

**DESIGN AND IMPLEMENTATION OF SMART HOME  
AUTOMATION AND SECURITY SYSTEM**

**MOHD ZULFADLI BIN IBRAHIM**

**MAY 2008**

I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation, and Automation)

Signature :

Supervisor's Name : EN MOHD ARIFF BIN MAT HANAFIAH

Date : MAY 2008

**DESIGN AND IMPLEMENTATION OF  
SMART HOME  
AUTOMATION AND SECURITY SYSTEM**

**MOHD ZULFADLI BIN IBRAHIM**

**This thesis submitted in accordance with the partial requirements of the  
Universiti Teknikal Malaysia Melaka for the  
Bachelor of Electrical Engineering  
(Control, Instrumentation & Automation)**

**Faculty of Electrical Engineering  
Universiti Teknikal Malaysia Melaka**

**MAY 2008**

## DECLARATION OF THESIS

I hereby, declare that this thesis entitled “Design and Implementation of Smart Home Automation and Security System” is a result of my own research, design and idea except for works that have been cited in the references.

Signature :

Name : MOHD ZULFADLI BIN IBRAHIM

Date : MAY 2008

## DEDICATION

For my beloved parents, Pn Rahimah Hj Jaafar and En Ibrahim Othman

## ACKNOWLEDGEMENT

Alhamdulillah... Thank You Allah...

I have a sign of relief after finished up my report of *Projek Sarjana Muda 2* successfully. Although I felt very pleasure but I do not forget to express my appreciation to those who have helped me a lot in my final project.

First of all, I would like to express my gratitude and thanks to my supervisor, En Mohd Ariff Bin Mat Hanafiah for his invaluable advice and guidance throughout the period of this semester. His guidance in this project will remain forever.

My appreciation also to my parents, En Ibrahim Bin Othman and Puan Rahimah Binti Hj Jaffar, who have been so tolerant and supports me all these years. Thanks for the encouragement, love and emotional supports.

I would also like to thank FKE Staff and Technician for co-operations, guidance and helps in this project. Nevertheless, my great appreciation dedicated to all my friends and those whom involve directly or indirectly in the development of this project. There is no such meaningful word than....Thank You So Much.

## ABSTRACT

This project is about the design and implementation of Smart Home Automation and Security System. It comprises of integration between Programmable Logic Controller (PLC), PIC Programming Controller, Global System Mobile (GSM) mobile communication, home automation, and security system. This project consists of Security Door Access, Security System Using GSM Controller, Home Appliances using GSM Controller, and Automatic Watering System. This combination of technology will produce a home automation called Smart Home System. Smart Home is an integration of various systems at home which is coordinated by Smart Home controller and controlled by users using command interfaces while security system is an electrical device that sets off an alarm when someone tries to break in. This project can be divided into two main parts which are hardware and software development. The hardware development includes the PLC wiring connection, PIC interfacing circuit, relay connection and home automation circuit. The software development includes develop the PLC ladder diagram, PIC controller source code, GSM message command, and relay diagram. This system is controlled by users using various centralized command interfaces such as hand phone, personal digital assistants (PDA), keypad and switches.

## ABSTRAK

Projek ini adalah berhubung dengan rekaan dan pengaplikasian Rumah Pintar Sistem Automasi dan Keselamatan. Ia meliputi gabungan antara *Programmable Logic Controller (PLC)*, *PIC Programming Controller*, *Global System Mobile (GSM)*, pengatomasian rumah, dan sistem keselamatan. Projek ini merangkumi Akses Keselamatan Pintu, Sistem Keselamatan dengan Pengawal GSM, Peralatan Rumah dengan Pengawal GSM, dan Sistem Penyiraman Automatik. Gabungan teknologi ini akan membentuk sistem pengautomasian rumah iaitu Sistem Rumah Pintar. Rumah Pintar ialah gabungan pelbagai sistem di rumah yang dikawal oleh Pengawal Rumah Pintar dan digunakan oleh pengguna dengan menggunakan arahan antaramuka manakala sistem keselamatan adalah alat elektrik yang akan mengaktifkan penggera apabila berlaku pencerobohan. Projek ini dibahagikan kepada dua bahagian iaitu pembangunan perkakasan dan perisian. Pembangunan perkakasan ini meliputi sambungan pendawaian PLC, litar antaramuka PIC, sambungan geganti, dan litar pengautomasian rumah. Pembangunan perisian pula meliputi rajah tangga PLC, kod pengawal PIC, arahan mesej GSM, dan rajah geganti. Sistem ini juga dikawal oleh pengguna menggunakan pelbagai arahan antaramuka seperti telefon bimbit, PDA, papan kekunci, dan suis.

**TABLE OF CONTENTS**

<b>PROJECT TITLE</b>	<b>i</b>
<b>DECLARATION OF THESIS</b>	<b>ii</b>
<b>DEDICATION</b>	<b>iii</b>
<b>ACKNOWLEDGEMENT</b>	<b>iv</b>
<b>ABSTRACT</b>	<b>v</b>
<b>ABSTRAK</b>	<b>vi</b>
<b>TABLE OF CONTENTS</b>	<b>vii</b>
<b>LIST OF TABLES</b>	<b>xiv</b>
<b>LIST OF FIGURES</b>	<b>xv</b>
<b>LIST OF ABBREVIATION</b>	<b>xvii</b>
<b>LIST OF APPENDICES</b>	<b>xviii</b>



<b>CHAPTER</b>	<b>TITLE</b>	<b>PAGE</b>
<b>1.0</b>	<b>INTRODUCTION</b>	
1.1	Project Back ground	1
1.2	Overview of Smart Home for Security System	2
1.2.1	Security System Using GSM Controller	2
1.2.2	Home Appliances Using GSM Controller	3
1.2.3	Security Door Access	3
1.2.4	Automatic Watering System	3
1.3	Problem Statement	4
1.4	Project Objectives	5
1.5	Project Scope	7
<b>2.0</b>	<b>LITERATURE REVIEW</b>	
2.1	Previous Research	
2.1.1	HF Radio Frequency Monitoring and Surveillance	8
2.1.2	Intelligent Automatic Door Lock	
2.1.3	Web-Based Visual Intelligence Surveillance and Security System	9
2.1.4	Development of Real-Time Embedded System with Speech Recognition for Smart House	11

2.2	Components Theory	12
2.2.1	Motion Detector	12
2.2.2	Magnetic switch sensor	16
2.2.3	Op-Amplifier (LM741)	18
2.2.3.1	Description of Op-Amplifier LM 741	18
2.2.3.2	Specification	19
2.2.4	RS232 Serial Port	20
2.2.5	Microcontroller PIC 16F767	22
2.2.5.1	Memory	23
2.2.5.2	Random-Access Memory	23
2.2.5.3	Read-Only Memory	23
2.2.6	Relay	24
2.2.7	Relay Omron MY Model	25
2.2.8	Signal Relay Omron G5V-1	26
2.2.9	Omron Photo Electric Sensor E3Z-D61 2M	27
2.2.10	Programmable Logic Controller Keyence KV 16-DR	28
2.2.11	GSM Modem	31
2.3	Concept of Global System for Mobile Communications	33
2.3.1	Architecture of the GSM Network	34
2.3.2	Mobile Station	35
2.3.3	Base Station Subsystem	35
2.3.4	Network Subsystem	35
2.4	Short Message Service	36

## **3.0 PROJECT METHODOLOGY**

3.1	Project Methodology	38
-----	---------------------	----

3.2	Project Planning	41
3.3	Thesis Outline	42
<b>4.0</b>	<b>RESULTS</b>	
4.1	Hardware and Software Development	44
4.1.1	Component Sizing	44
4.1.2	Components for Security and Home Appliances Automation System Using GSM Controller	45
4.1.3	Components for Security Door Access	48
4.1.4	Components for Automatic Watering System	50
4.2	Hardware Development	51
4.2.1	Hardware Development for Security and Home Appliances Automation System Using GSM Controller	51
4.3	Software Development	54
4.3.1	Automatic Watering System	54
4.3.1.1	Programmable Logic Controller (PLC) I/O Assignments for Automatic Watering System	54
4.3.1.2	Simulation using KV Builder for Automatic Watering System	55
4.3.1.3	Ladder Diagram of Automatic Watering System	57
4.3.1.4	Mnemonic Code of Automatic Watering System	58
4.3.2	Door Access Code	59
4.3.2.1	Programmable Logic Controller (PLC) I/O Assignments for Door Access Code	59
4.3.2.2	Simulation using KV Builder for Door Access Code	60
4.3.2.3	Ladder Diagram of Door Access Code	62

	4.3.2.4	Mnemonic Code of Door Access Code	63
4.3		AT Command Protocol	64
	4.3.1	Sending SMS Messages	64
	4.3.2	Receiving SMS Messages and Reading SMS Messages from Message Storage	64
	4.3.3	Select Message Service +CSMS	65
	4.3.4	New Message Acknowledgement +CNMA	65
	4.3.5	Save Settings +CSAS	65
	4.3.6	Preferred Message Format +CMGF	66
	4.3.7	Read Message +CMGR	66
	4.3.8	Send Message +CMGS	66
	4.3.9	List Message +CMGL	67
	4.3.10	Write Message to Memory +CMGW	68
	4.3.11	Delete Message +CMGD	68
4.4		Hyper Terminal Settings and Protocol	69
4.5		Discussion with Engineering Company	72
4.6		Expected Result	72
<b>5.0</b>		<b>DISCUSSION</b>	
5.1		Project Significances	73
	5.1.1	Significance to University	73
	5.1.2	Significance to Industry	73
	5.1.3	Significance to myself	73
5.2		Benefits of the Smart Home	74
	5.2.1	Convenience at your finger tip	74
	5.2.2	Safety and intelligent security	74

5.2.3	User friendly	74
5.3	Analysis on the effectiveness of using the Short Message Services (SMS)	75
5.3.1	Advantages of SMS	75
5.3.2	SMS Criticism	76
5.3.3	Alternatives to SMS	76
5.4	Comparison between the relevant systems for Smart Home System.	77
<b>6.0</b>	<b>CONCLUSION AND RECOMMENDATION</b>	
6.1	Conclusion	78
6.2	Recommendations	78
6.3	Future Plans	79
<b>7.0</b>	<b>REFERENCES</b>	
7.1	References	80
7.1.1	Books	80
7.1.2	Newspapers	81
7.1.3	Magazines	81
7.1.4	Websites	81
7.1.5	Journal	82
7.1.6	User's Manual	82

**LIST OF TABLES**

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
2.1	RS 232 Pin Assignments (DB9 PC Signal Set)	21
4.1	Input Assignments for Automatic Watering System	54
4.2	Output Assignments for Automatic Watering System	54
4.3	Input Assignments for Door Access Code	59
4.4	Output Assignments for Door Access Code	59
5.1	Comparison between the Remote Technologies	77

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 2.1:	Pet Immune PIR Motion Detector	13
Figure 2.2:	Basic Motion Sensor Configuration	14
Figure 2.3:	How Motion Detector Work	15
Figure 2.4:	Door Magnetic Switch	16
Figure 2.5:	Position for Magnetic Contact Sensor	17
Figure 2.6:	Installation of Magnetic Switch	17
Figure 2.7:	LM 741	18
Figure 2.8:	LM 741 Pin Assignments	19
Figure 2.9:	RS 232 Cable	20
Figure 2.10:	DB 9	20
Figure 2.11:	Handshake Looping a PC Serial Connector	21
Figure 2.12:	PIC 16F767 Microcontroller	22
Figure 2.13:	Relay Pin Configuration	24
Figure 2.14:	Relay Omron MY Model	25
Figure 2.15:	Signal Relay Omron G5V-1	26
Figure 2.16:	Omron Photo Electric Sensor E3Z-D61 2M	27
Figure 2.17:	PLC System Overview	29
Figure 2.18:	PLC Keyence KV16 DR/DT	30
Figure 2.19:	GSM Modem	31

Figure 2.20:	GSM Modem to Personal Computer	32
Figure 2.21:	TDMA Access Method used by GSM	33
Figure 2.22:	General Architecture of a GSM Network	34
Figure 2.23:	How SMS Works	37
Figure 3.1:	Gantt Chart for Project Planning	40
Figure 3.2:	Flow Chart of Project Methodology	43
Figure 4.1:	Assembly of GSM Controller Circuit	51
Figure 4.2:	Assembly for GSM Controller's Components	51
Figure 4.3:	Connection Link with GSM Modem	52
Figure 4.4:	Testing using Hyper Terminal	52
Figure 4.5:	House Model (Front View)	53
Figure 4.6:	House Model (Full View)	54
Figure 4.7:	Simulation using KV Builder	55
Figure 4.8:	Running Mode Simulation	56
Figure 4.9:	Simulation using KV Builder	60
Figure 4.10:	Running Mode Simulation	61
Figure 4.11:	Connection Description	69
Figure 4.12:	Connection Port	70
Figure 4.13:	Port Properties	70
Figure 4.14:	Specification	71
Figure 4.15:	Delete old data	71
Figure 5.1:	SMS Messaging	75



## LIST OF ABBREVIATION

SMS	Short Message System
GSM	Global System Mobile
Tx	Transmitting
Rx	Receiving
GND	Ground
DC	Direct Current
N.C	Normally Close
N.O	Normally Open
COM	Common
PLC	Programmable Logic Controller

## LIST OF APPENDICES

<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
A	Printed Material	83
B	Datasheet of TIP 142	86
C	Specification of PLC Keyence KV 16-DR	90
D	Dimension of PLC Keyence KV 16-DR	93
E	Datasheet of PIC 16F767	96
F	Datasheet of Optocoupler	104
G	RS 232 Wiring Diagram	107
H	Datasheet of Voltage Regulator	109
I	Datasheet of PCB Signal Relay G5V-1	112
J	Datasheet of General Purpose Omron Relay MY	116
K	Datasheet of Photoelectric Sensor E3Z	130

## CHAPTER 1

### INTRODUCTION

#### 1.1 Project Background

Nowadays, there are many burglary cases happens, the residence in this country must concern and take any steps to prevent it. It shows the importance of the security system in Malaysia. Security system has already become an important to every home not only for the building and premises. Security systems have becoming more of a necessity rather than only an additional service to home owners. Many types of systems are available and the cost of a security system depends on the level of defense.

All good quality applications have a second line of protection and this is what this system is. Therefore, Smart Home Security System should be regarded as the second line of protection. Security system via SMS has not been used in Malaysia because the high cost. This project aims to utilize ordinary alarm equipment, the hand phone together with a microcontroller and electronic components to decrease the cost which the residence can afford for it.

Thus, this project aims to create a security system which is the second line protection against burglary and give signal through SMS to the user of the system about the incident and he/she can take fast action on it. Besides, it also offers the home automation system such as automatic watering system to make the user's life much easier.

Burglar security system and sensors is widely implemented in today's technology. But somehow most of the system only gives alert to the user when they are inside the house or nearby the house. What happen if they leave the house? With this Smart Home Security System, user will be alert on their house security whether there are at home or away from home. The idea is basically by having the sensor to detect any intruder and send the output to a controller which will send SMS to the owner's mobile phone whenever the owner is away from home.

As a very basic definition, home automation can be referred as anything which gives automatic control of electrical devices around the home. Smart Home is an integration of various systems at home such as security, home automation, CCTV and any system which is coordinated by a smart home controller and controlled by users using various centralized command interfaces.

Many years ago, some have said that a TV with remote control makes a person lazy. Today, we can't imagine buying a TV without a remote control function. It's not just about technology, but improvement of quality of living, which demands greater comfort, convenience and security. This is what the project will prove to improve the user's quality of living.

## **1.2 Overview of Design and Implementation of Smart Home for Security System.**

### **1.2.1 Security System Using GSM Controller**

Function of this system is to alert the user when motion detector detects the intruder through GSM mobile phone. Controller will send a SMS to the user automatically after the motion detector has detects the intruder. To achieve the objective, a microcontroller PIC 16F767 is used as the main processing unit for this system.

Therefore, the advantages of this system are user can secure their property with the motion detector whenever nobody is at home and the controller will trigger the house's alarm and at the same time alert the user through their mobile phone. This system will send a SMS to the number that is already program.

### **1.2.2 Home Appliances Using GSM Controller**

The functions of this Home Appliances GSM Controlled for Smart Home System project are to turn on or off the home appliances from anywhere by using

GSM communication. User has a full access to their home automation by trigger on/off devices, lights, or activates programmed sequences.

The advantages of this system are it has an ability to control the user-desired home appliances through SMS, can simulate live-in conditions when the house is leave unattended during holiday, and in-control of house's condition via SMS.

### **1.2.3 Security Door Access**

The functions of this security door access is to secure an entrance into the house using code number which controlled by PLC. The operation of this system is the user has to enter the code number within 15 seconds after the door is opened. And if not, the buzzer will sound.

### **1.2.4 Automatic Watering System**

In this system, it offers the user to have the automated household system which is watering system. It will water the lawn on the time programmed and on the rainy day, the moisture sensor will gives signal to close the water valve.

The advantages of the automatic watering system are to turn on and off to water the lawn for a programmed amount of time, moisture sensor prevents over-watering by given the signal to close the valve and cost saving.

## **1.3 Problem Statement**

The major reason to design this project is to solve user's problems in addition to improve knowledge and learn about the electrical communication system. The safety in premise or house depends on the owner. In Malaysia, there are no safety system using SMS but in overseas, there have safety system which the safety department and the owner of the premise could know when there are any bad incidents. Furthermore, people do not have time to look at their house in 24 hours to make sure their properties are safe.

A residence without a home security system is approximately three times more likely to be broken into than one without. Home owners who have home security systems lose an average of RM400 less in valuables in the event of a robbery. These facts proved that the installation of a home security system dissuades intruders and protects your home.

Thus, having a security alarm system may decrease the chances of a burglary. Even if the alarm system does not keep a burglar from breaking in, it may cause the burglar to stay a shorter amount of time.

- a) In most cases, entry is attempted at the rear of the houses where security is often poor and there is less chance of being observed. But, user couldn't see what was happening at their house anytime they want from wherever they are.
- b) By using conventional alarm system, user does not receive any signals when intruder enters the house. Therefore, no action can be done when burglary occurred.
- c) Some of the conventional alarm system gives false reactions due to improper situation such as over-sensitive i.e. lightning and etc.
- d) When out of town or house is leaved unattended during holiday, they had problem to create a lived-in look of their house to prevent burglary. Even there is timed-programmed lighting and it turned on at the same time and same place. This situation welcomes the intruders. So, there is a need such a system that may turn on different light at different time and on the different day.
- e) On the emergency situation, the user cannot take appropriate actions when nobody at the house such as turns on the alarm or any appliances.
- f) When having vacation, the user had a problem to water the lawn because of there are nobody at the house and they do not have automated watering system.

## 1.4 Project Objectives

The objective of this project is designed and implemented the Smart Home for security system. Smart Home is an integration of various systems at home which is coordinated by Smart Home controller and controlled by users using command interfaces.

Security System is an electrical device that sets off an alarm when someone tries to break in. The alarm can be buzzer or siren that may alerts the surrounding. Furthermore, the existing security systems mostly give out alarm when any sensor senses a target.

This alarm can only alert the owner only when they are inside the house or nearby the house. Thus we came out with a system that can also alert the owner even when they are not at home.

This project is divided into two major objectives:-

1. To design and modify the hardware of Smart Home System which is consists of the PLC wiring connection, PIC interfacing circuit, relay connection and home automation circuit.
2. To design the software which is to control all the system such as develop the PLC ladder diagram, PIC controller source code, GSM message command, and relay diagram.

### Project Sub-Objectives

- a) To activate the house's alarm and at the same time alert the user through GSM mobile phone. It would helps to secure the house with motion detection and guard the home from intruders.
- b) To allow the user to control house appliances using GSM system and to offer convenient control by automatically turn on and off the house appliances using SMS.

- c) To make our customer's home look lived-in to prevent burglary even if they are on vacation or working late.
- d) To implement the new communication technology for automation and security system rather than the conventional security system by making use of GSM as the interface between the human and the appliances.
- e) To control and automate irrigation for lawn watering system with input for rain sensing using moisture sensor.
- f) To secure an entrance into the house using code number and safeguard the compound of the house and helps to reduce a number of burglary cases due to the security weaknesses.

## **1.5 Project Scope**

After largely study on the security system for Smart Home concept, there are many issues must be considered to produce a preliminary design of Smart Home. The scopes of this project are:

- a) Design the home automatic watering system with moisture sensor.
- b) Design the door access code number system using PLC.
- c) Design the system to turn on and off the home appliances using SMS.
- d) Design the system which alerts the user if the intruder enters the house.
- e) This project will utilize the PLC and PIC as the main processing unit and therefore the project of developing software for the controller to be applied onto a demonstration set.