

**DEVELOPMENT OF AN AUTOMATED SMART ROOM CONTROLLER
USING ATMEL AT89S52**

BY

EMI IZHANIZAM BIN AZMI

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ABBREVIATIONS

SMS	Short Messaging Service
RF	Radio Frequency
IR	Infrared
GSM	Global Satellite Mobile
GPRS	General Packet Radio Service
EDGE	Enhanced Data GSM Environment
USB	Universal Serial Bus
PC	Personal Computer
CMOS	Complementary Metal Oxide Semiconductor
RAM	Random Access Memory
EEPROM	Electrically Erasable Programmable Read Only Memory
MUX	Multiplexer
CPU	Central Processor Unit
ALU	Arithmetic Logic Unit
FPGA	Field Programmable Gate Array
ASIC	Application-Specific Integrated Circuit
RTC	Real Time Clock
UART	Universal Asynchronous Receiver Transmitter
AC	Alternate Current
DC	Direct Current
LCD	Liquid Crystal Display
LED	Light-Emitting Diode

ADC	Analogue to Digital Converter
ROM	Read Only Memory
PCB	Printed Circuit Board
PWM	Pulse Width Modulation

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ABSTRACT

When electrical appliances are used without any surveillance, the cost of electricity increases. The cost may increase further when there are air-conditioners involved. It has been foreseen that in the year 2020, all electrical appliances will be controlled automatically. A system which can accommodate such functionalities is a smart system. One type of smart system is a smart room system. It is an information technology, computer-based system which facilitates human in controlling the use of appliances and hence, reduce the cost of electricity. Although there have been various smart home systems nowadays, not all has incorporated a built-in display panel to facilitate the control of the electrical-appliances and rooms. Therefore, this project focuses on designing and developing a smart room with a display panel using a microcontroller. The smart room system has three main objectives. The first objective is to develop the main software to automatically control all the electrical appliances in the smart room. The second objective is to build a display panel for controlling the number of occupants and the electrical appliance in the room. The last objective involves the development of a system that automatically controls the use of the air-conditioners and fans, depending on the room temperature. The main works of this project include the development of a smart sensor system, home automation system, the main software and the integrated model. The final phase of the project involves developing the smart room prototype. The successfully developed microcontroller components have been tested and found to be fully functioning. Such a system has shown to be useful in that it provides users with an efficient environment as all appliances can be

automatically controlled by a computer. Moreover the users can in real-time, observe up-to-date information of their smart room condition through a built-in display panel.

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ABSTRAK

Peningkatan kos penggunaan elektrik menjadi semakin ketara sekiranya perkakasan elektrik dipasang tanpa pengawasan. Ianya bertambah kritikal apabila alat penghawa dingin digunakan secara tidak terkawal. Telah dijangkakan bahawa menjelang tahun 2020, aktiviti di rumah kediaman akan dipengaruhi oleh kawalan secara automatik sepenuhnya. Kawalan sedemikian dapat dijalankan menggunakan sistem bestari. Salah satu system bestari ialah system bilik bestari. Ia adalah produk teknologi informasi berasaskan sistem komputer yang memudahkan manusia dalam mengawal penggunaan perkakasan dan seterusnya dapat menjimatkan elektrik. Walaupun terdapat pelbagai jenis system rumah bestari pada masa kini, namun bukan kesemuanya mempunyai papan paparan yang memudahkan pemantauan penggunaan alatan elektrik dan bilik tersebut. Oleh yang demikian, projek ini tertumpu kepada rekabentuk dan pembangunan sistem bilik bestari dengan papan paparan menggunakan mikropengawal. Objektif bilik bestari ini terbahagi kepada tiga iaitu membangunkan perisian utama bagi memastikan kesemua peralatan elektrik di dalam bilik bestari dapat bertindak secara automatik, membangunkan papan paparan yang tersendiri bagi tujuan memantau pergerakan manusia dan peralatan yang sedang digunakan di dalam bilik bestari dan membangunkan sistem yang dapat mengawal penggunaan alat penghawa dingin dan kipas secara automatik mengikut kesesuaian suhu bilik. Kerja-kerja utama kajian ini melibatkan pembangunan sistem penerima bestari, pembangunan sistem automasi kediaman, rekabentuk serta pembangunan perisian utama, dan pembangunan model bersepadu. Fasa terakhir adalah pembangunan prototaip sistem bilik bestari tersebut. Sistem mikropengawal yang berjaya dibangunkan

telah diuji dan didapati bahawa kesemua komponennya dapat berfungsi sepenuhnya secara automatik. Sistem bilik bestari dapat memberikan pengguna persekitaran yang cekap di mana kesemua peralatan elektronik dapat dikawal secara automatik. Tambahan pula, dalam masa nyata, pengguna dapat mengawasi keadaan bilik bestari melalui papan paparan.

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CHAPTER 1 – INTRODUCTION

1.1 Background of an Automated Smart Room System

One of the advantages of the fast-moving information technology is when a system is capable of automatically measuring, evaluating and reacting to any changes that surrounds it. One of the end products of such a system is a Smart Room. Generally, a smart room system is closely connected with the information technology and the communication system, resulting in a more efficient and productive environment. A variety of smart room systems have been developed in the past few years. Most of the products use existing facilities such as the internet, mobile phones and a lot other communication tools to control the electrical appliances (Briere, 2003).

The internet is one of the medium to connect smart rooms with users. With the system, electrical appliances in the smart room can be controlled through web-browsing (Wong et al, 2007). Still, there are a few weaknesses associated to such communication. For example, the internet can easily be hacked. Thus, a smart room may not actually be in a safe condition. Introducing mobile phones as a medium is typically a way out of this problem. With mobile phones, the users can control their smart rooms easily as all they need to do is to send an SMS to the system in order to communicate with the electrical appliances in the smart room only a particular mobile phone number is recognized and obeyed by the system (Rifat Shahriyar et al, 2008). Though safer, the use of mobile phones can lead to a much higher phone bill. The phone bill will be parallel with the use of the smart room system technology thus making it less efficient.

A radio-frequency (RF) based system has been introduced to overcome this problem (Robert, 2004). Through this type of system, the user is only required to control the smart room system using a controller model which will be supplied to them. The weakness of this system it does not have the ability to function automatically and a variety of inputs are also needed. Other than that, the system also does not have a built-in display panel for observation of the room or home.

1.2 Problem Statement and Motivation

The smart room or home acts as a smart tracker that can be beneficial to create a much efficient life from the aspect of saving the power source and electricity cost (Horn, 1991). For instance, in a hot weather, the smart room system will switch on the fans for the comfort of the occupants. Whenever the temperature reaches its maximum, fans will be switched off, windows closed and air conditioner switched on and when the temperature decreases to a minimum, air conditioners will be off and fans will be switched back on. Besides that, as soon as the smart room detects that there are no more occupants in the room all the electrical appliances will be switched off automatically. This can prevent electricity waste.

In this project, a display panel has been introduced as a method to monitor the smart room. Other than that, most smart home systems use computers as the monitoring tool. This will burden users who do not own a computer.

The display panel focused in this project actually replaces the computer monitor as a tool used in previous projects.

1.3 Project Objectives

In this project, a smart room system is developed to help home owners overcome critical problems related to higher cost of living. It is developed to overcome the problems of rising electricity usage by most homes especially the ones equipped with air conditioners. Thus the objectives of the project are as follows:

- i. To design and develop a smart room system where each electrical appliance in the smart room operate automatically and effectively
- ii. To develop a display panel for the smart room
- iii. To develop a system that is capable of controlling the air conditioner and fans based on room temperature

This project also involves software development that is capable of interacting with the electrical appliances. This is to ensure that necessary actions are taken accordingly.

1.4 Dissertation Outline

The next chapter, Chapter 2 gives an overview of smart room systems available today. These researches are taken as the basic references to this project. The literature review chapter also includes an overview of the most important component used in the development of a smart system, which is the microcontroller chip. There are three chips that are being taken into consideration; the AT89S52 from ATMEL, 80C51 from Intel and MC68HC705MC4 from Motorola.

Chapter 3 explains the work done in developing the system. Among the topics included in this chapter are the hardware and software development, and the various tests carried out to verify the functionality of the system.

Chapter 4 describes the results and observation obtained based on the tests done in Chapter 3. The results from the test phase are also discussed in this chapter.

Chapter 5 is the last chapter in this dissertation. It reveals the conclusion for this project, where the objectives of the smart room system as stated in Chapter 1 has reached its goals. Besides that, the chapter also provides a few suggestions for future work that can be carried out to improve the work.

CHAPTER 2 – LITERATURE REVIEW

2.1 Introduction

Until today, a lot of researches related to smart home had been done. Some of these researches and projects had been done based on the concept of automated smart home. Most of these smart homes require instructions from the user almost all the time. The design of a smart home system required cabling works. Installing the smart home system in new houses (under development) is very straightforward because any cabling works can be done during the construction stages. However, it is a problem for completed houses as most of the existing home owners do not like hacking, plastering and repainting of walls in order to install a smart home system. Hence, it requires another alternative to overcome this problem so that the existing home owners can enjoy the benefits of the smart home system. One of the options is to use existing cables in every home where existing power line cables can be used to transmit data to control the electrical devices in a home. The other option is using a wireless technology. However, to use wireless technology for the entire house is very expensive.

In this chapter, a few existing smart home projects by a few researchers are reviewed to discuss the development of each project. The discussion focuses on smart home systems with rather distinct technology to highlight the improvement in the system.

2.2 Existing Smart Home Systems

2.2.1 Project by Jasper Wong et al

In 2007, researchers Jasper Wong et al had successfully discovered an application in improving the existing smart homes. They used the internet as a medium to create a connection between the user and the electronic equipments in the smart home. With this system, the users are able to monitor their homes from their respective office or absolutely anywhere in the world, provided that internet connection is available (Wong et al, 2007).

The system is operational when the users access the specific website created for this project using any internet-ready computer. This particular website is equipped with a security system where the users are required to enter a username and a password in order to use it (Wong et al, 2007). Once entered, the website will provide the latest status on the condition of all electronic equipments that are controlled by the house. This includes the lamps, fans, doors and etceteras. Besides that, by using this system, the users can control the on-off switch for the same equipments (Wong et al, 2007). This process is initiated when the users click on the available button in the website. This button will then send a signal through the internet connection directly to the computer in the home. The computer acts as a server that is connected to the infra-red (IR) remote control module. Once the server accepts this instruction, a signal is generated again to enable communication between the IR remote control module and the server. Based on the generated signal, the IR remote control module interprets the received instruction and act accordingly that is to either switch on or switch off the electronic equipment.

Figure 2-1 illustrates the flow of the process system.

Despite all the nice features of this system, there is one problem associated to the system. It is obvious that for such a system, a computer is an important tool in this project. Therefore, it is a must for the user to own a personal computer at home which increases the overall system cost. How about the home owners that does not own a computer? It would not be fair for them. Other than that, to use the computer for 24 hours and 7 days a week straight will result in a drastic rise in the electricity cost.

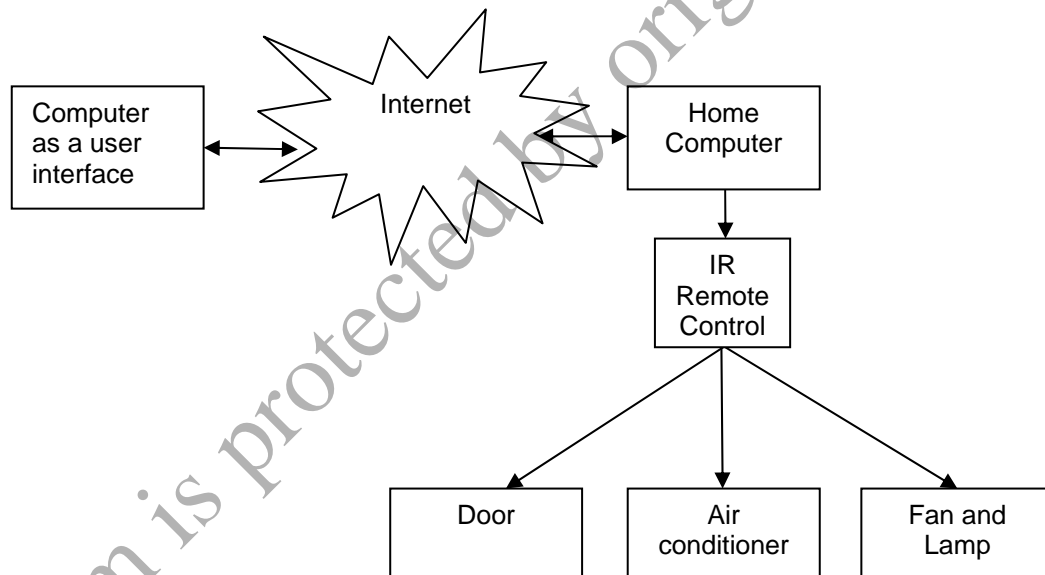


Figure 2-1 Structural diagram of the smart home by Jasper Wong et al

Another disadvantage of the system is related to security issues. Illegal website invasion by a computer networking hacker may occur and the intruder could take control of the home. Internet is a place crowded with various types of traffics, often hostile to each other (Rifat Shahriyar et al, 2008). Security vulnerability is the most striking alert point of the Internet. Whenever a web based application goes live, a

lot of efforts have to take place before it can be said to be secured. It is important to ensure that no malicious party ever gains control and abolishes everything. Also to use the web, it requires resources like flawless internet connections and hosting servers, which may not always fit into the concept of remote controlling.

2.2.2 Project by by Rifat Syahriar et al

Rifat Syahriar et al (2008) from Bangladesh University of Engineering & Technology had done some research on the use of another medium in a smart home to overcome the problems created from internet medium. Another candidate solution to this remote communication problem is the use of mobile telephony.

Mobile telephony offers a wide range of communication services like voice and data transfer through SMS and other enhanced data transfer protocols like GPRS, EDGE at a relatively low price and at a wide variety of places on the earth (Rifat Shahriyar et al, 2008). On the other hand, the security is better achieved using of strict traffic control. The method of remote controlling of home appliances will be adhering because of its unparallel availability and modest security at an affordable price.

In this research, a different feasible ways are produced to leverage the mobile telephony using the existing services but redefining the trivial purposes they serve. Several different methods were studied where by the cell phones were used to control the home appliances of a smart home (Rifat Shahriyar et al, 2008). They proposed two approaches for controlling home appliances. One was to make a custom-built controller from scratch for controlling the home appliances using

wired connection. The main problem of the system is the controller's connections which are rather clumsy as well as not reliable. It is better to use the available home controllers than to devise one from scratch to aid this goal as there are standardized home controllers in the market and they offer wide coverage of controllable appliances. The home appliances controlling part is connected to the X10 and concentrated on the communication between the mobile phone and the X10 controller for remote controlling of the X10 controller. X10 is chosen over others due to its wide availability (Rifat Shahriyar et al, 2008). Figure 2-2 shows the structural flow of the smart home by Rifat Syahriar et al.

Remote mobile acts as a user interface where the users will provide instructions according to certain formats using short messaging system (SMS). This SMS will be accepted by the home mobile and the information will then be transferred to the home computer to be interpreted. The resulting instruction will generate a signal to the X10 Controller using universal serial bus (USB) or serial communications. The X10 controller will again interpret the signal to obtain the necessary information and send it to the required modules. Finally, the X10 appliance module will provide information to the home appliance to interact according to the instruction given (Rifat Shahriyar et al, 2008).

The technology used in the system by Rifat Syahriar et al is considered as the most up-to-date and modern system. Nevertheless, there are still a few weakness is spotted in this system.

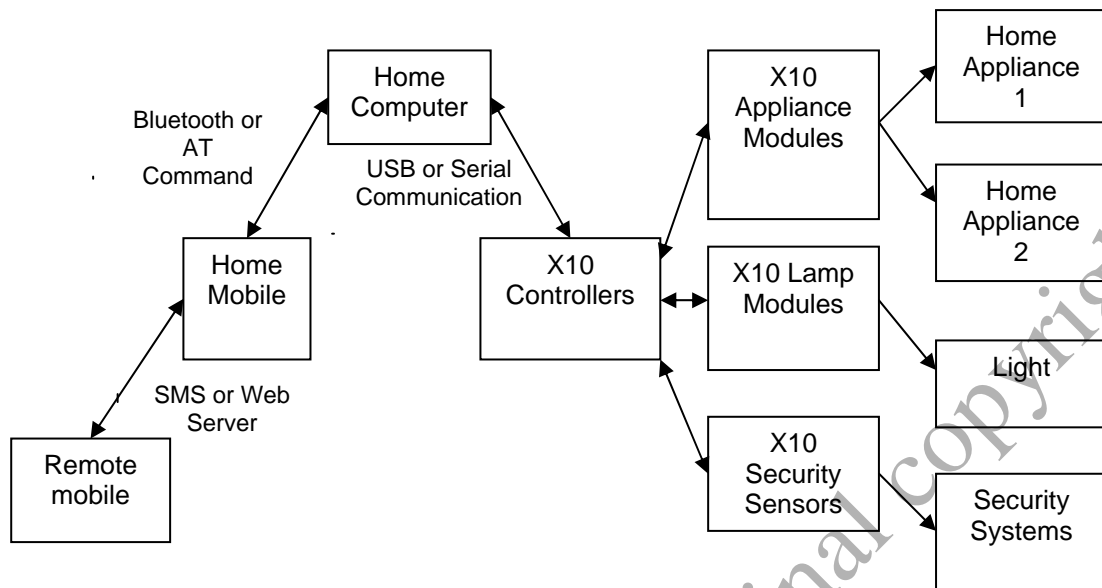


Figure 2-2 Structural flow the smart home by Rifat Syahriar et al

Amongst them is the quite high maintenance cost for such a system. This is because every time an instruction is sent to communicate with the electronic equipments in the house using SMS, necessary charges is incurred based on the fixed rate by the Telecommunication company. Other than that, such a smart home system is not appropriate to be used when the occupants is at home. It is only suitable when they are outside the house.

2.2.3 Project by by J.G. Robert

J.G. Robert used a new approach to replace the existing smart home to a much perfect and effective system. The researcher combined the internet technology and mobile phones to ensure that the user had a choice when communicating with the smart home. Other than that, he also introduced and applied the radio frequency (RF) technology as the communication medium. There are also sensors used in this