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Energy Efficient Routing Protocol in Wireless Sensor Networks

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ABSTRACT

Wireless Sensor Network (WSN) consists of several sensor nodes which continuously monitor or sensing its environmental or physical condition and agreeably sends the sensing information to the Base Station or Sink. WSNs are application-specific, where the design requirements of WSNs change according to the application. Hence, routing protocol requirements are changed from one application to another. WSN is mainly used to send the critical messages, many protocols have been proposed to increase network lifetime. A new protocol called Fair Efficient Location-based Gossiping (FELGossiping) to address the problems of Gossiping and its extensions are proposed. FELGossiping consists of three phases: Initialization, Information Gathering and Routing. It shows how our approach increases the network energy and as a result maximizes the network life time. Saving the nodes energy leads to an increase in the node life in the network.

Keywords: Wireless Sensor Network, Gossiping, Routing Algorithm, Fair Energy Consumption

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I. INTRODUCTION

Wireless Sensor Networks consist of tiny sensor nodes that, in turn, consist of sensors (temperature, light, humidity, radiation, etc.), microprocessor, memory, transceivers, and power supply. In order to realize the existing and potential application for WSNs, advanced and extremely efficient communication protocols are required. WSNs are application-specific, where the design requirements of WSNs change according to the application. Hence, routing protocol requirements are changed from one application to another. For instance, the requirements of routing protocols designed for environ-mental applications are different in many aspects from those designed for military or health applications. However, routing protocols for all Wireless Sensor net-works, regardless of the application, must try to maximize the network life time and minimize the overall energy consumption in the network. Network lifetimeis a critical concern in the design of WSNs. In many applications, replacing or recharging sensors is some-times impossible. Therefore, many protocols have been proposed to increase network lifetime. It is difficultto analyze network lifetime because it depends on many factors, like network architecture and protocols, data collection initiation, lifetime definition, channel characteristics, and the energy consumption model. For all routing protocols, energy consumption during communication is a major energy depletion parameter; the number of transmissions must be reduced as much as possible to achieve extended battery life. For these reasons, the energy consumption parameter is a top priority.

In this article, we propose a new routing protocol based on Gossiping called Fair Efficient Location-based Gossiping(FELGossiping) to improve the problems of Gossiping andits extensions. FELGossiping consists of three phases: Initialization, Information Gathering and Routing. In the first phase, each node generates the gradient to the sink. In the second phase, the FEL Gossiping sends a request message to the other nodes to receive the information of other members or neighboring nodes. Once the hop count and the remainder energy of the member nodes are known, FELGossiping chooses two nodes in the third phase. The nodes are chosen near to the base station, according to the hop count of the selected nodes with the sink node, in order to deliver thepacket to the sink. After selecting two nodes, the protocol only chooses one of the two nodes to send the packet. The node with more residual energy is selected, and the message is sent to the selected node to broadcast the packet to the base station. Finally, we present some optimal strategies and through simulation results show that the optimal routing strategies provide a significant benefit.

II. NEW ALGORITHM

With some changes to the Gossiping protocol we can decrease the energy consumption and also increase the network lifetime. Therefore, in order to resolve the draw-backs of the Gossiping protocol, we have proposed a new protocol as an extension for Gossiping. In this protocol we have increased the network lifetime by selecting a node with a maximum residual energy and lower distance to the sink. We have also achieved a high packet delivery ratio and reduced the delay in delivering the packet.

The new algorithm consists of three phases: Network Initialization Phase, Information Gathering Phase and Routing Phase. In this section we explain three parts of the algorithm as follows.

Network Initialization Phase

The network initialization phase starts after the sensor nodes are randomly distributed in the application area. In the beginning, the base station broadcasts a “HELLO” message to its neighbors. The HELLO message contains: the Base Station Address (fixed) and Hop Count (variable). The hop count is used to setup the gradient to the base station, which means it shows the node distance to the base station. After broadcasting the HELLO message, all 1 -hop neighbors will receive this message and get the base station address and the hop count. Each node saves the hop count in its memory and increases the hop count by 1. The new hop count is then replaced with the old one. After each node has received the HELLO message it will continue to broadcast this message to farther nodes. As shown in Figure 1, at each stage the hop count will be incremented by 1.

When a node receives a HELLO message it will check whether it already has a gradient. If it has a gradient, it will compare it to the hop count of its own message and will replace its hop count with the message’s hop count if the latter is smaller, and will add 1 to the hop count prior to broadcasting it. However, if its hop count is smaller than or equal to the hop count of the message, it will discard the message. This case occurs due the message has broadcasted previously through different routes. As a result, the gradient will keep the best route. Finally, the process will continue until all the sensors receive the HELLO message, at that time the network initialization phase will be completed. Now each node through the gradient knows its distance to the base station. Figure 1 show how the HELLO message is broadcastthrough the network. In Figure 1(a) 1-hop neighbor to the Base Station will store the hop count in its memory and start constructing the gradient. Each node increments the message hop count by 1 and broadcasts the message with the new hop count (at this time is has become 2). In Figure 1(b) we can see that the HELLO message hasreached 1-hop neighbors; two of them become broad-casting nodes which in turn continue broadcasting the message. Then the neighbors of the broadcasting node receive the message and compare the hop count of the message with their own. If it is smaller than its hop count, they will discard the message as shown in the Figure 1. The process will continue until completing the initialization phase as shown in Figure 1(c).

Information Gathering Phase

After detecting the event the source node will draw a transmission radius of 40 m to deal with the nearby nodes.
All sensors have GPS and can move to any position within their mobility range. The source node then gene-rates the request message to acquire the information from the neighboring nodes in its transmission radius. The request message is contained in the hop count of the neighboring node to the sink, or the distance of nodes from the sink and the residual energy of all nodes. After that, the nodes that received the request message send their information to the source node or to the node that detected the event.

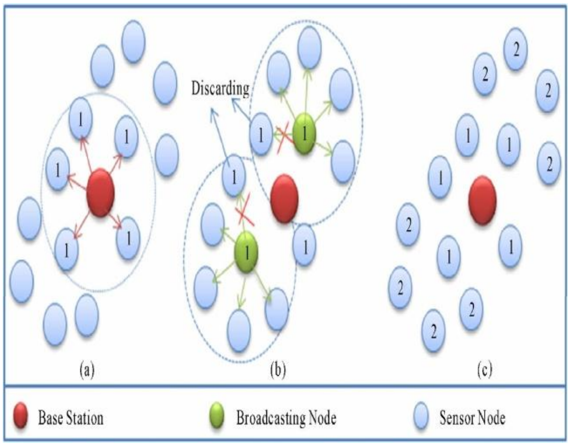


Figure 1. Network initialization phase

Routing Phase

After the network request phase finishes, the routing phase will start. Following we state some assumptions:

- At the start all nodes are full of energy and have the same amount of energy.
- Each node knows its remaining energy at any stage of its life.
- Each node has a transmission radius of 40 m.

After this, the receiving neighbor replies to this request by using its residual energy and hop count. Next, the source chooses within its transmission radius two neighboring nodes that have the minimum hop count towards the sink. Figure 2 shows the selection of valid nodes in a defined radius. The hop count of one node will be a unit lower than the other node, or equivalent. After choosing two nodes near the sink, we compare between these two nodes according to the residual energy of the two nodes. Figure 3 shows this operation clearly among two selected nodes, we select the nodes that had the most residual energy and we ignore the maximum hop count of the two nodes. If two nodes have the same residual energy we take the nodes that have a lower hop count to the sink. After that the source node sends the packet to the selected node. Upon receiving the message the node repeats the information gathering phase and routing phase processing to transmit the message to another node. Figure 4 shows the routing operation. The process continues until the message reaches the sink or the TTL is finished. The sent packet is including message and packet header.

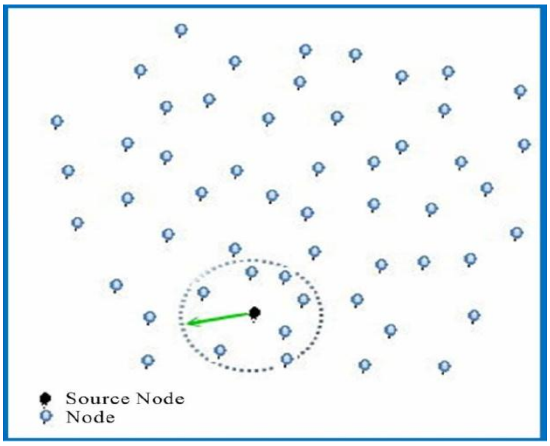


Figure 2.Source node outlining its transmission radius.

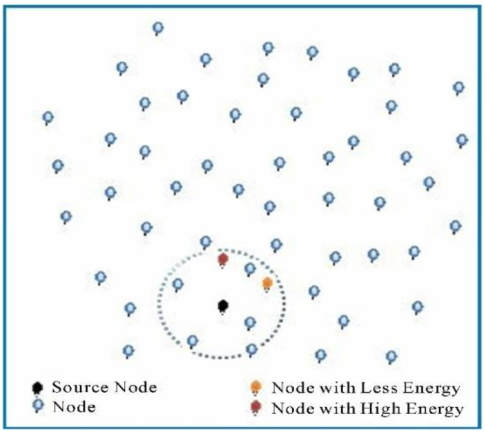


Figure 3. Source node within its transmission radius selecting two nodes

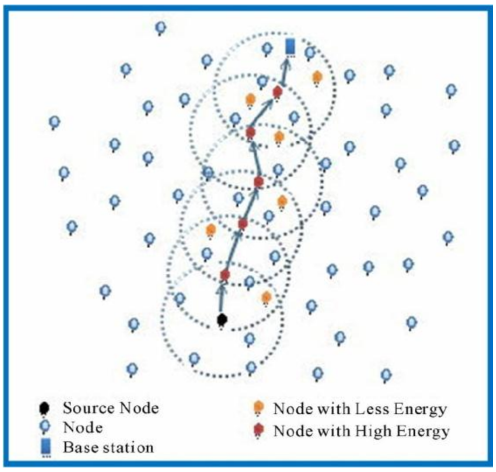


Figure 4.Routing Phase

III. PERFORMANCE EVALUATION

We assume some the parameters to implement the simulation results:

Radius

The radius of coverage of the sensors is 40 m. Any sensor that detects the event draws the transmission radius to limit the number of nodes in its transmission range.

Residual Energy

It shows the amount of energy remaining. Assume that in the beginning the energy of all nodes is same.

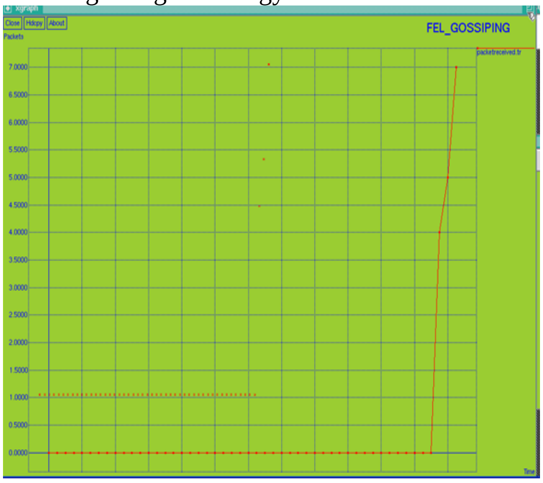


Figure 5.Packet Received

Location of sensor

All sensors have GPS or other location devices and can move to any position (with known coordinates) within their mobility range. It can be shown that the proposed FELGossiping routing protocol performs better when compared to the other routing protocols. The performance of the proposed protocol by comparing packet loss, delay, live node and total energy saving per round.

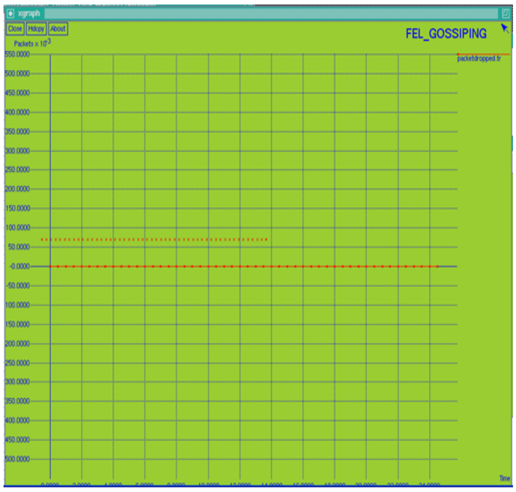
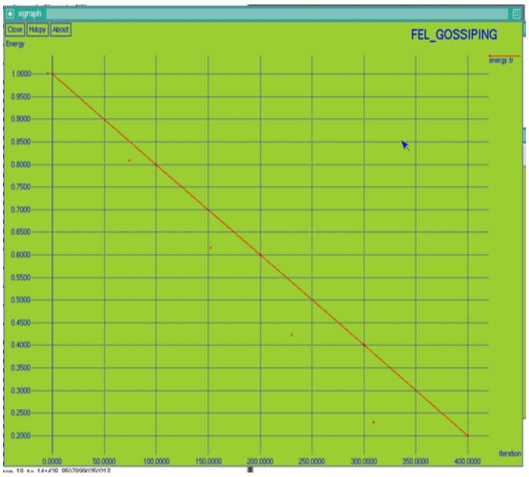


Figure 6. Packet Loss

Energy Consumption

In proposed protocol there lay nodes are not selected blindly (without knowing their residual energy) as is done in the other routing protocols in this comparison. Moreover, energy reduction for each node occurs for every transmission or reception made. Hence, the probability of choosing the same node as the next hop is reduced. Thereby, the energy has been balanced and fairly used. All this leads to saving energy and hence prolonging the overall network lifetime compared to the other protocols.



Figuere 7. Energy Consumption

IV. CONCLUSION

Wireless Sensor Networks are powered by the limited capacity of batteries. Due to the power management activities of these sensor nodes, the network topology changes dynamically. These essential properties pose additional challenges to communication protocols. In this work the operation of a Gossiping routing protocol with safe energy consumption, and discussed the factors of energy optimization are studied. By carefully attending to the Gossiping protocol find that by altering the ways in which we choose the next hop, the network life- time can be extended.As a result, in proposed protocol; firstly have extended the network lifetime through fair use of the energy by selecting nodes with the maximum residual energy and lowest distance to the sink. Secondly, information gathering achieved a high packet delivery ratio (number of non-reaching nodes has been reduced) and reduced the delay in delivering the packet. Thirdly, routing reduced the message overheads and the energy consumed by the nodes that have already tried to send the data to the base station by sending an acknowledgement message of the successful reception of the packet.

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