Development of Intelligent Detection Modules for Home Security System

Yung Chin Lin[1,3], Song H. Chia[1,2], Ting L. Chien[2], Jr H. Guo[2]

[1]*Department of Electrical Engineering, National Yunlin University of Science & Technology, Yunlin, Taiwan*
[2]*Department of Electronic Engineering, Wu-Feng Institute of Techonlogy, Chia-Yi, Taiwan*
[3]*Department of Electrical Engineering, Wu-Feng Institute of Techonlogy, Chia-Yi, Taiwan*
(Tel :+886-5-226-7125 ext7131l; Fax :+886-5-226-9201)
yclin@mail.wfc.edu.tw, csh@mail.wfc.edu.tw, cdl@mail.wfc.edu.tw

Abstract: The security detection and appliance control of intelligent building, home is essential, to human life. An unlucky event was often caused by the negligence of humans. We have developed a multi interface based security system for home automation. The structure of the security system is divided into many modules. Each module has two variety interfaces (wireless RF and I2C). There are fire detection module, intruder detection module, environment detection module, AC power detection and diagnosis module, and application control module. In the application control module, we use two-wire communication method through wireless RF and GSM interface. These modules have voice alarm for event condition. We have designed a general user interface (GUI) for the home security system. The user interface can supervise these modules using RF device, and remote supervised using wireless Internet.

Keywords: home automation, wireless RF, I2C, GSM.

I. INTRODUCTION

Intelligent buildings and home can provide safety, convenience and welfare for human living in the 21st century, and allow effective management of resource with minimum life-time costs at the same time. An intelligent building system (IBS) is the integration of various services and contains security system, building heating, ventilating and air-conditioning (HVAC) technologies, computer system (Fig. 1), tele - communication and Internet. The most important role o f the intelligent building is security system. In the security system, redundant and complementally information results can enhance system reliability and certainty of intelligent building using multisensor fusion method. In generally, the home automation is a part of the intelligent building. The most important of the home automation is the security system. The appliance control is not negligent.

Wang and So [1] presented the history of development of building automation system (BAS). The structure of features of a modern BAS was introduced and future trends of BAS are discussed. Azegami and Fujiyoshi [2] described a systematic approach to intelligent building design. Kujuro and Yasuda [3] discussed the systems evolution in intelligent building. The quality of building services can be enhanced by updated information processing and communications functions of building automation systems. Finley et al. [4] presented a survey of intelligent building and reviews issues such as system perspective, subsystem services, multi-tenant building. Flax [5] discussed components and cost benefits of the intelligent building. Chung and Fu expect to set up the standard of appliances and communication protocols, and propose a complete system architecture with integrate control kernel to construct an intelligent building system [6, 7].

The paper is organized as follows: section II describes the system structure of the security system for home automation. Section III explains detection principles and diagnostic methods for these detection modules of security system. Section IV presents the experimental results for the home security system, and presents the function of these detection modules. The brief concluding comments are described in Section V.

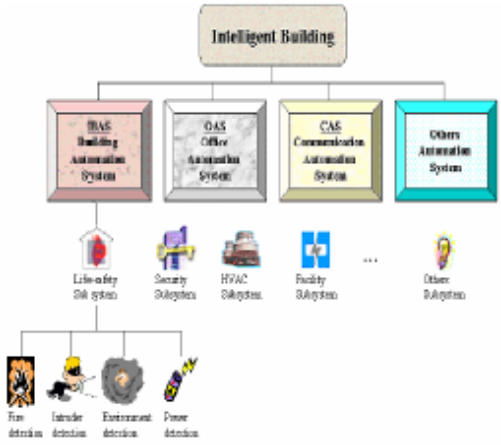

Fig. 1. Intelligent Building Architecture

II. SYSTEM STRUCTURE.

In the architecture, there are many modules in the system. These modules are independent and autonomous, and can work concurrently, each module can transmits the sensory data, parameter values and detection results to the main controller (IPC) through wireless series interface(RS232), and transmits detection results to the mobile phone using GSM module, too. These modules can speech the real-time status using voice. We have designed auxiliary module for these modules, and can receives the detection and diagnosis results from each module, and transmits the signal to the supervised computer. In the other way, these modules can transmit the signal to the supervised computer using series interface, too. We develop a general user interface for the home security system. The security system communicates with mobile phone using GSM (Global System for Mobile) modular. The GSM modular (WMOD2) was made by Wavecom. The modular is a seft-contained E-GSM900/GSM1800 (or E-GSM900/GSM1900) dual band module.

We propose distributed structure security system for home automation system based on the multi-models fusion architecture. In the security system, there are fire detection module, intruder detection module, environment detection module and power detection and diagnosis module. We use three flame sensors to detect fire happened and diagnose fault sensors. In the intruder detection module, we use IR sensor, magnetic sensor and touch sensor to detection intruder. In the environment module, we use humidity sensor, illumination sensor, temperature sensor to detect environment variable. Finally, we use four current sensors to detect power state, and we list these sensors in Table I.

Table I. Sensors of security system

Module	Sensors
Fire detection module	Three flame sensors,
Intruder detection module	Touch sensor, magnetic sensor, IR sensor and body sensor.
Environment detection module	humidity sensor, illumination sensor, gas sensor, voice sensor
Power detection and diagnosis module	Four current sensors.

III. DETECTION MODULE

- **Fire detection module**

We use weighted average method to detect fire event. The weighted average of n sensor measurements x_i with weights $0 \le \omega_i \le 1$ is

$$\bar{x} = \sum_{i=1}^{n} \omega_i x_i \quad (1)$$

$$\sum_{i=1}^{n} \omega_i \quad (2)$$

and $\omega_i = 0$ if x_i is not within some specified threshold. The weights can be used to account for the differences in accuracy between sensors, and a moving average can be used to fuse together a sequence of measurements from a single sensor so that the more recent measurements are given a greater weight. The prototype of the fire detection module is shown in Fig. 2. In the detection module, we set the same weight for these flame sensors.

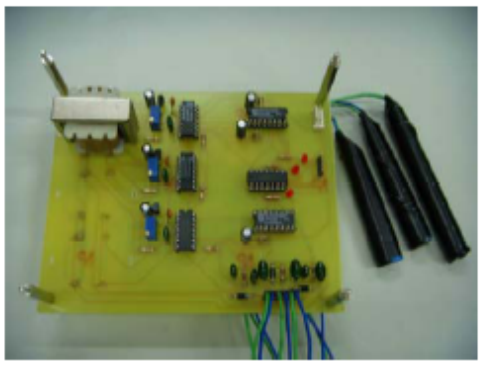

Fig. 2. The prototype of the fire detection module

- **Intruder detection module**

The input signal of the intruder detection module is digital. The user can use touch sensor, magnetic sensor, IR sensor and body sensor to detect intruder. The detection module is shown in Fig. 3(a). If the input sensor detect intruder, the output state is "on", otherwise, the output state is "off". Four variety sensors can decide four variety results. It has four input points in the detection module.

- **Environment Detection Module**

The environment function contains humidity detection, illumination detection and temperature detection. The environment information can be extracted using approaches based on statistical signal

detection theory. The user can set maximum and minimum of these detection signals by the supervised computer. These detection values of the module can transmit to the supervised computer with wireless RF interface. The prototype of the fire detection module is shown in Fig. 3(b).

(a) Intruder module (b) Environment module

(c) Power module (d) Environment module

Fig. 3. The prototype of the security detection module

- **Power Detection Module**

The redundant management method is developed for the power detection module. The proposed method is not only to detect power value, but also to diagnose sensory state. So we use the redundancy management method for detection and isolation of faulty sensors [13]. The prototype of the fire detection module is shown in Fig. 3(c). the controller of these security modules is HOLTECK microprocessor.

- **Appliance Control Module**

The controller of the appliance control module is HOLTECK microprocessor, too. The module can receive the wireless RF signal to control the appliance, and transmits the result to the supervised computer using wireless RF interface. The appliance control module can speak the status on real-time. Then the supervised computer can transmits the status to the user by the wireless Internet and GSM modern. That is to say, the user can uses mobile phone to control the appliance, and display the results on the mobile phone panel using GSM module. The appliance control module is shown in Fig. 3(d).

- **User Interface**

The user interface of the supervised system is shown in Fig. 4 for the home security system. There are three regions in the supervised monitor. This is the graphic supervised monitor for the security system in the region A. The user can program the status of security modules and appliance control modules, and receive the status of these modules. The region B can display the arrangement of these security and appliance control modules. It can display the real-time measured values for these security modules. The region C can program the steps for any security signal input. For example, if the intruder happened, we can program alarm, and hazard, and control the appliance module, and transmit the status to the user by the Internet or GSM modern.

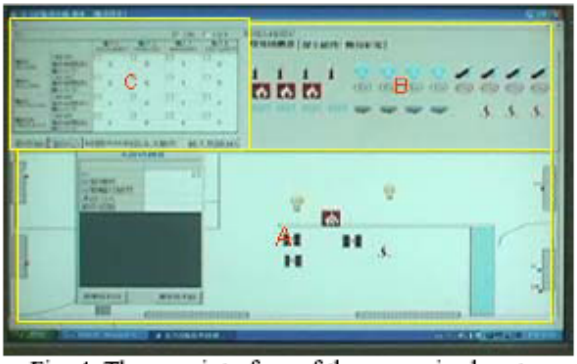

Fig. 4. The user interface of the supervised system

IV. EXPERINMENTAL RESULTS

In the intruder detection module, we use magnetic sensor to detect the intruder. The intruder detection module can transmit the decision results to the supervised computer and mobile phone through the wireless RF interface and GSM module. The experimental results are shown in Fig. 5. The user put off the magnetic sensor from the intruder detection (from a to b). The module can transmit the signal to the supervised computer, and the supervised computer can transmits the intruder status to the user using GSM modern to be shown in Fig 5(c). The accuracy of the

method is over 95%.

In the power detection system, we use four AC type current sensors to detect the current variety of home automation. In this paper, we use the redundant management method to detect current values, and isolate the faulty current sensor. The power detection module can display the current value on the LCD panel, and transmit the detection values (four current measured values, maximum value, minimum value and exact measured value) to the supervised computer. This experimental result is shown in Fig. 6(a). The user can use the mouse to touch the sensor, and it can display the real-time measured value in the panel. This experimental scenario is shown in Fig. 6(b).The user can set the maximum current value of the power detection module using the supervised computer.

(a) (b) (c)

Fig. 5. The experimental result for intruder detection

(a) (b)

Fig. 6. The experimental result for intruder detection

VI. CONCLUSION

We have presented a multi interface based detection module that is applied in home automation. These detection modules have two interfaces, one is wireless RF interface, and the other is voice interface. The security system contains four detection modules and one application control module. The detection modules have fire detection module, intruder detection module, environment detection module and power detection and diagnosis module. There are two methods (weighted average method and redundancy management method) be applied in status detection and sensor fault diagnosis. First we program the general user interface for the home security system. Then we design the hardware structure using the four detection and diagnosis methods. The detection and diagnosis module can transmit the detection and diagnosis results to the user through GSM modern, too. In the future, we want to supervise these detection and diagnosis modules through Internet.

ACKNOWLEDGMENT

This work was supported by the Wu-Feng Institute of Techonlogy of Taiwan, R. O. C. under Grand WFC-E-A7-9607-79.

REFERENCES

[1] C. W. Wang and A. T. P. So, "Building Automation In The Century," in proceedings of the 4-th International Conference on Advance on Advances in Power System Control, Operation Management, APCOM-97, Hong Kong, November 1997, pp.819-824.

[2] M. Azegami and H. Fujixoshi, "A systematic Approach to Intelligent Building Design," IEEE Communications Magazine, October 1993, pp.46-48.

[3] Kujuro and H. Yasuda, "Systems Evolution in Intelligent Building," IEEE Communication Magazine, October 1993, pp.22-26.

[4] Marion R. Finley, Jr. Ancilla Karajura and Raphael Nbogni, "Survey of Intelligent Building Concepts," IEEE Communication Magazine, April 1991, pp.18-20.

[5] M. Fiax, "Intelligent Building," IEEE Communication Magazine, April 1991, pp.24-27.

[6] W. Y. Chung, L. C. Fu and S. S. Hung, "A Flexible, Hierarchical and Distributed Control Kernel Architecture for Rapid Resource Integration of Intelligent System", IEEE International Conference on Robotics Automation, Seoul, Korea, May 21-26, 2001, pp.1981-1987.

[7] L. C. Fu and T. J. Shih, "Holonic Supervisory Control and Data Acquisition Kernel for 21st Century Intelligent Building System", IEEE International Conference on Robotics and Automation, San Francisco CA, April 2000, pp.2641-2646.

[8]Ren C. Luo, Kuo L. Su and Chi W. Deng "Power Supply Diagnosis System Using Redundant Sensor for Intelligent Security Robot", IEEE International Conference on Industrial Electronic, Control, and Instrumentation (IECON'2003), PP2500-2506。