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ENERGY SAVING OPTIMIZATION ALGORITHM FOR NODE SELECTION IN WIRELESS SENSOR NETWORK

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Abstract-**In wireless sensor network, energy optimization plays an important role. For that purpose, routing protocols are designed to create an energy efficient network. Generally, sensors are powered by batteries. But these batteries have limited energy. It is well known that transmitting data consumes much more energy than collecting data. So, the aim of this project is to design an energy efficient protocol with long lifetime. Here, the opportunistic routing theory is considered as basic principle. Using that protocol, energy saving is based on the distance between the nodes and its residual energy. Particularly, Energy saving via opportunistic routing algorithm (ENS_OR) is used. Here, energy saving via opportunistic routing algorithm is used to choose efficient nodes between source and destination. Initially, a forward list is selected based on the nodes distance and energy. In that specifically, energy efficient node (EEN) is selected to do the transmission. These EEN nodes are near to the optimal distance. If any node fails to transmit the packet while transmission, a new node is selected to complete that transmission. So, using this algorithm more energy can be saved than other protocols.**

I.INTRODUCTION

A wireless sensor network is a self configuring network of small sensor nodes communicating among themselves using radio signals and deployed in quantity to sense, monitor and understand the physical world. Wireless sensor nodes are called motes. Wireless sensor network (WSN) are spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound , pressure, ect. and to cooperatively pass their data through the network to a main location. The more modern networks are bidirectional, also enabling control of sensor activity. The development of wireless sensor network was motivated by military applications such as battlefield surveillance; today such as networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. The wireless sensor network is built of nodes. These nodes may be a few hundreds or even thousands, where each node is connected to one or sometimes several sensors. Cross-layer is becoming an important studying area for wireless communications. Traditional layered approach cannot share different information among different layers, which leads to each layer not having complete information. The traditional layered approach cannot guarantee the optimization of the entire network.Each such sensor network node has typically several parts. They are 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 is used. A sensor node might vary in size from that of a shoebox down 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 are based on resources such as energy, memory, computational speed and communication 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. Applications of wsn are area monitoring, health care monitoring, environment/earth sensing, air pollution monitoring, forest fire detection, landslide detection, water quality monitoring, natural disaster prevention, chemical agent detection, structural health monitoring etc.

II.ENERGY SAVING SYSTEM

The advent of efficient wireless communications and advancement in electronics has enabled the development of low-power, low-cost, and multifunctional wireless sensor nodes that are characterized by miniaturization and

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integration. In WSNs, thousands of physically embedded sensor nodes are distributed in possibly harsh terrain and in most applications, it is impossible to replenish energy via replacing batteries. In order to cooperatively monitor physical or environmental conditions, the main task of sensor nodes is to collect and transmit data. It is well known that transmitting data consumes much more energy than collecting data. To improve the energy efficiency for transmitting data, most of the existing energy-efficient routing protocols attempt to find the minimum energy path between a source and a sink to achieve optimalenergy consumption.. This system uses an energy-efficient routing algorithm for above 1-D queue network, namely, Energy Saving[15] via Opportunistic Routing (ENS_OR). ENS_OR adopts a new concept called energy equivalent node (EEN), which selecting relay nodes based on opportunistic routing theory, to virtually derive the optimal transmission distance for energy saving and maximizing the lifetime of whole network. Since sensor nodes are usually static, each sensor's unique information, such as the distance of the sensor node to the sink and the residual energy of each 1 transmission distance and residual energy level. Nodes in this forwarder set that node, are crucial to determine the optimal transmission distance; thus, it is necessary to consider these factors together for opportunistic routing decision. ENS_OR selects a forwarder set and prioritizes nodes in it, according to their virtual optimal transmission distance and residual energy level. Nodes in this forwarder set that are closer to EENs and have more residual energy than the sender can be selected as forwarder candidates. Our scheme is targeted for relatively dense 1-D queue networks, and can improve the energy efficiency and prolong the lifetime of the network.

A. Contribution of ENS-OR

The main contributions of this paper include the following.

1) Calculate the optimal transmission distance between the nodes in the network and further modify the value based on the real conditions.

2) Then define the concept of EEN to conduct energy optimal strategy at the position based on the optimal transmission distance.

3) Choose the forwarder list based on the distances to EEN and the residual energy of each node into EEN is important for the selection of relay nodes.

4) Then propose ENS_OR algorithm to reduces the energy usage and increase the network lifetime.

B. Control Network

Consider a multi hop WSN in a 1-D queue model as shown in Figure 1 assume that the scheme is targeted for relatively dense network, i.e., each relay node has plenty of neighboring nodes. Nodes have some knowledge of the location information of their direct neighboring nodes and the position of the source node and the sink node.

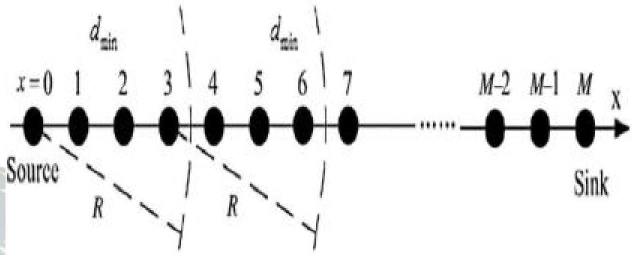

Figure 1: Queuing model of relay with maximal transmission range of R and minimal transmission range

Every wireless sensor node has fixed maximum transmission range R and minimal transmission range dmin. The 1-D queue network is then constructed by a connected graph G = (V, E), where V is a set of sensor nodes aligned on a single line and E is a set of directed links between communication nodes. Then, the indices are set as {0, 1, 2, . . . , h, n, . . .,M − 1,M} from left to right, and two specific nodes with index 0 and index M among them as the source node and the sink node. Let N (h) represents as the neighbor set of a node h. Each directed link (h, n) has a nonnegative weigh w (h, n), which denotes the total energy dissipation in transmission and receiving required by node h to its neighboring node n.

1) Energy Model

The energy model refers to a simplified power model of radio communication as it is used. The energy consumption can be expressed as follows:

$$E_T = (E_{elec} + \varepsilon_{amp} d^{\tau})B \qquad (1)$$

Where,E_{elec} is the basic energy consumption of sensor board to run the transmitter or receiver circuitry, and ε_{amp} is its energy dissipated in the transmit amplifier. dis the distance between transmitter and receiver, τ is the channel path-loss exponent of the antenna, which is affected by radio frequency(RF) environment and satisfies $2 \leq \tau \leq 4$. $E_T$denotes the energy consumption to transmit a B-bit message in a distance d. On the other hand, the energy consumption of receiver $E_R$can be calculated as follows:

$$E_R = E_{elec}B \qquad (2)$$

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In this model, since the noise and environmental factor are constant, only the transmitter can adjust its transmission power to make ET reach a minimum value.

C. Optimal Transmission Scheme

In this section, energy consumption analysis is conducted on the proposed 1-D model, where data are delivered to sink node through hop-by-hop connected relay nodes. Objective of this section is to design an energy-efficient opportunistic routing strategy for each relay node that ensures minimum power cost and protects the nodes with relatively low residual energy.

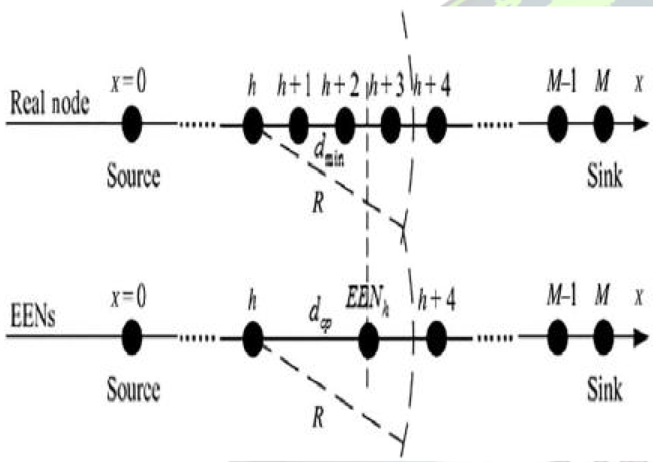

Figure 2: Real nodes and EEN in 1-D queue model.

corresponding optimal transmission distance d_{op} for node h is given by

$$d_{op} = \{(2E_{elec})/[(\tau - 1)\varepsilon_{amp}]\}^{1/\tau}$$

$$d_{min} < dop \leq R.$$

However, the distance between optimal next relay node to source node could not actually equal[8] to d_{op}. To solve the problem, further usethe EEN to select the optimal next relay nodes. In figure 2 real nodes and EEN nodes are placed. This shows how EEN reduces the number of real nodes in the system. $d_{min}$is known as a minimum distance between the nodes.d_{op} isa optimal distance between the nodes. Optimal distance means that is less than the radiation range of the node and greater than the minimum distance. It is more useful for data transmission.

D. Opportunistic Routing Algorithm

In this section further analyze the energy consumption of large-scale network under 1-D model.

1) Optimal Energy Strategy

In order to acquire the minimum energy consumption during data transmission in whole network, it introduces the concept of EEN to conduct energy optimal strategy at the position based on the optimal transmission distance dop. However, the optimal energy strategy does not explicitly take care of the residual energy of relay nodes in the network. For instance, in the case of hop-by-hop transmissions toward the sink node, the relay nodes lying closer to the EENs tend to deplete their energy faster than the others, since dop is a constant. As a consequence, this uneven energy depletion dramatically reduces the network lifetime and quickly exhausts the energy of these relay nodes. Furthermore, such imbalance of energy consumption eventually results in a network partition, although there may be still significant amounts of energy left at the nodes farther away. Therefore, it should readdress the optimal energy strategy for large-scale network. Inspired from the opportunity routing approach, EEN is formed by jointly considering the distribution of real nodes and their relay priority.

2) Selection of forwarding set

The energy consumption function is convex with respect to the number of hops n. this is used to achieve optimal energy strategy by choosing optimal hops n_{op} to determine optimal transmission distance d_{op}. In addition, factors such as energy-balanced of a network and the residual energy of nodes are also considered while selecting the available next-hop forwarder. Assume that , the node h is sending a data packet to sink, and h + i is one of neighbors of node h. If it is closer to the estimated result and has more residual energy, the neighboring node h + i can be a forwarding candidate, then the network can obtain better energy usage. Moreover, these eligible candidates rank themselves according to their distances from the EEN and the residual energy of each node as,

$$P(h+i) = \begin{cases} 2(d_{h+i} - d_h)\left[\frac{1}{|d_{h+i} - d_{op}|} + E_{h+i} - \varsigma\right] \\ (h+i) \epsilon F(h), \quad -R \leq i \leq R \end{cases} \tag{3}$$

Where,$d_{h+i} - d_h$is the distance between node h and neighbor node h + i, E_{h+i}denotes the residual energy of node h + i, and ζ denotes the value of energy threshold. F(h) is the selected forwarding candidate set of node h. The larger the value of P(h + i) is, the higher priority of the node will be in the network. Only the forwarder candidate with the highest priority is selected as the next forwarder. This use above forwarding candidate set to decide corresponding energy saving[15] strategy, which is specifically achieved through the following opportunistic routing algorithm, called ENS_OR.

3) ENS_OR Algorithm

This algorithm shows how to select and prioritize the forwarder set priority order.priority based on optimal energy strategy on each node. In addition, the transmitted data can be naturally classified into two categories: 1) the former is the collected data of its own; and 2) the latter is the relay data from other nodes. Obviously, it should distinguish incoming data that the data of second category by tracing the ID of sender. Eventually, this introduce ENS_OR algorithm [8] for energy saving to select the next relay node which has the highest priority in forwarder set to forward the incoming ENS_OR algorithm.

III.RESULTS AND CONCLUSION

This simulation test is used to evaluate the real time performance of ENS-OR network in NS version 2. NS version 2 is an object-oriented, discrete event driven network simulator developed at UC Berkely written in C++ and OTcl. NS is primarily useful for simulating local and wide area networks. Although NS is airly easy to get the simulation output. Here the program is written inOTcl language. OTcl means Tool command language with Object-oriented.Initially, nodes are created in the network. Source and destination arementioned by using the program. Then the node sent the hello packet to each other nodes. Those nodes sent the acknowledgement to the requested nodes. This action is used to calculate the distance between the nodes in the network. In the next step, forward list is created by using the minimum distance between the source and destination path. Distances between these nodes are calculated by using the strength of the returned signal. Then the energy equivalent node can be calculated by using the optimal distance and residual energy of the node. These nodes are selected from the forward list nodes. By using this EEN node signal transmission is done for an energy efficient packet transmission. If any node is repaired during signal transmission then other efficient node will be selected during the run time of the network. So it reduces the signal loss and then it saves more energy. Here graphs are plotted to show the values of the parameters like delay, throughput and packet loss in figure 3. Initially delay is high because of the hello packet. This packet sent to all nodes. So delay is larger in the beginning. Then the delay is reduced because it is a hop by hop transmission. This is shown in the following graph. These graphs are getting from the NS2 simulator with respect to the program values.

Figure 3: Graph between time vs. delay

Figure 4 represent the measure of throughput. Throughput is an information technology term that describes how many unit of information are processed in a given time. In the graph the throughput values are higher in the starting stage. Then it shows the low value in the period of node damage in the network. After that throughput values are increased.

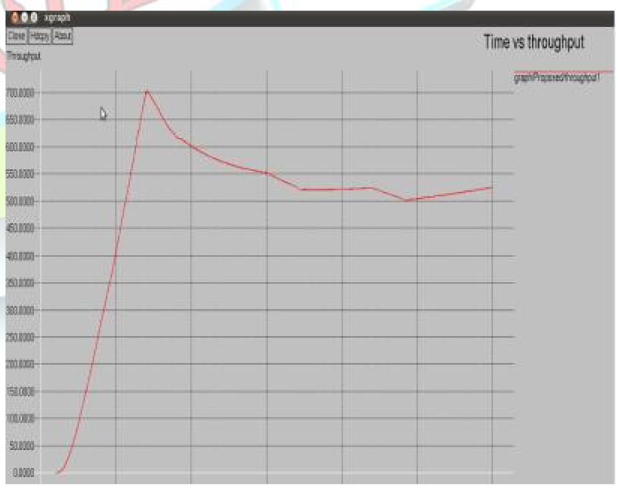

Figure 4: Graph for throughput

The following graph is used to find the packet loss in Figure 5. In the initial stage, it will be more to mention the hello packet loss. Then the network has very low packet loss.

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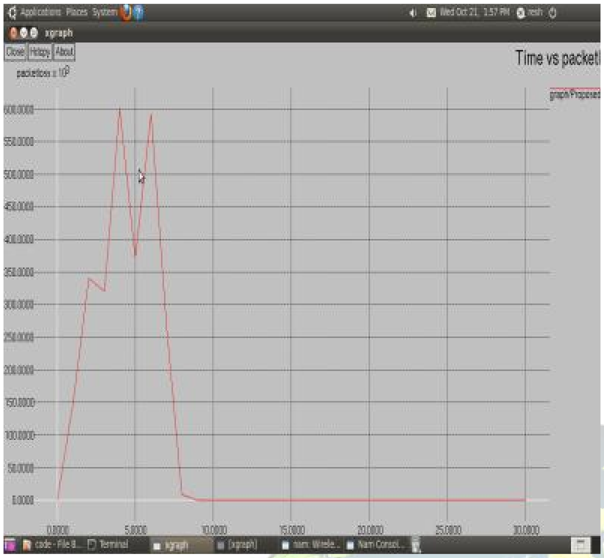

Figure 5: Time vs. packet loss graph

This project is used to focus on minimizing energy consumption and maximizing network lifetime of multi path network where sensors locations are predetermined and unchangeable. For this matter, knowledge from opportunistic routing theory to optimize the network energy efficiency is borrowed. By considering the differences among sensor nodes in terms of both their distance to sink and residual energy of each other. Here, the implementation of an opportunistic routing theory is used to virtually realize the relay node when actual relay nodes are predetermined which cannot be moved to the place according to the optimal transmission distance. This will prolong the lifetime of the network. Hence, an energy-efficient opportunistic routing strategy is design to ensure minimum power is cost and protects the nodes with relatively low residual energy. Numerous simulation results and real test bed results show that the proposed solution ENS_OR makes significant improvements in energy saving and network partition as other existing routing algorithms. In future energy saving will increase by using the extension of algorithm with sleep node in the network.

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