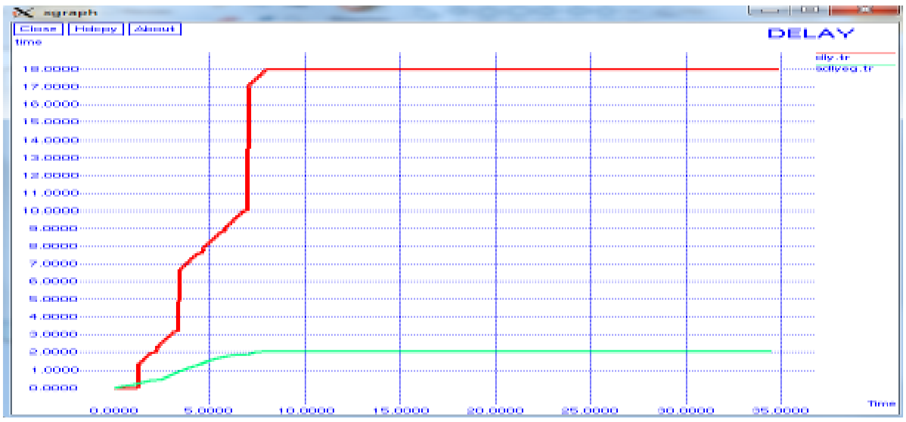

Fig 4. Delay

ENERGY RATIO

The efficient utilization of the network energy refers to the ratio of the utilized energy to the initial energy in the network at the time of network death. Maximization of the effective utilization of the network energy can be expressed by the following formula

$$Max\ (\eta) = \min\left(\frac{\sum_{i\in n} E^i_{left}}{\sum_{i\in n} E^i_{init}}\right) \quad \ldots(3)$$

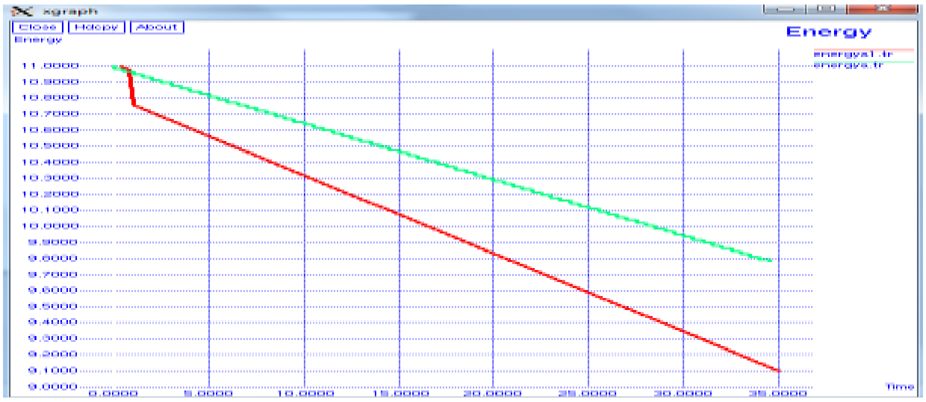

Fig 5. Energy Ratio

VI. Conclusion

In this paper, we propose to improve Energy Efficiency for reducing network delay in Wireless Sensor Network. In this scheme, the network is firstly divided into clusters by using global information. And each of them has the same number of sensor nodes in order to balance the energy consumption of intra-cluster. In succession, task separation, the tasks of traditional single cluster head are separated and achieved by two cluster heads respectively, is proposed to reduce the traffic burden for single cluster head. Then, we explore an energy-efficient and reliable inter-cluster routing algorithm, which considers comprehensively three factors: residual energy, distance and available buffer space of nodes. Thus minimizes both the energy consumption and network delay in WSN. Future work can be done on obtaining the test-bed results and scaling the network to a bigger one to analyze the performance of the same.

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