Design of Transmission Power Control mechanism using Shortest-Path Technique

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Abstract. There are a number of studies that propose transmission power control algorithms in wireless sensor networks. However, these algorithms have a lot of overhead in the initialization phase since a number of packets have to be transmitted to determine the optimal transmission power level. Moreover, the optimal transmission power level brings about an increment of the mean hop-count. The high hop-count increases the overall message latency and the energy consumption by increasing the number of packets in multi-hop communication. This paper proposes the transmission power control technique considering the shortest-path to minimize the hop-count without the occurrence of any power control messages.

Keywords: Sensor Network, Transmission Power Control, Tiny-OS, Shortest-Path, Hop-count.

1 Introduction

Wireless sensor networks refer to the atypical communication networks that wireless sensor nodes are constructed as the structure to be responsible for the communication relay task for each other. At that time, not only the sensor nodes are little durable since they are manufactured to work based upon the insufficient power supply, but also because the network configuration is not always fixed in the situation required mobility, their operations are needed to be disturbed little by such external environment's change. Therefore, the researches considered the energy efficiency such as LEACH[1], PEDAP[2], SHORT[3] and so on were proposed using such directional characteristics of data transmission. The module consuming most power in a wireless sensor node is the module of radio communication. Therefore, reducing the amount of energy consumption in the radio communication's module could be more efficient method for decreasing the energy consumption of battery than controlling other module.

In order to solve such problem, this paper proposes the transmission power control technique that considers the shortest path not to generate additional control messages to maximize the advertising messages' usage needed for configuring the network in the tree based network. In addition, the proposed method is implemented in Tiny-OS, and the transmission power control technique is applied to measure the amount of energy consumption to compare the amount of energy consumption in the general network.

2 Implementing the system

For evaluating the performance of the technique proposed in this paper, the experimental environment is implemented on the Tiny-OS 1.1 which is a public operating system for wireless sensor networks. The nodes used in the experimental environment are 17 Hmotes used the Telos based platform, and 4 MicaZs. Table 1 represents the specification of sensor nodes used in the experiment.

Table 1. The specification of MicaZ and Telos.

Mote Type	MicaZ	Telos
Microcontroller		
Type	ATmega128	MSP430
Program memory(KB)	128	48
RAM(KB)	4	10
Radio		
Type	CC2420	
Data Rate(Kbps)	250	
Power Consumption		
Minimum Operation(V)	2.7	1.8
Total Active Power(mA) MCU + RF(RX)	23.3	21.8

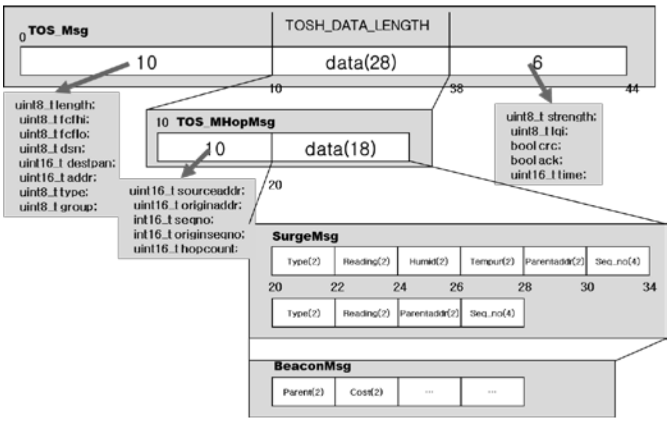

Fig. 1. The message structure of Tiny-OS

Fig. 1 shows the message structure of Tiny-OS. In Tiny-OS, the length of data message should be assigned as the same in order to be able to communicate between Micaz and Hmote. In experimental environment, the values of *TOSH_DATA_LENGTH* is specified as 28 to be able to communicate each other.

The RSSI and LQI for all the messages are stored in strength and LQI of *TOS_Msg*, respectively. In Tiny-OS, the tree-based network is implemented in the *LQIMultihopRouter* component. The *LQIMultihopRouter* component establishes the parent by using LQI as a cost.

In Fig. 2, *MultihopEngineM* component performs a role that brings the parent's address for establishing the path to send the message to the corresponding address, or participates in multi-hop transferring messages of other node.

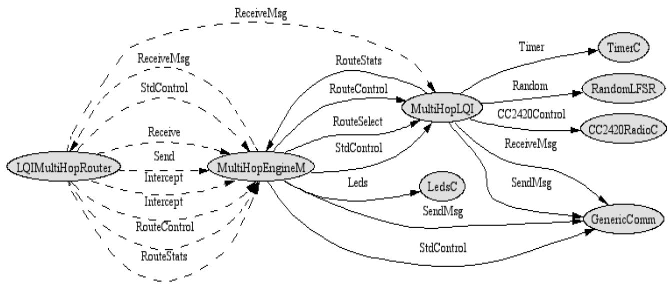

Fig. 2. The graph of *LQIMultihopRouter* component

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MultihopLQI component is responsible for sending and receiving the advertising messages, and performs a role that receives each node's advertising message to measure and established the parent depending on the measured value.

The *MultihopLQI* and *MultihopEngineM* components are modified to apply the technique proposed in this paper.

Table 2. The information added into the advertising message.

Added information	Description
powerLevel	Power level for itself
minLqiChildNode	Child node which LQI is the minimum
parentLqi	LQI of parent node
minLqiChild	The minimum LQI among child nodes
typeAdjustedPower	Level to determine the power strength

The advertising message basically includes the information such as the address of parent, cost, and number of hops for constructing the tree-based network. Some information is added into the advertising message for the transmission power control technique, and the added information is as Table 2. Hmote exploited for the experiment of the transmission power control technique uses CC2420 radio chip. Since Tiny-OS provides the function (SetRFPower) for controlling the transmission power level for supporting this radio chip, it is used.

3 Conclusion

This paper proposed the transmission power control technique considering the shortest path not to generate additional control packets. The network applied the proposed technique reduced the average current during transmission about 25% less than the previous case.

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