VOICE INTEGRATED HOME AUTOMATION AND SECURITY SYSTEM THROUGH TELEPHONE LINE

Kamil Çetin
e-mail: k.c.78@hotmail.com

Özge Şahin
e-mail: ozge.sahin@deu.edu.tr

Dokuz Eylül University, Faculty of Engineering, Department of Electrical & Electronics Engineering, 35160, Buca, Izmir, Turkey

Key words: Home automation, microcontroller, sensor, telephone, voice integrated.

ABSTRACT

The aim of this study is to show the benefits of smart living systems, their areas of usage and also to present an application process. Details about the technical substructure and application of the designed home automation system through telephone line are described. Voice recording and playing system is integrated with the system

I. INTRODUCTION

The impact of home automation on domestic lifestyles will be as far ranging as was that of factory automation on industry and its benefits will be available to all sectors of society. Home automation can be achieved not only with the household robot but with embedded computing power and memory within dozens of pieces of domestic equipment, each of which can communicate with the user and with other equipments. Within the integrated home system the communication media will include infra-red, radio, mains wires, installed twisted wires and coaxial cable, and later perhaps optical fibre. Applications will include security, lighting, heating, cooking, washing appliances, audio and video systems, energy management as well as a number of new applications such as health monitoring, home publishing and entertainment. Some applications are shown in Figure 1.

Figure 1. A sample home automation system

For example, when the heating system is linked to home automation, home always keeps the room temperature at the level set by the owner and money is saved on top of that. That way humans not only always have a healthy climate at home, but also economize on costs; saving up to %30 a year just from a heating system with individual room control and window monitoring. Consumption management is good for even more, though, such as automatically switching high-consumption devices on like the washing machine during those times of the day when rates are the lowest. Some applications are shown in Figure 1. Remote controlling or monitoring can be achieved with that system. So life may be more comfortable and more secure.

Nowadays home automation has much innovation. Some of them are bluetooth home control, neural fuzzy, USB home control network system, RF network, wireless home automation networks [1,2]. In section two, the most common home automation standards and their recent innovations will be mentioned. In section three, it will be discussed about manufacturing, circuit components and sensors used in the phone controlled home automation hardware. Software and operation of the system will also be explained in section four.

II. HOME AUTOMATION STANDARDS

Most proposals for home automation communications have been derived from other industries. The choice of protocol is important because it can impact network performance and appliance costs. This is explained by discussing progress by the International Electrotechnical Commission (IEC) and International Organization for Standardization (ISO) at establishing a worldwide standard for home automation [3]. The world has complex standards and specifications as home technologies expand to encompass computer and communication networks. International home automation standards can be separated into two groups depending on working as groups and proprietary. Some of these standards are given Table 1.

Table 1. Home automation standards

Standard	Media	Description
Ce BUS [4,5]	All	The Consumer Electronic Bus Standard (EIA-600) is a protocol specification developed by the Electronic Industries Association (EIA) to support the interconnection and interoperation of consumer products in a home.
HAVI [6,7]	IEEE 1394	Home Audio Visual Interoperability is a Consumer Electronics (CE) industry standard that will ensure interoperability between digital audio and video devices from different vendors and brands that are connected via a network in the consumer's home.
Bati BUS [8]	Twist Pair	Link sensors and actuators to building systems that control HVAC, security, access, and life safety. Scheduled to converge with EIB and EHS.
Home PNA	Phone Line	The Home Phone line Networking Alliance (HomePNA) is an association of industry-leading companies working together to ensure adoption of a single, unified phone line networking standard and rapidly bring to market a range of interoperable home networking solutions.
X10 [9]	Power Line	The father of power line home automation protocols. Facilitates control of household devices over the existing home wiring system.
Lon Works [10,11]	All	Home and commercial control network. A Lon Works control network is any group of devices working together to sense, monitor, communicate, and control.
Z-Wave	RF	Zensys' RF-based technology Z-wave is designed specifically for full home control, enabling power outlets and switches, thermostats, access control, intruder and fire alarms, and other home control networks to go wireless.
Zig Bee [12]	Wire-less	The ZigBee Alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked, monitoring and control products based on an open global standard.

III. HARDWARE DESIGN OF THE TELEPHONE CONTROLLED HOME AUTOMATION SYSTEM

Home automation which constructs the main concept of the study is shown in the modelled scenarios with control panels, environment units, and sensors. A microcontroller based circuit is designed in order to control electrical devices and feedback is received from home. Almost every home has its own telephone line. That's why phone line is selected for sending and receiving information. Voice recording and playing system is integrated with the system for getting audible feedback and warning messages. A Liquid Crystal Display (LCD) and keypad is added to the system to attain ease of use. A power supply is also included against power interrupts or voltage drops.

A circuit is designed that can control devices at home and conditions of sensors can be informed to the phone numbers which are entered previously. Therefore, the circuit may be separated into two parts as control and alarm units. Both of them are programmed by using microcontroller. A Peripheral Interface Controller (PIC) is used as the microcontroller device. Its code was written in Assembly language. Telephone controlled home automation system is designed as shown in Figure 2. Sensors are mounted on a wooden board and lamps are used to simulate the devices controlled by the telephone.

Figure 2. Telephone controlled home automation system

Main circuit and block diagram of the system are shown in Figures 3 and 4.

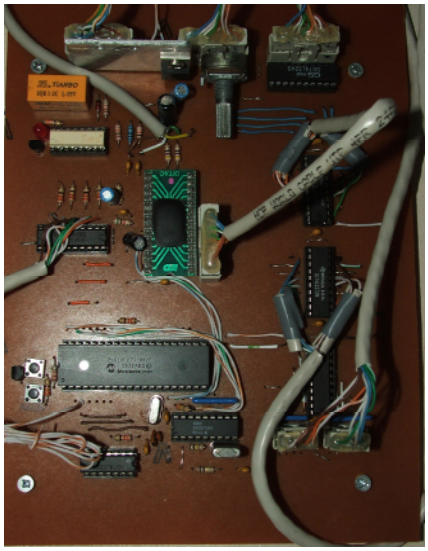

Figure 3. Main circuit of the system

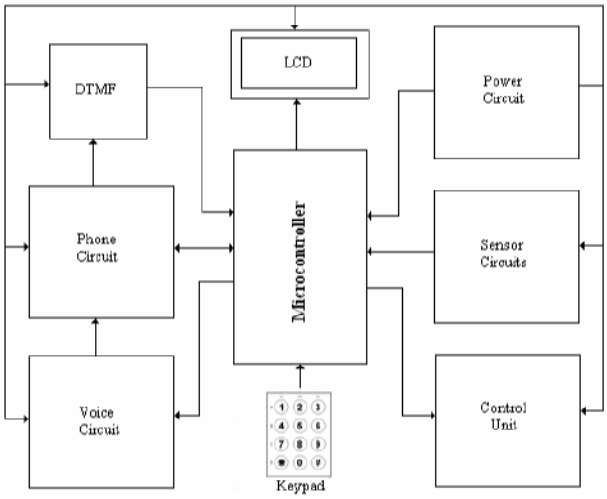

Figure 4. Block diagram of the system

The system has two main circuits as mentioned before. Whole system is connected to phone line. When the control unit is called from an external phone, voice circuit sends "şifreyi giriniz" message to phone line to request a password. After password is entered, voice circuit sends "cihazı tuşlayınız" message to phone line to define the devices. The control circuit can control up to eight devices according to the keys pushed. The system uses smoke sensor, motion sensor, temperature sensor, electrical and water detectors. Alarm unit can inform six different states. When the system detects emergency state, alarm circuit sends the situation to the microcontroller. Telephone circuit calls defined phone numbers. Voice circuit sends related message to phone line. Voice messages resulting in sensor triggering are given in Table 2.

Table 2. Types and numbers of voice messages

Type of Message	Triggered Sensor	Voice Message	Message Number
Feedback	-	"şifreyi giriniz"	01
	-	"cihazı tuşlayınız"	02
Warning	Motion	"evde hırsız var"	03
	Smoke	"evde yangın çıktı"	04
	Electrical	"elektrik geldi"	05
	Electrical	"elektrik gitti"	06
	Water	"su geldi"	07
	Water	"su gitti"	08
	Water	"evi su bastı"	09
	Temperature	"sıcaklık yüksek"	10
	Temperature	"sıcaklık düşük"	11

IV. SOFTWARE DESIGN OF THE TELEPHONE CONTROLLED HOME AUTOMATION SYSTEM

Assembly language is used to program the PIC microcontroller. Assembler was required to compile assembly codes to hexadecimal codes for PIC. Software is written using MPLAB program for 16F877 microcontroller integrated circuit (IC) of Microchip firm.

When the system is initialized, characters appear on the LCD as the entrance menu is shown in Figure 5. At first, temperature of environment, time and date are seen on the LCD.

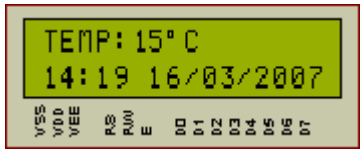

Figure 5. Entrance menu

Keypad is used to follow the menu. When '*' was pressed, password is required. Password has four numbers of which default value is '1234'. If password is entered wrong, screen returns to entrance menu. After password is entered correctly, '*' is required to be pressed. After '*' is pressed, the main menu appears as shown in Figure 6.

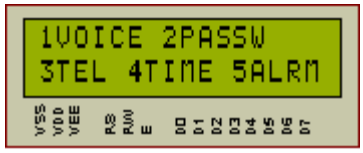

Figure 6. Main menu

'1' should be pressed to enter the voice menu. Here, eleven messages can be played and recorded repeatedly. If '2' is pressed in the main menu, the password menu appears on the LCD. Here, default or previous password

can be changed by a new password. '3' is pressed to define and clear three different phone numbers. '4' is pressed to set time and date. '5' should be pressed to enter the alarm menu. In this menu, sensors can be set active or inactive.

V. RESULTS AND DISCUSSION

The main advantage of the realized system over various security and control systems is that it is a bidirectional control system. It contains both control circuit to turn on/off electrical devices from remote locations and warning system to inform dangerous situations such as fire, flood, etc. These are all realized using the simple phone line which can be reached from everywhere. Besides, this system has sound feedback from devices and it can send voice messages in case of any danger.

Moreover, this system works as a smart home automation system. Namely, it enables the user to control several home security and electrical devices by the concept of smart life system. This concept means the routines about house are realized automatically, the ideal comfort conditions, and probable malfunctions and danger warnings in a living area can be managed by the system.

As a result, the system is constructed according to this concept of use. In the system, constructed over the internal phone lines, DTMF decoder is used to reach the control panel. Electrical devices can be turned on/off through the telephone line. Besides, situations of motion sensors, steam detectors, electricity and water malfunctions and floods can be informed to phone numbers which are saved previously by using the same phone substructure. The integrated heat sensor also warns the related person via phone when the temperature reaches the level that is determined by the user.

The set up and adjustments of the system were realized via phone key set that exists on the phone of the house automation system. For forming an easy use of interface, an LCD panel was added on the phone. The main control circuit was realized by programming single PIC16F877 microcontroller in the Assembly language. This provides more flexible control and more reliable system.

VI. CONCLUSION

By separating system into zones, program scenarios will be provided inside the environment units. Besides, steam detector and glass breakdown sensor can be added to fulfil the construction of the complete automation system. The internet connection can be done effectively by adapting the system substructure into the TCP/IP protocols.

According to the improvements of today's automation technologies, the need of secure and more comfortable life emerges designing and using so called smart living system. The subject matter of the study focuses on the growing need of the building and security applications in the field of their interactive and remote controls, and presents possible solutions therein.

REFERENCES

1. H.J. Zainzinger, An artificial intelligence based tool for home automation using MATLAB, 10th IEEE International Conference on Tools with Artificial Intelligence, pp. 256-261, 1998.
2. Kim Y.S., Kim H.S., Lee C.G., The development of USB home control network system**,** Control, Automation, Robotics and Vision Conference, ICARCV 8th, Vol. 1, pp. 289-293, 2004.
3. K.P. Wacks, International Development Of Home Automation Standards, Home and Building Automation Consultant, 1992.
4. G. Evans, The EIA Consumer Electronic Bus twisted pair network, Consumer Electronics, IEEE Transactions, Vol. 37, pp. 101-107, 1991.
5. B.E. Markwalter, S.K. Fitzpatrick, P.J. Hargaden, S.C. Appling, Design influences for the CEBus automation protocol, Consumer Electronics, IEEE Transactions, Vol. 37, pp. 145-153, 1991.
6. R.G. Wendorft, R.T. Udink, M.P. Bodlaender, Remote execution of HAVi applications on Internet-enabled devices, Consumer Electronics, IEEE Transactions, Vol. 47, pp. 485-495, 2001.
7. R. Lea, S. Gibbs, A. Dara-Abrams, E. Eytchison, Networking home entertainment devices with HAVI, Consumer Electronics, IEEE Transactions, Vol. 33, pp. 35-43, 2000.
8. M. Teoh Chee Hooi Singh, Y.K. Siah, A.R. bin Ahmad, Building low-cost intelligent building components with controller area network (CAN) bus, Electrical and Electronic Technology, TENCON. Proceedings of IEEE Region 10th International Conference, Vol. 1, pp. 466-468, 2001.
9. A. Arora, R. Jagannathan, Yi-Min Wang, Model-based fault detection in powerline networking, Parallel and Distributed Processing Symposium., Proceedings International, IPDPS, pp. 8-15, 2002.
10. Byoung-Hee Kim, Kwang-Hyun Cho, Kyoung-Sup Park, Towards LonWorks technology and its applications to automation, Science and Technology, 2000. KORUS 2000. Proceedings. The 4th Korea-Russia International Symposium, Vol. 2 pp. 197-202, 2000.
11. H. Shahnasser, Quan Wang, Controlling industrial devices over TCP/IP by using LonWorks, Global Telecommunications Conference, GLOBECOM 98, The Bridge to Global Integration, IEEE, Vol.2 pp. 1309-1314, 1998.
12. D. Egan, The emergence of ZigBee in building automation and industrial control, Computing & Control Engineering Journal, IEEE, Vol. 16, Issue 2, pp. 14-19, 2005.