DEVELOPMENT OF REMOTE MONITORING AND CONTROL OF KEYLESS ENTRY SYSTEM

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DEVELOPMENT OF REMOTE MONITORING AND CONTROL OF KEYLESS ENTRY SYSTEM

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

by

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I hereby, declared this report entitled "Development of Remote Monitoring and Control Of Keyless Entry System" 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 Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

…….....

(Dr. Mohd Nazrin Bin Muhammad) – Signature and Sign

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ABSTRAK

Apabila kadar teknologi bertambah dengan masa, masyarakat berusaha untuk mencipta dan mengembangkan cara yang lebih mudah untuk hidup dan mengurus tugas harian mereka. Cara yang ideal ialah mengubah semua peranti elektronik ke peranti IoT yang boleh diakses di mana-mana, bila-bila masa dan sesiapa sahaja yang mempunyai pengesahan. Sistem pemantauan jarak jauh IoT sistem kemasukan tanpa kunci direka oleh pengguna untuk membuka sistem kemasukan dengan telefon pintarnya. Sistem ini juga membolehkan pengguna memantau keupayaan bateri dengan mengukur keadaan caj bateri yang digunakan. Sistem ini mempunyai modul Wi-Fi di atasnya yang memindahkan data dari awan, membolehkan pengguna memantau jauh dari mana-mana menggunakan perkhidmatan IoT. Kedua-dua perkakasan dan perisian telah dibangunkan dalam penyelidikan ini untuk mencapai matlamat penyelidikan. Prestasi sistem telah dinilai dari segi ketepatan voltan bateri yang diukur dan kadar penghantaran data. Keputusan menyatakan bahawa sistem dapat melaksanakan perintah buka kunci dalam masa 10 saat dan ketepatan voltan bateri diukur oleh NodeMCU dalam toleransi 6%.

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ABSTRACT

As the rate of technology increases over with time, society is seeking to create and develop easier ways to live and manage their daily tasks. The ideal way is to transform all electronic device to IoT device that can be access anywhere, anytime and anyone with authentication. The IoT remote monitoring system of keyless entry system is designed to ease the user to unlock an entry system with his/her smart phone. The system also allows the user to monitoring the capacity of battery by measure the voltage of battery and replace or recharge it before it runs out. The system has a Wi-Fi module on it which transfer data from cloud, allows user to remote monitoring from anywhere using IoT service. Both hardware and software were developed in this research to achieve the objective of research. Performance of system had been evaluated in term of accuracy of battery voltage measured and rate of data transmission. The results stated that the system able to perform unlock command within 10 seconds and the accuracy of battery voltage measured by NodeMCU within tolerance of 6%.

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DEDICATION

Only

my beloved father, Cheah Ah Seng

my appreciated mother, Ng Joo Heok

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

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TABLE OF CONTENTS

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LIST OF TABLES

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LIST OF FIGURES

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LIST OF ABBREVIATIONS

ADC	-	Analog to Digital Conversion
API	-	Application Programming Interface
APK	-	Android Package
GUI	-	Graphical User Interface
IDE	-	Integrated Development Environment
IoT	-	Internet of Things
RFID	-	Radio Frequency Identification
SoC	-	State of Charge
UI	-	User Interface
XML	-	eXtensible Markup Language

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CHAPTER 1
INTRODUCTION

1.1 Background of Study

The Internet of things (IoT) refers to a type of network to connect devices with the Internet based on stipulated protocols through information sensing equipment to conduct information exchange and communications in order to achieve intelligent recognitions, positioning, tracing, monitoring, and administration (Patel et al., 2016). Through IoT, it enabled user to collect information from all type of media like people, animals, vehicles, kitchen appliances (Anitha, 2017). Therefore, any object in the physical world that can be supplied with an IP address to enable data transmission over a network can be integrated into the IoT system. This can be done by integrating them with electronic hardware such as sensors, software and networking equipment.

The architecture of IoT consists of 3 layers, which is name as perception layer, network layer and application layer (Kalmeshwar & K S, 2017). The perception layer responsible to collect data from sensing device like physical parameters from the environment. The existence of network layer is to connect the IoT device with the server and responsible for transmitting and processing data between the connected devices. While the application layer provides specific service to specific user.

The Internet of Things (IoT) involves interaction between people and device. Data sensed and collect by a device need to be sent to the users for the purpose of monitoring and future analysis. Typically, a computer is used to create and develop the application to receive those data. Yet currently, people are concerning connect anywhere, anytime and with anything, the used of desktop as monitoring system is far less efficient to meet the current demands. When comparing a traditional computer to an android phone, the traditional computer is far more heavy than existing phone. Even though the existence of laptop, the smart phone's prevalence modern life provides a "constantly present, personal service

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channel", that has higher vote than laptop in term of portability (Gershman, 2002). Users able to keep in touch with their community and manage daily with the built-in Wi-Fi feature. This feature make mobile phone a "great potential to be the default physical interface for ubiquitous computing applications" (Ballagas et al., 2006).

Android is a mobile operating system develop by Google and it launch in 2007, since then millions of users from global are attracted to it. As it is based on Linux kernel and other open software, anyone can develop application to suit their requirements with the ease of programming. Due to this reason, the Android phone was mainly chosen as the handheld terminal to receive and analyse data from IoT device. All the data from device is collected and transmitted to cloud-based storage and the user able to view real-time information by retrieve the information using android phone with authority. Thus, Wi-Fi is chosen in this thesis to transmit data to the handheld terminal in order to access anywhere by the user.

1.2 Problem Statement

Many approaches have been proposed and applied to replace traditional key to unlock the entry system. The rate of technological is increasing with time, society is looking to create and develop easier ways to live and manage their daily tasks. Recent years, the governments, schools and companies begin to use the radio frequency identification (RFID) instead. However, the virtual RFID card is an additional accessory to the owner and is prone to loss or being stolen. Even though there are some researcher propose biometrics recognition system, its accuracy is depending and affected by aging, injuries, and other external factors that change these features. The biometric systems require relatively high sensor resolution; thereby increase the product cost and restrict their popularization. Based on the above considerations, we proposed a remote monitoring system of keyless entry system using mobile application.

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1.3 Objective

The study on the remote monitoring and control of keyless entry system seeks to attain the following objectives:

1. To design and develop application connected with mobile phone to remote control the keyless entry system.
2. To measure battery capacity that powered the microcontroller and post the data to cloud.
3. To evaluate the effectiveness and performance of final system in term of transmission rate of data and the accuracy of battery capacity.

1.4 Scope

This project will focus on the development of mobile application to remote monitoring and control keyless entry system. NodeMCU is selected as the microcontroller in this project. The power supply of the entry system is 7.4V Li ion battery. The system will be experiment using solenoid linear actuator instead of motor to obtain the results.

1.5 Important of Study

The design and implementation of mobile application to control an electronic lock is necessary and able to cope with market demand. This is due to people nowadays spent noticeable amount of time in using of smart phone. Besides that, the constant present of smart phone allow make people able to communicate with IoT device with ease. Through the implementation of mobile application, it aids user to lock and unlock entry system effortless with just tip of finger.

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1.6 Organization of Report

This project presents the development of remote monitoring and control keyless entry system. This report has five chapters. The first chapter will be describing about a brief introduction about the project consist the background, objective, problem statement and scope of the project. A literature review of recent work on theory for the device and concept involved and application is presented in chapter 2. Chapter 3 describe about explanation about equipment, component, procedure, rule and technique applies in developing this project. Chapter 4 outline and discuss the result of the project. And finally, chapter 5 summarizes the contributions of this work.

1.7 Summary

In this section, background of study related to IoT is made. The problem statement and objective are constructed which will be specific, measurable and achievable. Next, the scope of the project is defined and organization of report is made to describe the flow of the report in every chapter.

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CHAPTER 2
LITERATURE REVIEW

The overall goals of this chapter were firstly to establish the significance of the general field of study, then identify a place where a new contribution could be made. The bulk of the chapter was on evaluating the different methodologies used in modelling state of charge of battery. Three type of wireless communication system is being reviewed and compared to choose the suitable approach for this project. Lastly, the difference between App Inventor 2 and Java is tabulated to show which is more suit to be apply.

2.1 Related Work

Electronic lock based IoT technology was proposed by Lee et al. that using Morse code. Authors claimed that they use LED's (Light emitting diodes) that already exist within smart phones as an encrypting medium to send signals, while photosensitive resistor act as the receiver of signal. A microcontroller is used to decrypt the optical signal that emit by LED and it able to upload real time status via cloud where the owner able to remote control the system. Several different brightness of light circumstances was used by author to test the performance of the system in real time. The authors claimed that the system is highly resistant and perform well under various illumination environment (Lee et al., 2016).

Advait Churi et al. proposed an electronic lock that unlock using Bluetooth enable smart phone. Digital password is entered in smart phone to unlock the door within the remote zone. Author stated that the project has a significant feature of keeping track of user that use the system by capture the image of user. A notification is sent to the administrator via email to alert any unauthenticated users. The author suggested that the system can be improve by adding biometric recognition technique that enhance the security of the system (Churi et al., 2016).

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Author Hwang and Baek presented a wireless access monitoring and control system using ZigBee tag. Human detection module, ZigBee module and digital door lock is used in the system. Authors stated that ZigBee module is designed to support wireless sensor network. When user approach toward the digital door lock, it automatically detects the existence of ZigBee tag on the person wirelessly. The digital door lock will open if the identification code is correct, otherwise the door remains close. Authors claimed that it is convenient system for consumer and has extensible and flexible characteristic (Il-Kyu Hwang & Jin-Wook Baek, 2007).

Umar Farooq et al. have implemented RFID based security to access entry system in hostels inside the Punjab University premises. An RFID reader is installed at the front of each hostel room, users are required to use RFID to access the entry system. the system will sound an alarm when the RFID and user image is mismatch. With the help of a web server, the system able to monitor entrance and exit and keep track of the entry system (Farooq et al., 2014). However, RFID is an extra item that require user to bring along and it tend to loss and being stolen.

2.2 Method for Estimate the Battery State of Charge

Most of the IoT devices require battery as power supply to the system. Modelling state of charge of battery is necessary when the system functions only when the battery is available. Without it, the system tends to fail to function when the battery depleted. State of Charge (SoC) of a battery is defined as the ratio of its current capacity Q(t) to the nominal capacity Q_n (Chang, 2013). The nominal capacity refers to the maximum amount of charge that can be stored in the battery that specified by the producer. The SOC can be written as Equation 2.1:

$$SOC(t) = \frac{Q(t)}{Q_n} \qquad \text{Equation 2.1}$$

There are various approaches to estimate the state of charge of battery. Typically, the estimation of SoC can be done by measuring the battery voltage, either in open circuit or with load connected. The estimation of charge level of battery is made using voltage-based method relating the SoC with the voltage measured. However, this method is not suitable to

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apply to lithium battery. This is due to few different polarizations occurs during the operation of lithium battery (Lajara et al., 2015).

Another way to estimate the SoC of battery is to measure the discharge current. The method is called as coulomb counting method. The discharge current of a battery is being measured and integrate the result over a certain period to predict SoC. This can be done by knowing the charge balanced in the battery and deduce it with the extracted charge(Chang, 2013). The SoC is compute using Equation 2.2:

$$SoC(t) = SoC(t-1) + \frac{I(t)}{Q_n}\Delta t \qquad \text{Equation 2.2}$$

,where I(t) is the discharging current, Q_n is the nominal capacity and SoC(t-1) is the previously estimated SoC value(Chang, 2013). Still, author stated that this method need user to calibrate regularly with separate device in when perform Coulomb Counting. The accuracy of Coulomb Counting depend on the aspects such as temperature, discharge current and cycle life(Ng et al., 2009).

One of different kind of SoC estimation approaches is electrochemical models. Author S.Dey stated that the electrochemical models can be classified as high accuracy of SoC estimation compare to data-driven models and equivalent circuit models (Dey & Ayalew, 2017). The electrochemical models involved the simulation of internal chemical processes within the battery, which results in high precision. However, the complex algorithm and computation require high specification device and not suitable to execute on a microcontroller (Rohner et al., 2013).

2.3 ThingSpeak (TS)

ThingSpeak is a web based open API IoT source information platform that comprehensive in storing the sensor data of varied 'IoT applications' and conspire the sensed data output in graphical form at the web level (Pasha, 2016). With the aid of internet, ThingSpeak able to track the updated status from the connected device and control it over a distance with host microcontroller such as 'Arduino'. The interface of ThingSpeak provides simple communication capabilities to objects within the IoT environment.

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With ThingSpeak, user allow to create channel that have field for data, field for location, field for status for varied sensed data. Each channel allows user to store up 8 fields of data, using up to 255 alphanumeric character each. There are also 4 dedicated fields for positional data, consisting of: Description, Latitude, Longitude, and Elevation (Gómez Maureira et al., 2014). All incoming data is time and date stamped and receives a sequential ID. Once a channel has been created, data can be published by accessing the ThingSpeak API with a 'write key', a randomly created unique alphanumeric string used for authentication. Consequently, a 'read key' is used to access channel data in case it is set to keep its data private (the default setting). Channels can also be made public in which case no read key is required.

Based on the ThingSpeak website, 'things' are objects that are given sensors to collect data. Data is sent and received via simple "Hypertext Transfer Protocol" (HTTP) POSTs. This communication happens through plaintext, JSON or XML (Gómez Maureira et al., 2014). The data is then uploaded to the cloud and from there can be used for variety of purposes. JavaScript Object Notation (JSON) is a data interchange format that enhance the server-to-browser communications. It is often to send data from server to clients using JSON format instead of XML due to it is shorter to read and quicker to write.

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2.4 Wireless Communication systems

Wireless communication system is a type of information transmission without the requirement of wire. Wide area wireless communication is necessary for the Internet of Things. For wide-area IoT applications, a mobile broadband network is more preferable because devices move over a wide area (Dhillon et al., 2017). There are three main wireless communication of systems, which is Bluetooth, ZigBee and Wi-Fi. The comparison of these wireless communication system is tabulated as show in Table 2.1.

Table 2.1: Comparison of wireless commination system *(Challoo et al., 2012)*

Specification	ZigBee	Wi-Fi	Bluetooth
Standard	IEEE 802.15.4 and ZigBee Alliance	IEEE 802.11	IEEE 802.15.1
Network Type	WPAN (Wireless Personal Area Network)	WLAN (Wireless Local Area Network)	PAN (Personal Area Network)
Frequency Band	2.4GHz	2.4GHz and 5GHz	2.4-2.48 GHz
Channel Bandwidth	2 MHz	22 MHz	1 MHz
Network Topology	Star and mesh type	BSS, ESS configuration	Point-to-point
Data Transmission Rate	up to 250 Kbps low data rate	11 Mbps - 54 Mbps	3 Mbps
Typical Distance Coverage	10 meters	32 -95 meters	10 meters (device of 25mW), 100 meters (device of 100mW)

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2.5 Integrated Development Environment (IDE)

An integrated development environment (IDE) is a software application that provides platform to developer to write and test software. Through IDE, developers able to use numerous tools throughout creation, building and testing of software code. With a IDE, a developer able to select, deploy, integrate and manage these tools together by using development tools that include text editor, code libraries, compilers and test platforms (Margaret Rouse, 2018). Coding errors able to identify and figure out by using integrated IDE toolkit.

An IDE usually comprise of a code editor, a compiler or interpreter, and a debugger, accessed via single graphical user interface (GUI). User writes and edits source code in the code editor and the compiler translates the source code into a readable language that can be executed for a computer (Margaret Rouse, 2018). The function of debugger is to test the software for any problem or bugs. Through an IDE's interface, a developer or team of developers can compile and execute code incrementally and manage changes to source code in a uniform way. Third-party version control libraries like GitHub able to integrate with most of the IDEs.

There are many different types of IDE that able to create and develop android application. However, only App Inventor 2 and Java is being compare in this project since these IDE are widely used by designer and developer. Based on the research done by author (Kowalczyk et al., 2016), the comparison made between App Inventor 2 and Java are in term of application design, application implementation and performance tests. The comparison is tabulated as Table 2.2,

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