



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

WIRELESS HOME SWITCH USING ARDUINO UNO

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Telecommunication) (Hons.)

by

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DECLARATION

I hereby, declare this report entitled “Smart Home Swith controlled by Arduino Uno and Android Smartphone” is the result of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Engineering Technology Telecommunications with Honours. The members of the supervisory is as follow:

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(Madam Izadora Binti Mustaffa)

ABSTRACT

This paper presents a design and prototype of a light switch which can control over Wi-Fi technology via Android Smartphone Application. Conventional light switch require user to walk to the switch box area and switch on the light manually, this system assists the elderly or disabled person to turn on or off switches. The proposed system consists of two main components; the improve design of light switch and an Android Application. The light switch was redesigned by using Arduino Uno, relay and ESP8266 Wi-Fi module. The Android Application can setup the light switch to connect to user home Wi-Fi router and control the ON/OFF of light switch. Arduino Uno was programmed to control the ESP8266 to connect to user's home Wi-Fi network and the user can use the Android Application to control the light switch.

ABSTRAK

Kertas ini membincangkan reka bentuk dan prototaip suis lampu yang boleh mengawal melalui teknologi Wi-Fi dan applikasi telefon pintar Android .Lampu konvensional memerlukan pengguna untuk berjalan kaki ke kawasan kotak suis dan menghidupkan cahaya secara manual, sistem ini membantu orang yang tua dan kurang upaya untuk menghidupkan atau mematikan suis. Sistem yang dicadangkan terdiri daripada dua komponen utama; memperbaiki reka bentuk suis lampu dan Android Permohonan. Suis lampu telah direka semula dengan menggunakan Arduino Uno, relay dan modul ESP8266 Wi-Fi. Aplikasi Android boleh setup suis lampu untuk menyambung ke rumah pengguna Wi-Fi router dan mengawal ON / OFF suis lampu. Arduino Uno telah diprogramkan untuk mengawal ESP8266 untuk menyambung kepada rangkaian Wi-Fi rumah pengguna dan pengguna boleh menggunakan Android Permohonan untuk mengawal suis lampu.

DEDICATIONS

To my beloved parents and all my family, who always support me during my project, and also my housemate and my fellow friends who willing to help me in my project.

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CHAPTER 1

INTRODUCTION

1.1 Background

In 1884, first light switch was invented by John Henry Holmes, for over 100 years, the design of home switch is almost the same in terms of functionality, which the user will need to walk to the switch box in home to switch on or off of home appliances. Due to evolution of technology, the design of a home switch should be improving. Now days, almost all home will have a Wi-Fi router because of internet service subscription. The idea of improve the home switch is adding a Wi-Fi chip and Arduino kit to connect the switch to Wi-Fi router in home, and then control the switch by using android smartphone. This switch can eliminate the step of walking to the switch box in home to improve living quality. This is a good solution for old citizen which may have sore foot problem and also disable person. Besides that, due the switch is control by android application(app), future develop of the app can add many other features, for example, timer control of switch which can switch on or off of home appliance in certain time set, the app also can monitor the status of switch whether it's on or off state.

1.2 Problem Statement

The traditional home switch will need the users walk to the switch box in home to switch on or off of home appliance. For example, a person is lying in bed and reading, when a person is tired, he (or she) need to wake up to switch off the light before sleeping. Also, for old citizen with sore foot problem or disabled persons, walking to the switch box is a difficult job for them. Therefore, if they can control

the switch by simple click in smartphone, this is a good improvement of living quality for them.

1.3 Objectives

The main objectives of this project are deeply concentrated on the aspect as listed below:

- i. To study which wireless technology that suitable for the product.
- ii. To design a home switch that can connect it to a Wi-Fi router and can be control by an android application (app).
- iii. To develop an android app to connect the smart switch to a router, connect to the switch to monitor and control it.

1.4 Scope

This project will focus on the hardware connection between electrical switch and Arduino. Also, the coding of Arduino will focus on connecting it to a Wi-Fi chip and electrical switch. After that, connect to a Wi-Fi router via Wi-Fi chip and connect to an android smartphone via the router. Finally, the android application can monitor and control the switch. Some wireless technologies will be studied and the most suitable technology will be chosen.

1.5 Thesis Outline

This report consists of five chapters, including introduction (Chapter 1), literature review (Chapter 2), methodology (Chapter 3), result and discussion (Chapter 4) as well as conclusion (chapter 5). The theory and implementation of the project with title “Smart Home Switch controlled by Arduino Kit and Android Smartphone” will be discussed in details in this report.

Chapter 1 consists of the overview of this project. In this chapter, background, problem statement, objectives, work scope, as well as thesis outlines of this project will be explained in details.

Chapter 2 consists of the projects which related to the home automation project done by others researchers. A brief introduction of the relevant projects and finding of projects will be discussed in this chapter. A comparison of various wireless technology also has discussed. Besides, the components used in this project will be explained in details.

Chapter 3 consists of the methods used to implement this project. This chapter include process of construct the project.

Chapter 4 consists of the result from software and hardware involved in this project and some explanation about the operation will be described. Analysis of data also will have discussed in this chapter. Relevant figure and table will add to analyse and illustrate the result.

Chapter 5 consists of the recommendation or future improvement idea about the project.

1.6 Conclusion

In a nutshell, this project introduced the design of low cost home appliances to help improving living quality and help old or disable person in their daily live. Nowadays, almost every person owns a smartphone, therefore, creating a app in a smartphone is one of a low cost and effective method to perform the controlling job of the smart home switch. Also, almost all family will have a Wi-Fi router, Wi-Fi technology also have many others advantages such as mature of technology, low cost, simple, secure and able to connect to more devices. Therefore, Wi-Fi is one of a suitable technology used in constructing the project. In Chapter 2, various wireless technologies will be study and review to find out the most suitable wireless technology and find more reason to use Wi-Fi technology in the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, several home automation systems are described and compared. These systems are, home automation, smart home, Wi-Fi home automation, ZigBee home automation, GSM home automation, powerline home automation

Home automation is the use of one or more computers (or devices) to control basic home functions and features automatically and sometimes remotely. An automated home is sometimes called a smart home. The concept of smart home is also associated to efficient use and energy saving of home appliances.

2.2 Technology used in home automation

An Evaluation of Wireless Home Automation Technologies research report compared many wireless technologies such as ZigBee, Z-Wave, INSTEON, Wavenis, and IP-based technology. The report pointed out ZigBee, Wi-Fi, 6LoWPAN, and UWB are open, publicly accessible standards which mean it have greater industry support, buyers also have wider range of option to select the product manufacturer. In term of power consumption, IPv6 (6LoWPAN) uses maximum transmission unit (MTU) to be higher than 1280 bytes in length. As a result, the transmissions become short and thereby reduce power consumption. While in term of communication range and network size Bluetooth and UWB support only 8 nodes, therefore unsuitable for large scale networks. ZWave and Insteon are more suitable for medium sized networks as they support between 200-300 nodes. Zigbee, 6LoWPAN and EnOcean are the optimal solutions for large scale networks, since they support 64000, 264, and 232 nodes

respectively. The report pointed out some key characteristic of wireless technology must have in order to deploy a good home automation network such as energy consumption, cost, security and safety, durability and environment friendly (Rathnayaka and Potdar 2011).

Table 2.1: Comparison between various wireless technology

Specification	Technologies				
	ZigBee	6LoWPAN	Z-Wave	INSTEON	Wi-Fi
RF band (MHz)	868/915/2400		868/908	904	2400
Range (m)	10~100		30~100	45	100
Bit rate (kb/s)	20/40/250		906/40/200	38.4	54000
Specification publicly available	YES		NO	NO	YES
Network Size	64000	2^{64}	232	256	2007

A report about Embedding Internet Technology for Home Automation compared some technology suitable to home automation. The report pointed out some home automation requirement which are future-proof, moderate cost, installation overhead, configuration effort, connectivity, user interaction, and security. The report suggests IPv6 for home automation have many advantages such as Matured and future-proof, Low-cost wireless with 6LoWPAN, easy installation, auto configuration and wide-scale connectivity. The report suggest all home appliances should connect to the internet, due to the large number availability of addresses of IPv6, the report recommend use of 6LoWPAN to deploy home automation (Kovatsch et al., 2010).

2.2.1 Bluetooth in home automation

A project uses Bluetooth technology to interconnect home appliances with a PC. This project will add Bluetooth module to a PC so that it can

connect and control with others home appliances. This project only can use PC computer to control home appliance. In the home appliance part, a microcontroller and Bluetooth module was added so that it can communicate with PC and receive command by PC to control the appliance. It also can monitor the status of home appliances or monitor temperature if temperature sensor was connected to it (Piyare and Tazil, 2011).

A Bluetooth Remote Home Automation System Using Android Application uses Bluetooth technology to interconnect home appliance, sensors with pc/smartphone to monitor can control light switch in a home. The project added humidity and temperature sensor and connect it to PIC microcontroller so that the information can be display in smartphone and PC. The project developed an application run on Symbian OS and also a software run on Windows so that a smartphone and PC can monitor humidity, temperature and control light switch in home (Ramlee et al. 2013).

2.2.2 ZigBee in home automation

A ZigBee-based home automation system project uses ZigBee technology to perform home automation, their aim was to identify the reason for slow adoption and evaluates the potentials of ZigBee. The Zigbee need a home coordinator to connect with other home appliances. Zigbee coordinator is responsible for creating and maintaining the network. The home coordinator also responsible for security and safety checking of connection between Zigbee devices. Their report also concluded Zigbee and Wi-Fi can exist together with less interference problems than alternative technologies currently available. Their report also stated Zigbee have less delay access than Wi-Fi which is 670ms over 1337ms, which mean Zigbee can control any home appliance at higher speed (Khusvinder Gill, Shuang-Hua Yang, Fang Yao, 2009).

Zigbee can be deploy in flexible way, wireless Home Security and Automation System Utilizing ZigBee based Multi-hop Communication uses

multi-hop communication to provide unlimited range of communication for the system as long as there are intermediate nodes that will pass the data from one node to another until it reaches the destination.

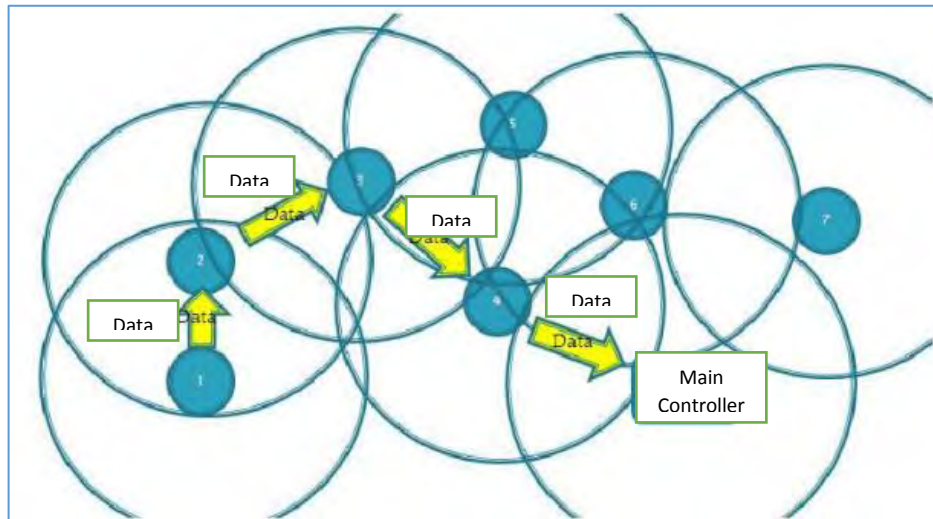


Figure 2.1: Multi-hop using ZigBee (Sarijari et al. 2008)

The design of this system can provide unlimited range and more devices can connect to the network(Sarijari et al., 2008).

2.2.3 GSM in home automation

A GSM Based Electrical Control System for Smart Home Application project uses GSM module to receive SMS from user's mobile phone, then integrate with a microcontroller to control electrical switch. Their use PIC16F877A microcontroller in the project. Due to widely availability of SMS services, the project has great compatibilities and also can remotely control switch in home. Their also added sensor to microcontroller which make it can monitor the safely of home. The disadvantage of the project is user must use special SMS commend to switch on electrical appliance in home and user need to pay SMS charges with each command sent. The

project also uses outdated smartphone and software (NOKIA N70, Symbian OS) to construct the project (Wahab et al., 2010).

2.2.4 Wi-Fi in home automation

A research about Wi-Fi Communication Using ESP8266 & PIC32 have study the capabilities of ESP8266 wireless module. The ESP8266 is a low cost wireless module with a complete AT command library which allow easy integration with a Wi-Fi network through serial communication. The project explored two modes of ESP8266 which as a station and access point (Rudinskiy 2013).

A Home Automation Using Internet of Things project uses Intel Galileo Board to develop smart home system. The Intel Galileo embedded with Wi-Fi module make it no need to add others hardware to complete the project. In the system, temperature, gas, PIR, LDR was added to monitor the safety in home. On the user interface, user must use PC/web browser in smartphone to control home switch, user must use a web browser to open a local private IP address which already programmed in the microcontroller to get access or control the system(Vinay and Kusuma, 2015).

2.2.5 Powerline communication in home automation

A Power Monitoring and Control for Electric Home Appliances Based on Power Line Communication uses powerline in home to transmit signal and control home appliance. Advantage of the AC powerline systems is that there is no need to use other cables respect to those already in place for the power network. The report included signaling method used to transmitting signal in power and collision avoiding method in signaling. A PPCOM (PLC Power-Controlled Outlet Module) which integrates the multiple AC power socket is required. This project require an embedded home server deployed in home, user can control home appliances remotely via the internet connection. But

this may create additional power consumption and also lead to higher cost while conducting the project. User can use web browser to monitor and control the home appliances. But the browser style designed user interface is not user friendly for a mobile phone user (Lien et al., 2008).

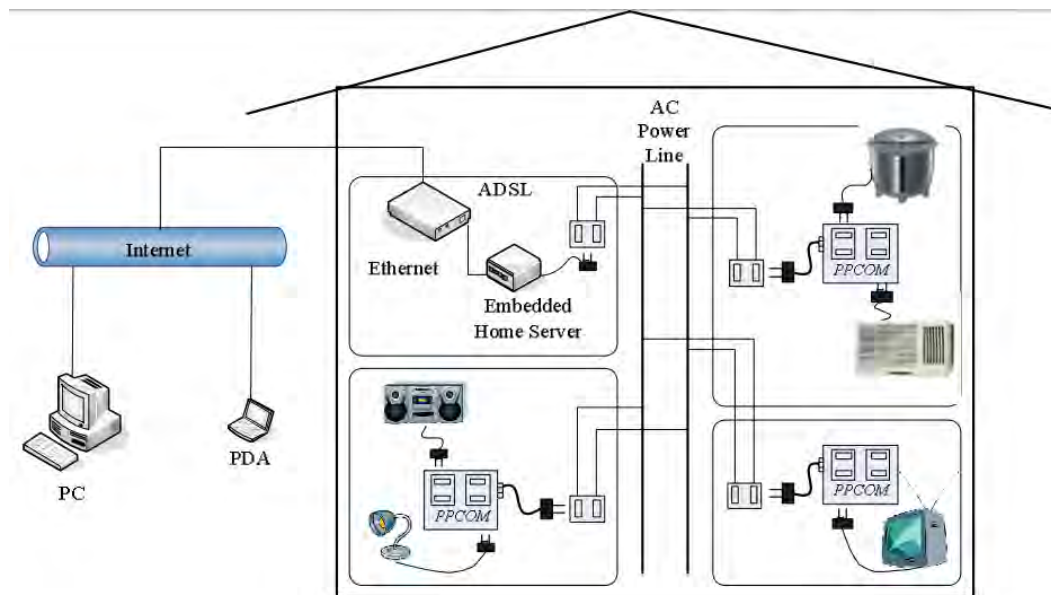


Figure 2.2: Home Automation using Powerline Communication(Lien et al., 2008)

2.3 Development of Arduino Microcontroller in project

A project uses Arduino to developed a low-cost multipurpose lab equipment. In some lab research activities, it requires millisecond-to-millisecond accuracy since modern operating systems (OS) are not designed to operate in real-time and with such accuracy. Therefore, dedicated and optimized expensive software such as MATLAB are required. One of the strengths of Arduinos is the possibility they afford to load the experimental script on the board's memory and let it run without interfacing with computers or external software, thus granting complete independence, portability, and accuracy. Accuracy tests show that Arduino boards may be an inexpensive tool for many psychological and neurophysiological labs (D'Ausilio, 2012).

2.4 User Interface and control of home automation

Home appliances can be control in many way, some system was designed to help disable person to control home appliances. In this section, the controlling method and user interface of home automation project were reviewed.

2.4.1 Voice recognition in home automation

A Wireless Home Automation System with Acoustic Controlling project uses voice recognition method to control home appliances. The aim of this project is to assist disable person to switch home appliances. The user need to give command to a special designed mobile device, the device then sent the command to particular home appliances (Chand and Chary, 2013).

2.4.2 Home automation with web server user interface

A project uses a web server to communicate with AVR-board. The aim of his project is to switch off the heating during winter holidays, but three days before returning home turn it on in order to come back in a well-heated house. His project can monitor multiple point of temperature in a house. His project uses Pollin 2011 AVR-board which already equipped with ATmega32 microcontroller and Ethernet controller. This board have a sample program enclosed by manufacturer. His project uses web language like REST interface to communication between computer and the microcontroller. The disadvantages of his project is the microcontroller need a Ethernet cable to connect it with a router, and the web interface is more suitable for a PC computer only, it's not user friendly when using it in a smartphone (Spale, 2015).

2.5 Electronic components

2.5.1 Arduino Microcontroller

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. C++ have many advantages such as object oriented, portable language, its low level language and C++ use multi-paradigm programming. It is useful for low level programming language and very efficient for general purpose. C++ also have good performance and good memory efficiency. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

Table 2.1: Comparison between different types of microcontroller

	Arduino UNO	Arduino 101	Arduino Mega 2560
Microcontroller	ATmega328p	Intel Curie	ATmega2560
CPU speed	16 MHz	32 MHz	16 MHz
Operating Voltage	5V	3.3V	5V
Digital I/O Pins	14 (of which 6 provide PWM output)	14 (of which 4 provide PWM output)	54 (of which 15 provide PWM output)