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A Study on the Improvement of Flat-based Routing Protocol in Sensor Network

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ABSTRACT

This paper describes the contents about the efficient routing technique for improvement of transmission in Wireless Sensor Networks. Existing flat-based routing protocols have several problems like data overlap and implosion. Gossiping Algorithm in WSN is able to reduce the overhead and transmit packets through already set up the path but it takes place the data delivery and problem of worst-case. In this paper, we try to solve two problems that are data delivery and worst-case by selecting neighbor nodes using RSSI and number of linkage. The proposed model is available to real-mote and we confirmed the improvement of the performance against existing models.

Key words: Wireless Sensor Networks, Routing Protocols

1. INTRODUCTION

Wireless Sensor Network (WSNs) is made of many wireless sensors for accurate sensing to environmental sources. Existing ways of WSN platform are micro-controller for computing and RF for wireless communication. Thus, the most important strategies of constructing the embedded system like WSN technology are to raise the efficiency of routing and durability of the network lifetime .WSN is required a number of sensors for the constructing the huge sensor field like remote-observation system or military service and social infrastructure. Routing Technique for WSNs is based on the sensing, processing, and communication [2]. Especially, Communication area is most important because the ratio of the consuming energy in communication is high. In this point of view, the way of minimum costs of communication in WSN and development of routing technique for energy-efficient network are required for extending life-time that depend on uniform energy-distribution of whole nodes and improvement of performance in all over WSNs. Low power profile or Energy-efficient routing techniques for wireless sensor network are distinguish from the Data Centric Routing based on the flat-based routing like Flooding and Gossiping and Hierarchical Routing based on the network clustering represented LEACH[2] and PEGASIS[2,7]. In this paper, our approaches basically focused on the way of selecting the neighborhood based on Gossiping protocol. In exploring the questions of the each transmission case, this paper will be limited to consideration of selecting the node that is used the combination of RSSI value and the number of connection link. The existing research of Routing protocol based on the Gossiping used the way of periodical broadcast message and selected the random neighbor node for setting up the path. The next processing is the transmission of reinforcement

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and transmits the data by uni-cast form. However, when you suppose the limitation of the sensor nodes sensor nodes easily have exhausted because nodes have the limitation power. In this case, source node can't help transmitting the broadcasting message continuously and takes place many packets overhead in the communication. It is required that routing protocol in WSN is able to decrease the overhead message and increase the efficiency of network. This paper is organized in the following manner. In the next section, we described related works that is related to wireless sensor network protocol for the design of proposed routing model. In the section 3, we designed the proposed routing algorithm for implementing and described the implementation method for examination by simulation. In proposed system, we described the way of set up restricted routing paths based on the signal strength of RF, backup paths and the method of filtering for data duplication. In the section 4, we described the result of examination by simulation and experimentation result through the device level. In the section 5, we described the result of our proposed model versus existed Gossiping Protocols and analysis of experimental results. Last chapter, we summarize this research and describe the conclusion.

2. RELATED WORKS

2.1 Flat Routing Protocol for WSN

Flooding-based protocol that is representative flat-based routing is the basic technique of routing which is used the wireless ad-hoc network [2,4,10]. The principle of this protocol is that sensor nodes send the message packet to the rest nodes and they are relaying the received packet to anyother nodes. So, one packet from a sensor node is sent by all nodes. Existed Flooding protocol is a technique that all nodes in one sensor field joins the network and communicates each other without any specific routing path. In this case, there are many overhead for finding the other nodes and costs of communication increase before setting up the proper routing paths. Moreover, sensor network that allows the fault tolerance use the Flooding protocol finding new node when the power of specific sensor node is dried up. Gossiping Protocol [2-5] is the solution of the overhead problem having the Flooding protocol. Gossiping protocol periodically transmits the advertise packet called the "hello packet" for recognizing the neighborhood nodes. Periodic advertise packet is broadcasted its own ID by period. It is only sent in one hop range and any other nodes that received the hello packet don't resend the hello packet to the other nodes. The process of finding neighbor nodes is randomly selected node which is searched by MAC information Gossiping and set up the routing path. Consequently, real communication is performed by uni-cast form and the data is transmitted to selected nodes by routing path. Gossiping protocol is able to decrease the node that takes part in communication but the serious problem of Gossiping protocol is that its performance has best case and worst case. Of particular important in this regard is randomly selecting the neighborhood node. In this case, if the source node always selects the most efficient case of neighbor node, its performance is very best but its delay time is maximum value and data delivery becomes minimum value. In most worst case, transmission data from source node to sink node that is last node and connect with the gateway is not sent because of disconnection of routing path. This problem is called 'Worst Case Problem in Gossiping'[1,3,4].

2.2 Gossiping

Representative problem of Flooding is low efficiency of network because too many nodes join the process of packet forwarding. Generally speaking, the basic concept of wireless sensor network is the transmission of small size packets accurately but there are many overheads in flooding protocol. For example, oversize of head section which is as-

signed for the routing table, hop information included the before and after links of nodes. For the solution of this flooding problems, gossiping protocols [1-3,10] is proposed. Gossiping protocol uses the ways of transmitting packet by probability function. Thus, this protocol transmits the periodic advertise message called 'hello packet' for finding the neighbor node in one hop count. Nodes which are received the hello packet shares with the information of neighbor nodes. This advertise packet is only transmitted in one hop count and is never forwarded by any other node [8]. In gossiping protocol, if one node is received the packet which have to forward it, relevant node must confirm the neighbor's information and select the neighbor node randomly [7]. Next, selected node is only received the packet by uni-cast form. Thus, Gossiping protocol can widely reduce the numbers of joining the nodes. The number of reduced node means reduction of packet and it is more efficient than flooding aspect of decreasing overhead of network and energy of transmission. Figure 1 shows the mechanism of Gossiping protocol. As you show the Figure 1,suppose the node 'A' has the data which is ready to transmit to node 'D'. Node 'A' randomly selected node 'B' in neighbor node 'B','H' and 'E'. If node 'B' selects the node 'C' and it is forwarding the packet to node 'C'. In this case, the routing path will set up 'A->B->C->D'. However, Gossiping protocol in Figure 1 describes the best case of its mechanism. if you suppose the worst case in Figure 1, node 'B' selects the neighbor node 'F' and node 'F' can't transmit the packet any more because node 'F' is alone in the its hop range. In this case, there is no solution for this problem in the classic Gossiping protocol. Many researchers try to solve this problem and its solutions have been proposed by related research. Representative solutions for this problem use the way of selecting the multiple neighbor nodes and transmit the packet at the same time and the sorting algorithm based on probability function which

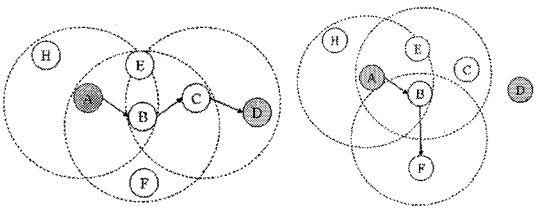

Fig. 1. Problems in Gossiping

is established on the carrier sensing. Although the data delivery of Gossiping protocol is lower than flooding algorithm but it is more efficient than flooding aspects of consuming the energy and reducing the overhead of network. Finally, in order to apply the flat-based routing technique to real field, advanced protocol that is mixed the merits of each protocol as well as improvement of performances is required

3. DESIGN OF THE PROPOSED MODEL

3.1 Core Mechanism

The core mechanism of our protocol is the following manner. First of all, a source node transmits the broadcast message to other neighbor which is in a single hop count after a source node has initialized by operating system. When the sensor node transmits the broadcast message, there are some problems that are occurred the packet collision and hidden terminal. In this paper, we have solved the problems using Virtual Carrier Sensing that transmits the RTS/CTS packet at first. For the first time, our proposed algorithm uses the neighbor's information. When all nodes is turned on the power, they are initialized the MCU and RF by OS scheduler and run the task for communication and routing. Each source node transmits the broadcast message (i.e. hello packet). 'Hello Packet' includes the ID that is the source node information. Broadcast Message is only transmitted in one hop count and can't be relayed by any neighbors. We don't consider the problem of getting out of hop counts. All nodes which is transmitted a broadcast

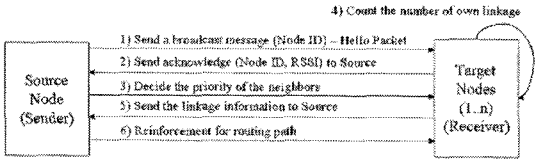

Fig. 2. Architecture of Multi-hop Sensor Network.

message, except of source node send the acknowledge message to source node. Acknowledgement message is included the own ID and signal strength until the destination of source node. Source nodes distinguish the target node which has highest RSSI signal strength and the others. Source node can decide the priority by this information. According to the reference, RSSI information is in proportion to the Link Quality. RSSI is a measurement of the power present in a received radio signal. If the node of RSSI value is higher than the other nodes it means that a source node and target node is more closer. Figure 2 shows the entire phases of proposed routing algorithm.

3.2 Routing Architecture

First of all, suppose the entire nodes are in the single hop count and state of the each node is idle or sleep. Following steps is like this

1) If the power is turned on, each node performs the Initialized task. Initialized task is included the MCU, RF, OS initial component.

2) Source Nodes which have to join the network transmit the broadcast message that is included own ID for find own neighbor nodes.

3) Nodes received data from source node measure the RSSI signal strength and transmit the acknowledge packet to source nodes.

4) Source nodes received the acknowledge message from neighbor nodes.

5) Source nodes select the priority of neighbor and store it to the network stack.

6) After the Phase 1~5 steps, all nodes have the linkage from sources to neighbors and each node transmits the packet included the number of linkage to the previous node.

7) if the linkage number of neighbor is below two or the node is deleted in routing table because it occurs the worst case problem.

Finally process of phase 1~7 in following steps, all nodes are able to transmit the data through one direction and set up the routing path. If any node is in communication or no carrier state, source nodes try to retransmit the packet. This mechanism is supported by CSMA/CA algorithm in CC2420 Chipset and if any specific node doesn't request message any more, source node can transmit the packet the next priority. Therefore, we suggest that the problem of worst case in Gossiping protocol is solved by this mechanism.

3.3 Joining the New Nodes

The node which is extension of network or recovery work after replacement of batteries must join the network. In this section, we described the process of joining new nodes. The process of new node joint is same process of described before chapter. New source nodes transmit the data and request the neighbor's information. Existing node responds the information of RSSI strength and linkage number. In this case, the phase is simpler than the initialize phases because existing network is set up the routing path and transmit the packet normally. Figure 4 shows the process of new node joining

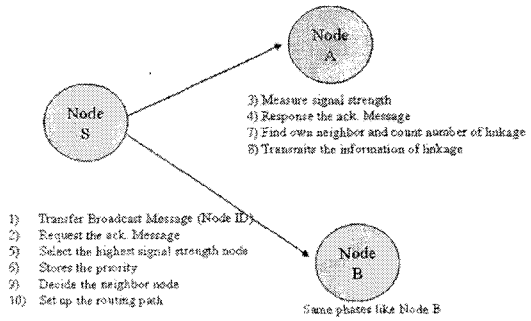

Fig. 3. Mechanism of proposed Model

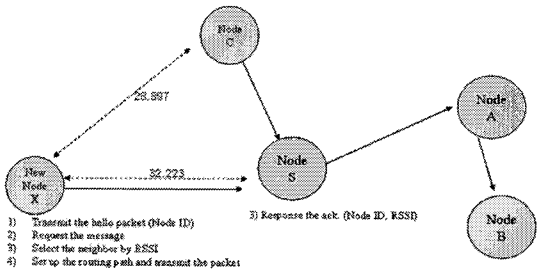

Fig. 4. Process of new node joining

4. IMPLEMENTATION AND EXPERIMENT

We tested the proposed model based on the PC platform in order to measure the performance by simulation. In this section, we will be limited to consideration of routing performance before porting the real MOTE. This simulation has no bearing the platform like PC or MOTE and we pay attention to consider the routing path, detection of signal strength.

4.1 Experiments by TOSSIM

As the Figure 5 is shown, total node number is 15 and these nodes are distributed by random. Suppose the source node is 11, source node sends

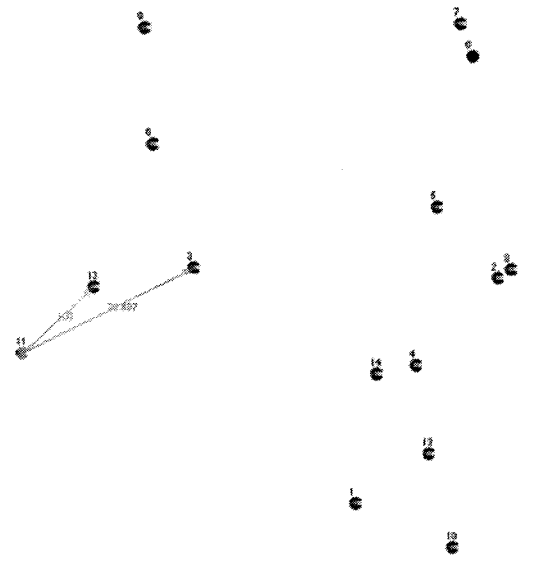

Fig. 5. Example of decision the neighbor (Phase 1)

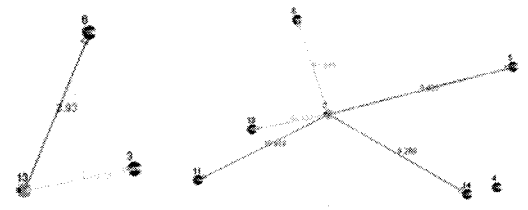

Fig. 6. Count the linkage Number (Phase 2)

the broadcast message (i.e. hello packet) and node number 13 and 3 response their node number and signal strength. In this case, node 13 is higher than node 3 and source node is set up the 1st priority node 13. The 2nd neighbor node is set up the node 11. As you shown Figure 6, the neighbor node (13) of source node 11 has 2 linkage and node 3 has 5 linkage. Therefore, the priority of neighbors information is decided the node 13 and is reinforced the routing path by 'UpdateTable' function.

The rest node decides the neighbor nodes and setting up the routing path by this technique. In reinforce the routing path, if the destination node is sink node which is end-terminal and connects the gateway the source node is able to ignore the priority and transmit the packet to sink directly.

5. EXPERIMENTAL RESULT & ANALYSIS

5.1 Routing Performance

In this experiment, we distributed the node because of reducing the standard deviation. Figure 7 shows the simulation task by TinyViz.

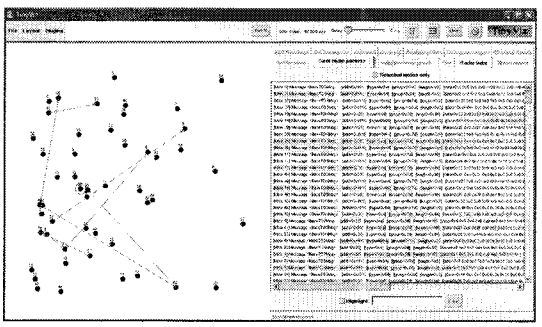

Fig. 7. Simulation Task

At first, we decide the source node to gather the information of temperature sensor. Source nodes are in the first column that is 0,8,16,24,32,40, and 48. Sink node is the last number 49. Source nodes gather the data by temperature sensor and perform the self-configuration using proposed algorithm. After the first test was performed we tested the many times on changing the source nodes number. Table 1 describes the results of the experiment. As the shown the Table 1, the delay time is increasing unit of network relatively have many hop-counts. Moreover, connectivity of node is about the same proportion although the number of node is increasing.

5.2 Comparing with Gossiping Protocols

We tried to compare our proposed protocol with existed Gossiping protocol. The main differences of our protocol are that the neighbor node is selected by information of signal strength and counting the edge node number against random selection. We compared the classic gossiping protocol with the proposed protocol and used the classic gossiping implemented by TinyOS 1.1.11 Version. Figure 8 shows the comparison of two techniques. Figure 8-(a) shows the comparison by Delay Time. Delay Time is relatively increasing as the numbers of node increase in proposed model. The main reason of increasing the delay time is in proportion to the number of nodes. On the contrary, when the node number is 25 delay-time is decreasing in classic Gossiping protocol. This phenomenon is given an explanation of using random technique of selecting neighbor node and classic

Table 1. Protocol Simulation Results by TOSSIM

Number of Nodes	Delay(ms)	Power Usage(mW)	Loss of Data(%)	Connectivity(%)
10	4733.36	27	54.22	99.54
25	6438.58	18.66	12.63	99.50
50	12821.50	10.22	2.39	99.51

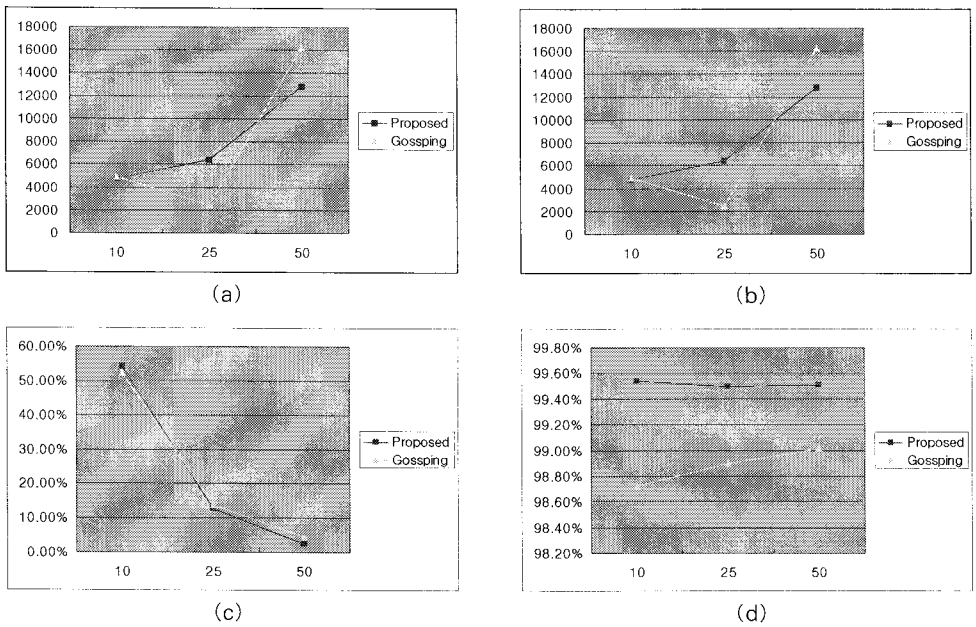

Fig. 8. Simulation Task. (a) Delay Time, (b)Power Usage, (c) Loss of data (d)Connectivity

Gossiping model doesn't consider the error rate and standard deviation. Figure 8-(b) shows about the power usage by Graph. Proposed model is a little more efficient than classic model. The reason is that proposed model use the way of selecting node before speaking before section. It is efficient that selecting node by signal strength is better than by random. After all, if the location of source node is far from the neighbor the signal strength is relatively weak and transmission power is an inverse proportion. Figure 8-(c) shows the proportion of loss data in proposed model vs. classic model. In proportion of data loss is no more difference between proposed model and classic model. However, the rate of data loss is over 50% in case of constructing small number of node. The reason is that there are no more way of solution between proposed model and classic model. However, if the number of node is guaranteed the proportion of data loss is rapidly decreased. Lastly, Figure 8-(d) shows the connectivity of proposed model vs. classic model in a single hop count. As you see the figure most of nodes guarantee the state of stability. However, the comparisons of proposed model with the classic mode are that proposed model doesn't transfer the packet if the signal strength is not guaranteed. The classic model is the way of random selection of neighbor node and it occurs to drop the reliability of transmission. On the contrary, there is no problem in proposed model because its mechanism is based on the priority level. Moreover, suppose the specification of wireless media like SNR ratio and white noise each protocol is shown the perfect connectivity.

6. CONCLUSION

Wireless Sensor Networks are a subset of wireless networking applications focused on enabling connectivity without specific infrastructure and the use of wires to sensors in general. The purposes of WSNs are gathering the information from environmental effect, communicating each other and construct its own network at any time and anywhere. So the self-configuration for constructing network and accurate routing technique are required. The routing technique of Wireless Sensor Network is mainly classified the Flat-based and Hierarchical-based technique. The former is used the network without any other infrastructure and the latter is used the large scale network or with access points. In this paper, we performed the research of the routing technique based on gossiping and try to raise the performance as we solve the problem having gossiping protocols. We designed the way of selecting neighbor node replaced the technique of reinforcement by RSSI with improving the random selection and tried to minimize the worst case problems using the linkage number. Using the way of this mechanism is more efficient than classic model aspects of Delay Time and Power Usage.

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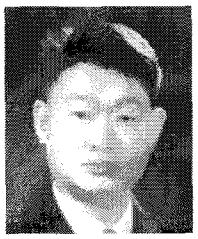

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