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SHDRP: Energy Effective Self Organized Hierarchical Dynamic Routing Protocol in Wireless Sensor Network

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Abstract—Wireless sensor network (WSN) is a system composed of a large number of micro-sensors nodes. This network is used to collect, compute and communicate the data to a base station (BS). Energy is the major constraint of sensor networks. So it's necessary to have which means energy efficient routing protocol should be employed to offer a long-life work time. To achieve the aim, we need not only to minimize total energy consumption but also to balance the load in the network. Researchers have proposed many protocols such as LEACH, BCDCP, ELCH, and GSTEB. In this paper, we propose a Self-Organized Hierarchical Dynamic Routing Protocol (SHDRP) which builds a routing tree using a process where, for each round, BS assigns a coordinator and broadcasts this selection to all sensor nodes. Subsequently, each node selects its intermediate head by considering only itself and its neighbors' information, thus making SHDRP a dynamic protocol. Simulation results show that SHDRP has a better performance than other protocols in balancing energy consumption, thus prolonging the lifetime of WSN.

*Index Terms— N*etwork lifetime, dynamic routing, self-organized, wireless sensor network.

I. INTRODUCTION

A main task of WSN is to periodically collect information of the interested area and transmit the information to BS. A simple approach to fulfilling this task is that each sensor node transmits data directly to BS. However, when BS is located far away from the target area, the sensor nodes will die quickly due to much energy consumption. On the other hand, since the distances between each node and BS are different, direct transmission leads to unbalanced energy consumption. To solve these problems, many protocols have been proposed. Of the protocols proposed, hierarchical protocols such as LEACH, BCDCP, ELCH and GSTEB can achieve satisfactory solutions.

Energy consumption of a node is based on operations. The operations include transmitting or receiving data messages, and processing requests. On the other hand, the energy consumption is due to the operation of constructing routing tree, overhearing, retransmitting

because of harsh environment, dealing with redundant broadcast overhead messages, and idle listening to the media.In this paper, we propose a Self-Organized Hierarchical Dynamic Routing Protocol (SHDRP). We consider a situation in which the network collects information periodically where each node continually senses the environment and sends the data back to BS.

II. Existing System

In LEACH, for the entire network, nodes selected according to a fraction p from all sensor nodes are chosen to serve as cluster heads (CHs), where p is a design parameter. The operations of LEACH are divided into several rounds. Each round includes a setup phase and a steady-state phase. During the setup phase, each node will decide whether to become a CH or not according to a predefined criterion. After CHs are chosen, each of other nodes will select its own CH and join the cluster according to the power of many received broadcast messages. Each node will choose the nearest CH.During the steady-state phase, CHs fuse the data received from their cluster members and send the fused data to BS by single-hop communication. LEACH uses randomization to rotate CHs for each round in order to evenly distribute the energy consumption. So LEACH can reduce the amount of data directly transmitted to BS and balance WSN load, thus achieving a factor of 8 times improvement compared with direct transmission.

In BCDCP is an improvement of LEACH on the manner of CH choosing. In each round, BCDCP selects CHs according to the residual energy of each node and a secondary parameter such as nodes proximity to their neighbours or nodes degrees. By iterations and competition, BCDCP ensures only one CH within a certain range, so uniform CHs distribution is achieved across the network. Compared with LEACH, BCDCP effectively prolongs network lifetime and is suitable for situations such as where each node has different initial energy.ELCH forms several clusters in the same way as LEACH, and each cluster has a cluster-head (CH). The nodes within a cluster construct a routing tree where the cluster-head is the root of it. For tree configuration, the cluster-head uses the distance information between the member nodes and itself. Each node is location-aware, it can estimate the distance between the root and itself. Every cluster is divided into some levels. The distance of a node to the root is the basis for determining its level in the cluster. Data transfer simultaneously happens between the nodes in two neighbouring levels, and each node fuses the received data and transmits it to its parent.

ELCH is an excellent protocol in which each node records the information of its neighbours and builds topography through computing, which is similar to SHDPR. But some

cluster-heads in the network consume more energy than other nodes when BS is located far away.GSTEB is a tree-based routing protocol that makes all the nodes form a minimum spanning tree, which costs minimum energy for data transmitting. It also has another version called GSTEB which slightly increases energy for data transmitting but balances energy consumption per node. However GSTEB are protocols that need BS to build the topography which will cause a large amount of energy waste. This is because if the network needs BS to build the topography, BS should send a lot of information to the sensor nodes, including what time is the Time Division Multiple Access (TDMA) slot, who are their leaf nodes and who are their intermediate nodes. This kind of information exchanging will cause a lot of energy to be wasted or will cause a long delay.

In this work, we assume that the system model has the following properties: The sensor nodes are randomly distributed in the square field and there is only one BS deployed far away from the area. Sensor nodes are stationary and energy constrained. Once deployed, they will keep operating until their energy is exhausted. BS is stationary, but BS is not energy constrained. All sensor nodes have power control capabilities; each node can change the power level and communicate with BS directly. Sensor nodes are location-aware. A sensor node can get its location information through other mechanisms such as GPS or position algorithms. Each node has its unique identifier (ID).

In this model, the energy dissipation of the radio caused by running the transmitter or receiver circuitry equals E_{elec} = 50 nJ/bit and the energy dissipation of the radio caused by running the transmit amplifier equals ϵ_{amp} = 100 pJ/bit/m^2. It is also assumed that $a\ r^2$ path loss due to free-space propagation model is used. The energy consumption of transmitting a k-bit packet to a distance d and receiving that packet is:

Transmitting : $E_{Tx}(k, \mathbf{d}) = E_{elec} \times k + \epsilon_{amp} \times k \times d^2$

Receiving :$E_{Rx}(k) = E_{elec} X\ k$

IV. Proposed System

Energy Effective Self Organized Hierarchical Dynamic Routing Protocol

The main aim of SHDRP is to achieve a longer network lifetime for different applications. In each round, BS assigns a root node and broadcasts its ID and its coordinates to all sensor nodes. Then the network computes the path either by transmitting the path information from BS to sensor nodes or by having the same tree structure being dynamically and individually built by each node. For both cases, SHDRP can change the root and reconstruct the routing tree with short delay and low energy consumption.

The operation of SHDRP is divided into Hierarchical Constructing Phase, Self-Organized Data Collecting and Transmitting Phase.

Hierarchical Construction Phase

Within each round, GSTEB performs the following steps to build a routing tree.
BS assigns a node as root and broadcasts coordinator ID and coordinator to all sensor node in the network. Each node select intermediate node based on the energy level and Communicates to the base station through coordinator . Here intermediate node selection

will be communicated to all the other nodes in the network.

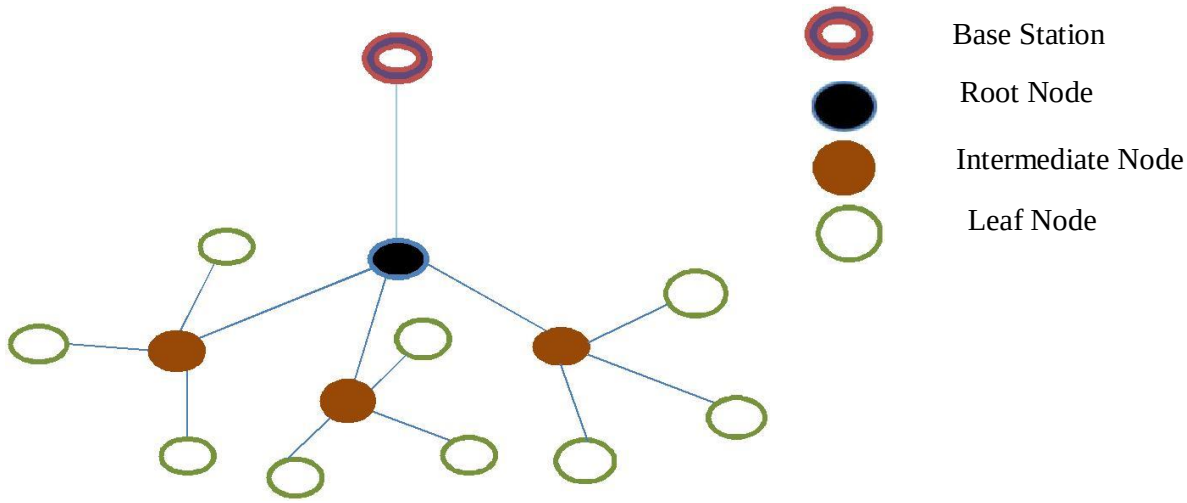

Figure.1: Topological representation of SHDPR

A. Self-Organized Data Collecting Phase:

After the routing tree is constructed, each sensor node collects information to generate a data which needs to be transmitted to BS. TDMA and DSSS (Direct Sequence Spread Spectrum) are both applied. This phase is divided into several TDMA time slots. In a time slot, only the leaf nodes try to send their data to intermediate node. After a node receives all the data from its leaf nodes, this node itself serves as a leaf node and tries to send the fused data in the next time slot. Each node knows their intermediate node. In each time slot, in order to reduce communication interference, we apply DSSS in which each leaf node communicates with its intermediate node using the DSS sequence determined by its intermediate node ID. Based upon the residual energy and energy level, intermediate node and the coordinator changes dynamically. The nodes organized themselves as intermediate node and coordinator based on the energy level and data are collected in each and every level.

B. Transmission Phase:

After self-organized data collection phase data transmission takes place. Each nodes communicate with their intermediate nodes and intermediate node is communicates with the coordinator. i.e. the data packet send form leaf node to intermediate through TDMA schedule and intermediate node send the correlated data to coordinator using DSSS. Finally coordinator sends the aggregated data to the station.

V Comparative Analysis and Simulation Results

The simulation model of SHDPR is done to evaluate the performance. We compare GSTEB with SHDPR and use the same network model as GSTEB. We generate a randomly distributed 100 to 200 nodes network of square area **50**m x 50 m with BS located at 50 m, 120 m. We let each node have 1J initial energy. As seen, the routing tree generated by SHDPR is better. We use a threshold value for node to act as intermediates. If the threshold value is more than the average then the node will act as intermediate node. In SHDPR, we employed dynamic coordinator that helps to transmit the data to the base station. We can find that SHDRP performs much better than GSTEB

To compare GSTEB with TBC, we use the same parameters as TBC as shown in [17]. BS is located at (50 m, 120 m) and the length of a data is 4000 bits. We compare the performance of GSTEB with the existing simulation results of TBC.

VI. Conclusion

In this work, we introduce SHDPR. Two definitions of network lifetime and two extreme cases of data fusion are proposed.The simulations show that when the data collected by sensors is strongly correlative, SHDPR outperforms LEACH, BCDCP, ELCH and GSTEB. Because SHDPR is a self-or-ganized dynamic protocol, it only consumes a small amount of energy in each round to change the topography for the purpose of energy balancing. All the leaf nodes can transmit data in the same TDMA time slot so that the transmitting delay is short.In some cases, we are more interested in the lifetime of the last node in the network. Some slight changes are made to make the performance of SHDPR similar to that of GSTEB. So GSTEB is nearly the optimal solution. Simulation results show that when lifetime is defined as the time from the start of the network operation to the death of the first node in the network, SHDPR prolongs the lifetime of the network compared with GSTEB.

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