UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF UBIQUITOUS HOME SECURITY SYSTEM USING ANDROID APPLICATION AND ARDUINO ETHERNET

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

by

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TAJUK: **DEVELOPMENT OF UBIQUITOUS HOME SECURITY SYSTEM USING ANDROID APPLICATION AND ARDUINO ETHERNET**

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I hereby, declared this report entitled "Development of Ubiquitous Home Security System Using Android Application and Arduino Ethernet" is the results 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 fulfillment of the requirements for the degree of Bachelor of Engineering Technology (Bachelor Degree in Electronic Engineering Technology (Industrial Electronic) (Hons.). The member of the supervisory is as follow:

…………………………

(Engr. Siti Halma Binti Johari)

ABSTRAK

Projek ini bertujuan untuk membangunkan sistem rumah pintar kos rendah yang berasaskan aplikasi Android berkomunikasi dengan rangkaian web mikro. Arduino Mega 2560 dan perisai Arduino Ethernet digunakan untuk melaksanakan pelayan mikro web dan menghapuskan penggunaan komputer peribadi supaya dapat menjimatkan kesuluruhan kos sistem kepada minimum. Arduino Mega 2560 lembaga pengawal mikro berdasarkan ATmega256 mempunyai 54 pin digital input / output dan diantaramukakan dengan perisai Arduino Ethernet melalui pin Arduino SPI. Peranti seperti suis lampu , pintu pagar elektrik, sensor pencerobohan , asap sensor atau gas dan siren telah diintegrasikan dalam sistem untuk menunjukkan daya maju dan keberkesanan sistem rumah pintar yang dicadangkan yang boleh dikawal dan dipantau dari lokasi yang jauh menggunakan aplikasi rumah pintar pelantar android. Aplikasi rumah pintar yang berkomunikasi dengan mikro web - pelayan melalui internet adalah dapat melaksanakan operasi rumah pintar seperti fungsi pensuisan, kawalan alam sekitar automatik dan pengesanan pencerobohan, dan kemudian siren diaktifkan.

ABSTRACT

This project purpose is to develop a low cost Smart Home system which is based on the Android application communicating with the micro-web server. The Arduino Mega 2560 and the Arduino Ethernet shield are used to implement the micro-web server and eliminate the use of a personal computer so that save to minimum the overall system cost. The Arduino Mega 2560 microcontroller board based on the ATmega256 have 54 digital input/output pins and interfaced with the Arduino Ethernet shield via Arduino SPI pins. Devices such as light switches, electric gate, intrusion detection sensors, smoke or gas sensors and sirens have been integrated in the system to demonstrate the feasibility and effectiveness of the proposed smart home system which can be controlled and monitored from a remote location using smart home android platform application . The smart home application which is communicate with the micro web-server via the internet is able to perform the smart home operations such as switching functionalities, automatic environmental control and intrusion detection, and then the siren goes on.

DEDICATION

To my beloved parents

Ahmat Khohairi bin Hayat and Rosminah bte Basiran

To my lecturer and supervisor, for her guidance and encouragement

Engr. Siti Halma Binti Johari

To my friends, for their unconditionally support

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First and foremost, I would like to thank my supervisor, Engr. Siti Halma Binti Johari for his encouragement and guidance throughout my Bachelor Degree Project 1 (BDP 1) and my Bachelor Degree Project 2 (BDP 2). I would also like to thank my family members for always being there to support me all the time.

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LIST OF ABBREVIATIONS

adb   -   Android Debug Bridge

ADT   -   Android Development Tools

AVD   -   Android Virtual Devices

FPGA   -   Field Programmable Gate Array

IP   -   Internet Protocol

LAN   -   Local Area Network

LED   -   Light-Emitting Diode

PLC   -   Programmable Logic Controller

SDK   -   Software Development Kit

SMS   -   Short Message Services

SPI   -   Serial Peripheral Interface

CHAPTER 1
INTRODUCTION

This chapter discusses on the project background, the problem statement, its objective as well as the scope of this project. Last but not least, the project significance which outlines benefit that can be derived from the outcome of this project be divided into appropriate chapters as guided here.

1.1   Project Background

Since the early 20th century, many researchers have made a study on enhancing the Smart Home. Complicated of system depending on the intelligence of its own Smart Home. Smart Home system could use some sensor nodes that are connected to the server for home surveillance. Previously, the connection is made using a wired transmission medium. A large number of wired sensor nodes are connected to the server. The main drawback is the limit of the range of a wired connection and network upgrades. In addition, in the process of upgrading the system is difficult to implement. Therefore, researchers have come to the idea to do it wirelessly.

Wireless communication reduces the hassle of connecting and increase the network range. In wireless, the Smart Home network range can be extended with the implementation of wireless sensor network through multi-hopping technique or so called ad-hoc network. In multi-hopping technique, the signal from the source to destination is sent through fewer wireless hops. In Smart Home system, a special device is needed to control the Smart Home.

Previously, the special device on a wired Smart Home system was to be designed along with the Smart Home system. Now, with a single, simple and adorable smart

phone, a Smart Home system can be controlled by far from the server and sensor nodes are wirelessly connected. This will ease the user to control the Smart Home system due to the handiness of the Smartphone itself. Figure 1.1 and Figure 1.2 in next page shows the global internet device sales and a lifetime of application of Smartphone.
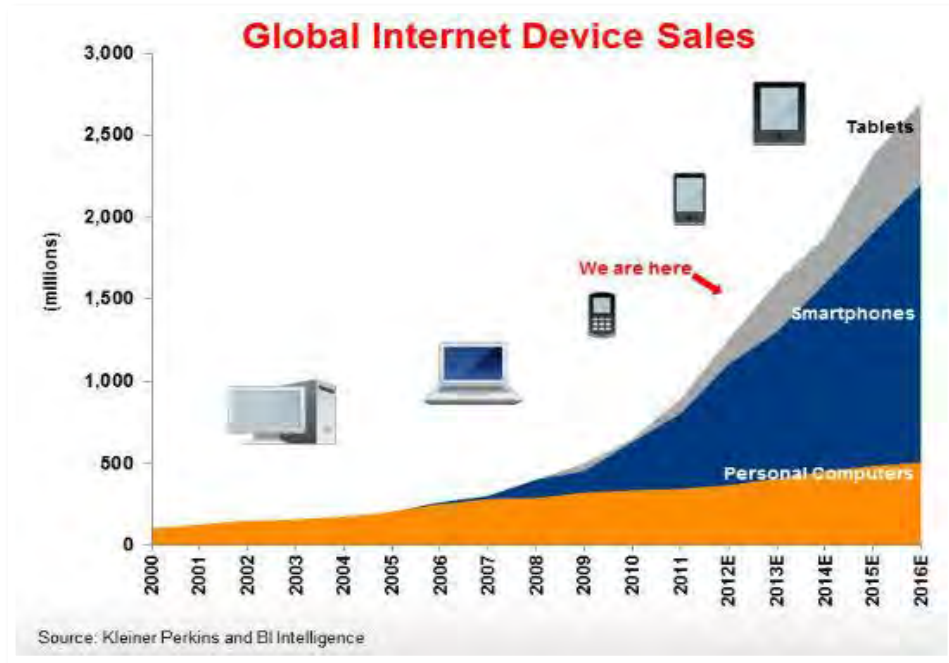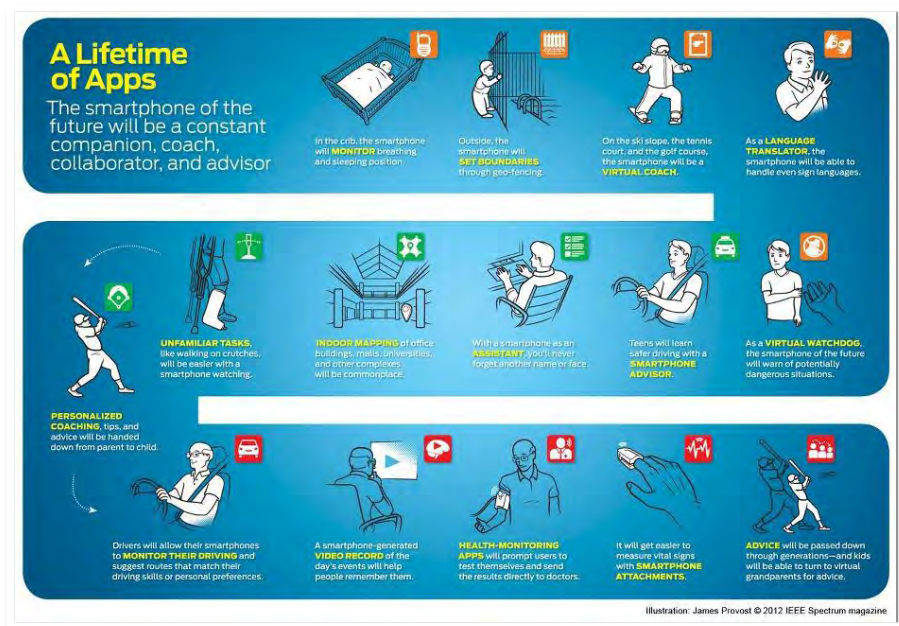

Figure 1.1: Global Internet Device Sale

Figure 1.2: A lifetime application of smartphone

With referring to Figure 1.1, the smart phones and tablets' sales is shown to exceed the sales of personal computer and continuously grow rapidly starting from the year of 2005. From this, we can see that the Android devices have dominated the market share from the past 8 years. On the other hand, Figure 1.2 shows how Android devices can assist the humans in their daily life and the possible applications that can be developed in the device. Android devices can be used at any stage of age, from the newborn baby up until the elderly people.

1.2   Problem Statement

Nowadays, home security system is very important to every house because there are have a lot of robbery cases happen in everywhere. Thus, a security system was created to help residents even they were far away from the house. In another word, this system is an investment for the peace of the residents.

Various smart systems have been proposed where the control via Bluetooth and short message services (SMS). However it limits the control to within the Bluetooth range of the environment while most other systems are not too feasible to be implemented as low cost solution.

Thus, the development of Ubiquitous Home Security System Using Android Application and Arduino Ethernet is proposed to achieve a low cost smart home system for remotely controlling and monitoring the smart home environment.

1.3   Objectives of Project

The main objectives of this project are:
1. To develop interface of android application, arduino microcontroller and arduino Ethernet.
2. To assemble software and hardware of alarm system.
3. To analyse the performance of Smart Home Security System.

1.4 Scope of Project

This project can be divided into two parts which consist of hardware and software development. To achieve the project's objective, the following scopes need to be fulfilled.

1. The alarm system is demonstrate only for android application.
2. The arduino microcontroller and arduino ethernet is interface with the android application using ip address.
3. In particular, this project is done to make a security system that easy to install and beside it is cheapest commercial.

CHAPTER 2
LITERATURE REVIEW

In this chapter, reviews of researches which are related to this project will be discussed. It will describe details about literature review on the parts and systems used in the project. In addition, it will include explanations of the component characteristics and the particular component chosen for this project.

2.1   Smart Home System

Since the early 20th century, a lot of work has been done to develop the Smart Home system. Basically, a Smart Home refers to a home with intelligent to control, monitoring and automate the home system. The Smart Home's degree of intelligence depends on the complexity of the system as shown in Figure 2.1:
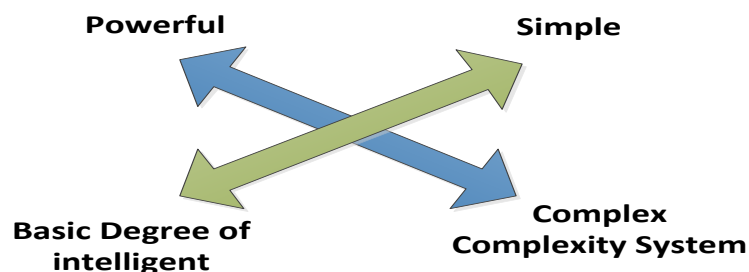

Figure 2.1: Trade of Smart Home system

From Figure 2.1, if the designated Smart Home system is to be powerful, the complexity of the system will increase. However, if only a simple system is desired, the complexity will be less. For example, if the Smart Home is used only for temperature monitoring, we will be requiring only simplex communication to

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perform the task. In other words, the Android device can only received information about the home temperature from the sensor but it could not send any order to it. However, if the system is needed to monitor, control, and automate the house, the system will be needed a more complex design to enable a duplex communication between the Android devices and the smart home environment. After a duplex communication has been established, only then the Android device could only send and received information to the sensor.

2.1.1   Variant of Smart Home System

The idea of developing a Smart Home since the early 20th century. In 1915 to 1920, the emergence of electrical home appliance began; domestic servants meant the household needed cheap and mechanical replacement. Home automation" From Wikipedia, the free encyclopedia [12]. In 1960, the first "wired home" was built by American hobbyist. After microcontroller has been invented, a lot of work has been done to develop the Smart Home system. During 1990, Smart Home system has been developed based on the merging of telematics and communication system "The Internet". Since 1990, The Internet technology and Smart Home system was tied strongly. The concept of the "Internet of Things" enhance Smart Home system tremendously. Recently, Smart Home system has reached another level of intelligence by way wireless communication. The low cost characteristic of wireless controlled smart home system for controlling and monitoring the home environment by using an embedded micro-web server with real Internet Protocol (IP) connectivity for accessing and controlling appliances and other devices remotely is presented by Internet of Things: Ubiquitous Home Control and Monitoring System using Android based Smart Phone [1]. Besides that, the usefulness and simplicity of Smartphone also can be applied to Smart Home system for remotely controlling and monitoring the smart home environment.

2.1.2 Element in Smart Home System

Smart Home system is the control and management of integrated of many small systems at home. Small systems can be lamp switch, temperature monitoring, motion detection, home surveillance and other sensors. The sensors in these systems will be controlled by users using interface devices such as remote control, computer and Smartphone. By increasing the type of sensor to be controlled, the main system needs to be more specialized to integrate the sub-systems to become the Smart Home system. The networking of system can be wired or wireless depending on application. Table 2.1 shows the summary of Smart Home system elements.

Table 2.1: Summary of elements in Smart Home system

Elements in Smart Home system	Example
Sensor	Temperature monitoring, lamp switch, home surveillance
User interface devices	Remote control, computer, Smartphone, tablet
Centralizing control	Micro controller, PLC, Computer, FPGA

2.2 Android Operating System

The Android operating system is based on open source Linux kernel with Java programming interface designed especially for touchscreen gadgets. Android phones are on the market since October 2008. Device manufacturers, wireless operators and enthusiastic developers are allowed to modify and distribute the software under the Apache License proposed by research on development of android applications [4].

2.3 Android Application

A system that operates, including middleware, key application, and software stack for a mobile device is the Google Android. September 23th, 2008 was the date for the first Google's Android Phone T-Mobile G1 was announced at Guastavino in New York based on Benchmark dalvik and native code for android system [5]. Android as well as a software stack, which is set of software subsystem needed to present a fully operational solution for Smartphone. This stack software includes an operating system, middleware (software that connects the low-level operating system to high-level application) that is partly based on Java and key application is written in Java such as web browser and a contact manager.

2.3.1 Android Development Tools

Android Development Tools (ADT) is a plugin for Eclipse IDE which enables Eclipse IDE in Android application development. The ADT allows the programmer to quickly set up new Android projects, create user interface, add packages based on an application programming interface, debugging using the Android software development kit and export signed or unsigned files (. apk) for application distribution. Eclipse IDE with ADT is highly recommended in Android application development. Both versions of Eclipse IDE and Android SDK must be compatible with each other before install the ADT plugin into Eclipse IDE proposed by Professional Android 4 application development [6].

2.3.2 Android SDK

Android Software Development Kit (Android SDK) offers all necessary instruments to develop Android applications included compiler, debugger, device emulator as well as its own virtual machine to run Android programs. Device emulator is used to test the Android applications using Android virtual devices (AVD). Android debug

bridge (adb) tool is in Android SDK, which allows connecting to a virtual or real device. Android Application Development and Implementation [7].

2.3.3 Dalvik Virtual Machine

Android applications are written primarily in Java programming. The Java source files are converted to Java class files by the Java compiler. Dalvik Virtual Machine is a special virtual machine used by the Android system to run Java based applications. The bytecode format used by Dalvik is different with Java bytecode. Therefore, Java class files have to be converted to Dalvik bytecode format before it runs on Android. An Android SDK tool called dx is used to convert Java class files into a .Dex (Dalvik Executable) file. All class files of one application are put into one compressed.Dex file. This will further be compiled into android package file (apk file), that can be installed on the android devices. Status and trends of mobile-health applications for android devices [8]. Figure 2.2 shows the Java source file conversion.
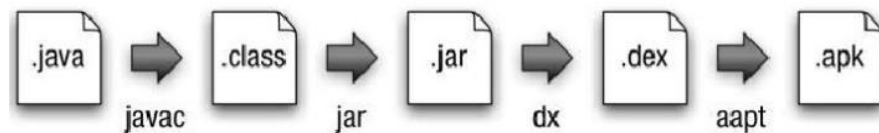

Figure 2.2: Java source file conversion

2.4 Arduino

Arduino is open source physical computing platform based on a microcontroller board and an integrated development environment to program the board. Arduino acquires several inputs such as switches or sensors and control several output such as lights, motor and others. Arduino software is compatible to Windows, Macintosh and Linux operating systems unlike most microcontroller systems are limited to Windows. The Arduino programming is simple for beginners.

2.5 Example of Smart Home System Project

A lot of research has been done by universities and organizations about Smart Home system. The following are advantages and disadvantages of previous Smart Home system projects.

2.5.1 Controlling via Bluetooth

Bluetooth Remote Home Automation System Using Android Application and Smart Living Using Bluetooth Based Android Smartphone [9, 10] are proposed about smart home is not a new term for the science community, however, it is far more distant from the people's vision and audition. As electronic technologies converge, the emerging field of home automation. Various intelligent systems have been proposed in which the control is via Bluetooth. Bluetooth capability is good and most of today's laptops or notebooks, tablets and mobile phones have a built-in adapter that will indirectly reduce the cost of the system. However, it limits the range of controls for the Bluetooth environment while most of the other systems is not very feasible to be applied as a low cost solution.

2.5.2 Wi-Fi based Home Automation System

In Design and Implementation of a Wi-Fi Based Home Automation System [15], Wi-Fi-based home automation system is presented. It uses a PC (with built-in Wi-Fi card)-based web servers that manage devices connected home. The users can manage and control system (LAN) or remotely (internet). The system supports a wide range of home automation devices such as power management components and security components. A similar architecture is proposed in Mobile IP-Based Architecture for Smart Homes [11] where the action is coordinated by the agent running on the PC. Other papers such as An internet based wireless home automation system for multifunctional devices [12] also presented Internet controlled system consisting of a