WSN Firmware Update Methods by Relay Node Selection

Yeungmoon Kwon and Byoungchul
,

[1] Dept. of Computer Engineering, Yeungnam University, Gyeongsan-si, Gyeungbuk, Korea
ymwkon@ynu.ac.kr, b.ahn@yu.ac.kr

Abstract. Wireless Sensor networks are used to many application areas such as environment monitoring, wild life monitoring and agriculture and so on. The functions of the WSNs are complex and their software is not simple. During the life time of sensor nodes, it is required to be reprogrammed their operations because of environment changes, control program bugs or program updates by adding functions or calibrations. To upgrade the control software of sensor nodes in WSNs remotely, this paper compares three update methods by relay node selections. The relay nodes could ne nodes with many-neighbors, nodes from the longest distance, and nodes selected by randomly. Their performance is measured by the number of relay nodes and energy consumptions. By the simulation results, Many-Neighbor method, which chooses relay nodes with many neighbors, shows better performance up to 10 percent than other methods.

Keywords: WSN, data relay, firmware upgrade.

1 Introduction

The recent rapid advance of semiconductor technology makes it possible to implement high performance sensor nodes with performing many functions. Therefore they have very complex control programs without increasing its hardware cost. Also they can be reused again for different application areas.

It is necessary for sensor nodes to reprogram because of environment changes, control program bugs or program updates. In this case, a lot of costs and efforts are wasted if they are recollected or replaced them with new nodes. Therefore, it is required to reprogram their software remotely as far as they are reusable.

In this paper, software upgrade methods for sensor nodes are discussed by selection methods of the relay nodes. Their performances are analyzed and compared by the energy consumptions, number of nodes and error rates.

2 Related works

Control software contains execution code for a processor of sensor nodes, it is very important to maintain reliable data transfer. A method for reliable data transfer in WSN is developed for 1:1 communication such as S-TCP[1] and RMTS[2]. But 1:1 communication methods are inefficient to upgrade many nodes of WSNs. It is necessary to study for large data transfer from one node to many nodes efficiently. A firmware data for sensor node is very larger than normal data, and there are some research for large data[3][4]. But, the direction to upgrade control software is the opposite direction of normal data transfer. There are some researches about upgrades for sensor nodes. But they are focused on system management, not an upgrade itself [5].

2 Simple system model

All sensor nodes of WSNs are assumed to be the same model with the memory size and the same processor. It means that all sensor nodes use the same software version. And a distance between two nodes is the same and the location of nodes is fixed.

The When a sink node starts to transfer its software data to others, all nodes stop their sensing operation and switch to the software upgrade mode. The sensing operation mode is operating in low power consumption and each node transmits its sensed data to the sink node. In case of software data transmission, data size is very large and must be transmitted very fast and continuously. If a node detects software data transmission protocol, it should switch the normal sensing mode to the software upgrade mode and prepare for software upgrade. When the node finishes receiving all software data, it requests lost or missing packets to its source node. After lost or missing data are received again, the node reprograms its own flash memory and restarts its operation again. After reprogramming, the node may relay software data to other nodes. But it is not necessary for all nodes to participate in relaying software to another node in WSNs. Only a few nodes relay software data to other nodes. It is very important to choose relay nodes because of overall performance.

To select a next relay node, three selecting methods are evaluated.

- Longest-Distance - A node is located at the longest distance from the relay node.
- Many-Neighbors - A node has many neighbor nodes.
- Randomly selected node - A node is selected randomly by the relay node

3 Simulation

NS-2 network simulator is used for the simulation. 100 nodes are deployed in the field uniformly. The distance between two nodes is 40m and each node has a 60m radio radius. Radio bandwidth is 256Kbps and firmware file size is 128 Kbytes. The

energy consumption is 75.9mW to send data and 62.7mW to receive data. Three selection methods are simulated to compare their performance.

Fig.1 and Fig2 is simulation result. Fig. 1 illustrates the number of relay nodes that participated in relay. In all case, the number of relay nodes is between 33 ~ 48. When a node is selected as a relay node by Many-Neighbors, the total number of relay nodes is the smallest.

Fig. 2 shows total energy consumption to upgrade all nodes. When the size of the data packet is 160 bytes, the energy consumption is low.

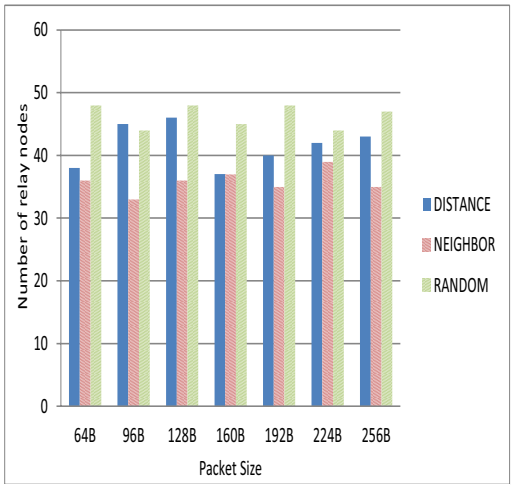

Fig. 1. Number of relay nodes

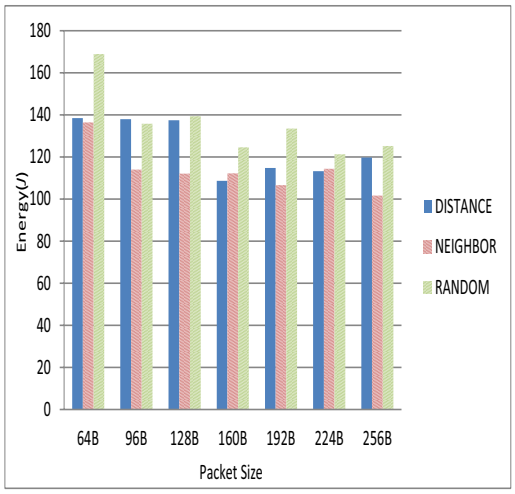

Fig. 2. Consumption of energy

4 Conclusions

In this paper, three software upgrade methods are proposed by selecting relay nodes in WSNs. The proposed methods are analyzed for the number of nodes to relay firmware data, energy consumptions and upgrade times. These factors are simulated and measured by the several packet sizes. The performance evaluations are measured by update times, the number of relay nodes, energy consumptions and error rates by packet sizes. By the simulation results, the Many-Neighbor method shows better performance up to 10 percent than other methods.

Through simulation results, the selection method of a relay node is very important and also the data packet size affects overall performance to update software.

References

1. Y. G. Iyer, S. Gandham, and S. Venkatesan, STCP: A Generic Transport Layer Protocol for Wireless Sensor Networks, Proc. of 14th International Conference on Computer Communications and Networks, pp.449-454, (2005).
2. F. Stann, and J. Heidemann, RMST: Reliable data transport in sensor networks, Proc. of the First IEEE. 2003 IEEE International Workshop on Sensor Network Protocols and Applications, pp. 102 -112, (2003).

3. W. Chen, P. Chen, W. Lee, and C. Huang, Design and Implementation of a Real Time Video Surveillance System with Wireless Sensor Networks, Proc. of Vehicular Technology Conference, 2008, pp.218-222, (2008).
4. Honggang Wang , Dongming Peng , Wei Wang , Hamid Sharif , Hsiao-Hwa Chen, Image transmissions with security enhancement based on region and path diversity in wireless sensor networks, IEEE Transactions on Wireless Communications, vol. 8, no. 2, pp.757-765, (2009).
5. C-C. Han, R. Kumar, R. Shea, M. Srivastavam, Sensor Network Software Update Management: a Survey, Intl. Journal of Network Management, no. 15, No. 4, John Wiley & Sons, pp. 283-294, (2005).
6. S. Kwon and I. Roh, A Head Selection Algorithm with Energy Threshold in Wireless Sensor Networks, Journal of IWIT, (2009)
7. C. Nam and etc, Energy-Efficient Cluster Head Selection Method in Wireless Sensor Networks, , Journal of IWIT, (2010)