An Effective Image Transmission Method in ZigBee System for Intruder Detection Systems

Seon-Ki Hwang*, Sang-Gu Lee**

Dept. of Computer Engineering. Hannam University, Korea
(Tel : 82-42-629-7551)
hwangsae7@naver.com, sglee@hnu.kr***

Abstract: The characteristics of ZigBee System are highly reliable, highly secure, able to use very lower power, cost effective, and an open global standard. In this paper, we implement an intruder detection system using image transmission techniques based on ZigBee networking. The proposed system is composed of many sensor modules of infrared, temperature, humidity and illumination, together with RFID reader and camera modules. Image transmission is performed only in the emergency environment such as intruder detection in order to reduce overhead in the routing transmission. This system will be applied to low-cost image-based ZigBee product and will provide good security, user convenience and easy use.

Keywords: ZigBee, RFID, Image transmission, Intruder detection system

I. INTRODUCTION

The characteristics of ZigBee System are highly reliable, highly secure, able to use very lower power, cost effective, and an open global standard. While most wireless applications are getting to go faster, ZigBee aims for low data rate and low power. So many ZigBee applications can be fitted on even 8-bit microcontrollers as like ATmega128. In this paper, we will propose an intruder detection system using image transmission based on ZigBee IEEE 802.15.4 protocol. The proposed system is composed of ATmega128 based ZigBee motes, many sensors to detect an intruder and to catch hold of indoor environment, and camera modules. This system provides user convenience and effectiveness.

The organization of this paper is as followings. In Chapter 2, Organization of the proposed system is covered. Experimentation and results are discussed in Chapter 3. And finally, Chapter 4 draws a conclusion.

II. ORGANIZATION OF THE PROPOSED SYSTEM

In the proposed system, we use ZigbeX motes and 13.56 MHz RFID tags and reader, many sensors including infrared sensor and camera modules. Each ZigbeX mote has ATmega128L microcontroller, CC2420 RF chip, and many sensors including temperature, humidity, and antenna module.

Figure 1 shows the entire organization of the proposed system. Mote 1 is a sink node that receives sensed data from other motes in RF communication and transfer data to main PC in serial communication. Mote 2 and 3 are installed on the floor and received the sensed data from motes from 4 to 9 through RF communication. In the mote 4, RFID reader is installed in order to identify visitors. In the mote 5, camera module C328 is added to acquire image information in the limited situation as like intruder detection and a fire occurring. Motes from 6 to 9 detect the temperature, humidity, illumination, and infrared sensing, and transfer data to main PC in RF communication via mote 1.

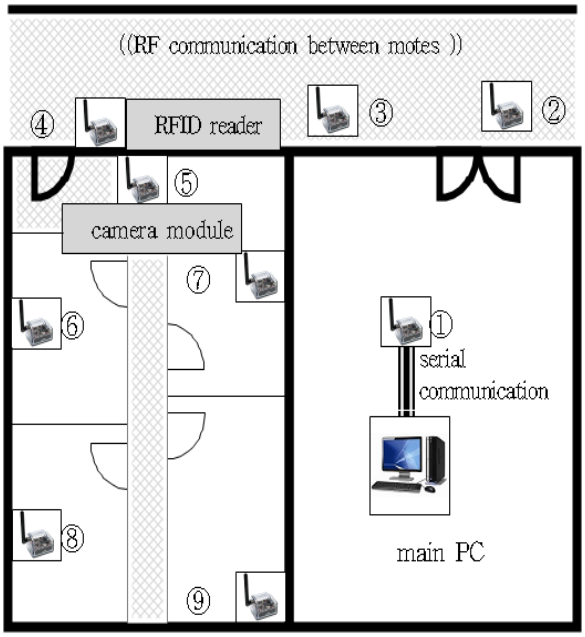

Fig.1. Organization of the entire system

In the proposed system, we can monitor a situation of environment using camera module in the limited situations. Originally, ZigBee system was developed for low data rate and low power consuming. Image transmission needs much data to transfer between motes. In this paper, therefore, we take the efficiency of image data transmission into fall account. ZigBee system uses 20~250kbps in speed, so it is not good for image in real-time, however, it is much efficient for monitoring on the unit of several minutes interval. In the proposed system, the camera module has image Codec inside and provides 160 * 128 pixel size image, and JPEG file. Camera module uses compressed data so that the system has not much overhead in image transmission.

Figure 2 shows the number of image frames per one minute in one node. We can know from this figure that the proposed system can receive about 18.5 frames in 20 minutes. In this figure, red line represents the average number of frames.

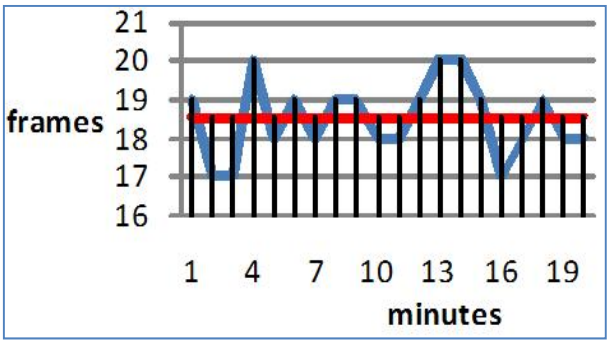

Fig.2. Number of Frames in minutes

III. EXPERIMENTAION AND RESULT

In this paper, we implemented a main operation program using Visual C++ MFC environment. For ZigBee environment, TinyOS is used for mesh networking and operating written in a language called NesC. In the NesC, all sensors are treated as objects.

Table 1 shows a sensed packet sample data in this system.

Table 1. Packet samples

7E 42 7D 5E 0 6A 7A 20 1 0 0 0 FE FF FE FF FF 0 0 0 1 AA A 5 3C 6 0 9F 0 0 7E
7E 42 7D 5E 0 6A 7A 20 1 0 0 0 FE FF FE FF FF 0 0 0 1 0 0 3A 0 FF D8 FF E0 0 11 4A 46 49 46 0 1 2 3 4 5 6 7 8 9 A FF DB 0 43 0 10 C C E C A 10 E E E 12 12 10 14 18 28 1A 18 16 16 18 32 24 26 1E 28 3A 34 3E 3C 3A 34 10 0 40 0 0 7E
7E 42 7D 5E 0 6A 7A 20 1 0 0 0 FE FF FE FF FF 0 0 0 1 1 0 3A 0 38 38 40 48 5C 4E 40 44 58 46 38 38 50 6E 52 58 60 62 68 68 68 3E 4E 72 7A 70 64 78 5C 66 68 64 FF DB 0 43 1 12 12 12 16 16 16 30 1A 1A 30 64 42 38 42 64 64 64 64 64 64 64 29 0 34 0 0 7E
. . .
7E 42 7D 5E 0 6A 7A 20 1 0 0 0 FE FF FE FF FF 0 0 0 1 7 0 3A 0 A B FF C4 0 B5 11 0 2 1 2 4 4 3 4 7 5 4 4 0 1 2 77 0 1 2 3 11 4 5 21 31 6 12 41 51 7 61 71 13 22 32 81 8 14 42 91 A1 B1 C1 9 23 33 52 F0 15 62 72 EA 0 8 0 0 7E

In Table 1, each part of one sensed packet is as like Table 2.

Table 2. Packet analysis

7E 42 7D 5E 0 7A 7A 20 3 0 0 0 FE FF FE FF CC 0 0 0 1A 0 36 0 8A 1 9C 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 7E

For Table 2, packet explanation is shown in the Table 3.

Table 3. Packet explanation

Data	Analysis
7E	Start byte
42	Packet type
7D 5E 0	Serial communication address
7A	Type (image or sensor)
7A	Group ID
20	Data length (16 byte)
3 0	Source node address
0 0	Destination node address
FE FF	Multi-hop communication
FE FF	Multi-hop communication
CC 0 0 0	Packet number
1A 0	Temperature
36 0	Humidity
8A 1	Illumination
9C 0	Infrared ray
0 0 0 0	Null
0 0 0 0	Null
0 0 0 0	Null
0 2	CRC check byte
7E	Last byte

Data (little-endian)	Calculation (big-endian)
1A 0	16*1+10 = 26
36 0	3*16+6 = 54
8A 1	16^2*1+16*8+10 = 394
9C 0	16*9+12 = 156

Figure 3 shows an acquired image through ZigBee networking in the proposed system.

Fig.3. Acquired image in the proposed system

Figure 4 shows the operation window of the proposed system. In this, there are many display items of command box, several sensor's data, visitors identification, moving routes, information of serial communication, and received packets.

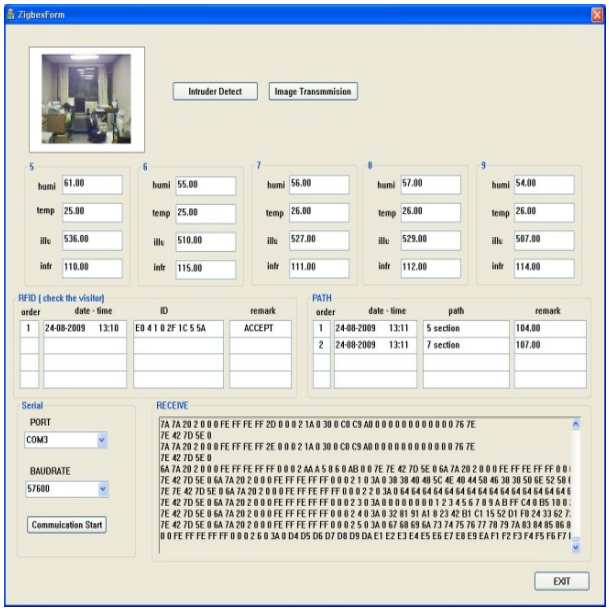

Fig.4. Operation window of the proposed system

VI. CONCLUSION

In this paper, have implemented an intruder detection system using image transmission based on ZigBee/IEEE 802.15.4 networking on emergency environment. Image data that are divided by 4 blocks are transferred in RF communication between nodes, therefore RF communication overhead are reduced.

The proposed system has major function such as

(1) Identification of image on emergency environment using user commands,
(2) Identification of real-time temperature, humidity, illumination, and infrared sensing data,
(3) Identification of visitors using RFID,
(4) and, identification of emergence on main PC.

In the future study, we will develop a more effective image transmission method without degradation of ZigBee performance.

ACKNOWLEDGEMENT

This work was supported by Security Engineering Research Center, granted by the Korea Ministry of Knowledge Economy.

REFERENCES

[1] Zhao and Guibas, Wireless sensor network, Morgan Kaufmann, 2004.
[2] Drew Gislason, ZIGBEE Wireless Networking, Newnes, 2008.
[3] Eady, Hands-On ZigBee, Newnes, 2007.
[4] Philip Levis, David Gay, "TinyOS Programming", Cambridge University Press, 2009.
[5] Mc. Andrew, An Introduction to Digital Image Processing with Matlab, Course Technology Ptr, Mar. 2004.
[6] ZigbeX, http://hanback.co.kr