UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPLICATION OF NFC SMARTPHONE IN INTELLIGENT PUBLIC TRANSPORT

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

by

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(WAN NORHISYAM BIN ABDUL RASHID)

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ABSTRACT

Developing a competent and efficient product is the most challenging things in today‟s market. Near Field Communication (NFC) technology is an evolved form of Radio Frequency Identification (RFID) for electronic devices which allows them to communicate with each other by simply touching or bringing them very close to each other. The Smartphone nowadays will not be only used as a camera, personal agenda, GPS; the NFC technologies increase initiatives to be used as a wallet for payment. NFC technology offers passengers who travel by public transport in a more convenience way by tap and go using Smartphone. So that, passenger can save energy, cost and time during busy hours. Develop a NFC project for passengers who travel using public transport. Design an application of program purposely for the Near Field Communication technology by using MIT apps inventor software. The designed system is analyzed in term of characteristics of NFC likely one way communication, two way communications, fast set up time, limited range and compatible with RFID module. Survey has been conducted to study the public awareness regarding NFC. As a conclusion, the best recommendation to improve the application of NFC Smartphone in public transport was proposed based on the analysis. The advantages of the NFC Smartphone application in public transport perhaps will become one of the high demand technologies in the market.

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ABSTRAK

Menghasilkan produk yang berdaya saing dan cekap adalah sesuatu perkara yang paling mencabar dalam pasaran hari ini. Teknologi Komunikasi Jarak Dekat (KJD) adalah satu bentuk peranti elektronik yang membolehkan telephone pintar berkomunikasi dengan tag KJD. KJD adalah subset daripada Identifikasi Frekuensi Radio (RFID). Pada masa kini, telephone pintar tidak hanya digunakan sebagai kamera, perancang jadual, GPS malah juga digunakan sebagai alat pembayaran dengan teknologi KJD. Teknologi KJD memberi manfaat kepada penumpang yang menaiki pengangkutan awam dengan cara yang lebih mudah melalui telefon pintar. Oleh itu, penumpang boleh menjimatkan tenaga, kos dan masa pada waktu puncak. Menghasilkan produk yang berdaya saing dalam sistem pembayaran menggunakan telefon pintar yang mempunyai KJD. Mencipta program Android yang baru dengan menggunakan MIT apps inventor. Sistem yang direka akan menganalisis daripada segi komunikasi sehala, komunikasi dua hala, masa reaksi, jarak terhad dan serasi dengan RFID dalam sistem KJD. Soal selidik akan dijalankan untuk meninjau pengetahuan awam mengenai KJD. Kesimpulannya, berdasarkan analisis yang dilakukan, keburukan KJD akan diperbaiki mengikut keperluan dan keinginan awam. Kelebihan aplikasi Smartphone KJD dalam pengangkutan awam akan menjadi nilai komersial di pasaran akan datang.

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DEDICATIONS

To my beloved parents, Tian Yee Cheong and Hooi Chooi Ching that have sacrificed so much and was always encouraging and support for the sake of your daughter to be a beneficial person to the society.

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LIST OF SYMBOLS AND ABBREVIATIONS

NFC	=	Near Field Communication
RFID	=	Radio Frequency Identification
WiFi	=	Wireless Fidelity Technology
RF	=	Radio Frequency
iOS	=	i Operating System
UID	=	Unique identifier
LRT	=	Light Rail Transit
MIT	=	Massachusetts Institute of Technology
ISO	=	International Organization For Standardization
IEEE	=	Institute of Electrical and Electronic Engineers
IEC	=	International Electrotechnical Commision
WPAN	=	Wireless Personal Area Network
GSM	=	Global System for Mobile Communication
2G	=	Second Generation
URL	=	Uniform Resource Locator
QR	=	Quick Response
APK	=	Android Package Kit
ID	=	Identification
SQL	=	Structured Query Language
MFGM	=	Mobile Fare Management
GFSK	=	Gaussian Frequency Shift Keying
DPSK	=	Differential Phase Shift Keying

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MAC	=	Media Access Control
NXP	=	Next experience
EFM	=	Electronic Fare Management
VDV	=	Association of German Transport Companies
WiGig	=	Wireless Gigabit Alliance

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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter reviews about the background of NFC, problem statements, project objectives, scope and limitations.

1.1 Background

Indeed, NFC is just a subset of RFID. RFID discovered in 1935 by Scottish physicists for military uses. In 1970, the first RFID radio transponder with memory is invented. The capabilities of RFID had been developed into the business and valuable components. (Jovix Atlas RFID Solution , 2015) RFID is a wireless communication device that transmits Radio Frequency (RF) signal and wait for a tag, reader and middleware to communicate. RFID design is under the frequency range of 120 kHz to 928MHz. Tag is also known as transponder, literally is a dipole antenna. The tag is classified into two groups; one is a passive tag while the other one is an active tag. For a passive tag, it does not contain a battery. An active tag contains a battery to relay the signal constantly. The memory size of tag store very little information according to the application. The application of RFID is inventory system, human implants, animal identification, and casino chip tracking. Reader can be stationary or moving objects. For example, stationary objects can be a fixed RFID and moving objects can be a smart card. A reader also can be programmed to receive information only from particular tags. (Mohammad Umair Yaqub, 13 February 2012) Middleware is a service that communicates and controls the reader to store database.

Near Field Communication, abbreviated NFC is launched in 2002. The NFC Forum formed in 2004 by Nokia, Philips and Sony. The NFC forum now has more than 175 member companies, including banks that issue credit, wireless carriers and

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mobile device makers. Many researches are conducted by many companies and academic organizations in this field for continuous improvement. The NFC forum is dedicated to promote NFC device compliance with sharing, pairing and transaction in a secure way. The NFC forum also dedicated to educate businessman about the NFC technology and make use of it. The NFC forum wishes to create NFC compliant devices for user. In 2006, the group had come out with the first set of specification for NFC tag. NFC tag contains memory to store read only information but there are certain tag that enabled the device alter old information and rewrite the new information. The specification for smart poster also created on the same year. Smart poster holds the information store in the NFC tag. Smart poster widely used in any place. The first NFC compatible phone is Nokia 6131 with low specification. As the year passed, the technology advanced the functionality of NFC from sharing information between two devices to payment, interact with smart poster, car parking and authentication access into building. Android produced its first NFC Smartphone is Samsung Nexus S, in 2010 while iOS produced its first NFC phone is iPhone 6 in 2014.(Near Field Communication.org, 2015)

NFC is a form of contactless communication between electronic devices. Contactless communication allows user to send the information in the fast and convenient way by waving NFC Smartphone over a NFC enabled device. There are three types of communication modes such as peer to peer mode, reader or writer mode and card emulation mode. Peer to peer mode allows two devices send and receive information. Reader or writer mode allows the devices to read the information stored on NFC tag attached in smart poster. Card emulation mode allows the user to purchase by using card. (Hamblen, 2012) NFC begins to use on new Smartphone to replace the hotel card, paper ticket, credit card, debit card, smart card and car keys. Both individuals and businesses have benefit. The break-through of NFC contributes a lot of improvement in taking the customer to the high quality level in public transport. For example, by integrating debit cards, paper ticket and coupon into NFC Smartphone, a customer can board the public transport, pay for transportation fees, redeem point and even exchange information from smart poster with the wave of NFC Smartphone. Faster transaction helps to reduce waiting time. Customers are satisfied with the service provided and less driving. The issue of traffic jam in the town during busy hour can be solved directly. Paper ticket and coupon is replaced by NFC electronic device cut down the paper consumption. NFC

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significantly contributes for saving the Earth. (Near Field Communication.org, 2015) So, the compatibility of NFC technology is quickly spreading throughout the world.

Regardless, NFC based application perform similar with Bluetooth on a Smartphone device. NFC communicates wirelessly between two devices with a short distance of 4cm. This ensures that the information is transferring in easy and secure way. NFC design based on Radio Frequency Identification (RFID) but focus on Smartphone. The technology behind NFC is known as tag and reader. Active device such as reader in the electronic payment station, create a radio frequency current communicates with NFC device or NFC tag and read the information. Passive device such as the NFC tag in smart poster, store information and waiting a device for interact. NFC uses ISO/IEC 18092:2013 for communication modes. The Near Field Communication Interface and Protocol (NFCIP-1) specifies the communication network for both active and passive device operates at the centre frequency of 13.56MHz. ISO/IEC 18092:2013 defines in particular, modulation schemes, coding, and transfer speeds, frame format of the RF interface, initialization schemes and condition required for data collision control during initialization. Moreover, ISO/IEC 18092:2013 specifics a transport protocol including protocol activation and data exchange methods. (JTC 1 Information technology, 2013) Therefore, NFC is designed in the frequency of 13.56MHz. At this frequency range, NFC tags mostly used the theory of magnetic induction similar to RFID tag and contactless smart card. NFC works when electrical signal applied to a winding of transformer produces magnetic flux lines that link the primary reader antenna to the secondary tag antenna. The slow data rate of transmit data up to 424kbps. NFC draws less power during transmission of data. NFC based application of payment perform similar with smart card. Smart card is the most frequently communication infrastructure deployed in e-Ticketing. Smart card based e-Ticketing are the high one-time investment and ongoing costly operating system with the highly complex multi-layered such as check-in and check-out devices at station, back end systems. For NFC based e-Ticketing, NFC Smartphone is a mobile technology infrastructure begins to deploy in ticketing system. (Stefan Stroh, 2007)

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1.2 Problem Statement

Basically, the widely use of Smart tag and Touch n Go in Malaysia‟s transportation for the last 10 years. The efficiency of smart card technology contributes people with the easiest way to pay the fare. The reaction time of Smart Tag and Touch n Go in a fraction of seconds, it seem so instantaneous and reduce a lot of waiting time. If using the manual payment, people had to wait for operator to process the transaction. The transponder inside the Smart tag or Touch n Go is a microprocessor chip. Thus, the chip contains different unique identifier (UID) can be programmed to store money and personal details. The microchip sends the radio frequency signal to the reader. (Hisham, JULY 2009)

However, there is a limitation of Smart Tag and Touch n Go. The cost of smart tag reader devices is very expensive and the extra chargers in smart card reload over the ATM or reload agents. The additional fees of RM0.50 and RM1.00 at cash deposit machine. The free reload of touch n go only available from manual transaction over the counter of Touch n Go Highway Office. If the touch n go card service is terminated, it took a month to receive the refund payment for card balance and deposit in cheque. Sometimes, the memory failure of smart card swiped the cash balance into zero, the Touch n Go company will not pay the balance back to the customer. In addition, since the reader is expensive, some stores may charge a basic minimum fee of 2% or spend minimum rm50 above for using smart card for payment. Nowadays, criminals are good at creating a false sense of security and someone might not able to protect their card details. (Scudder, 2012)

So, in order to end all these problems, this project is introduced as an automated way of collecting fare in LRT station. It is called as a NFC Payment System. NFC has specialized function in Smartphone. Smartphone is compatible for making contactless payment and transportation. NFC Smartphone does not need to reload, free to access the transportation gate, connect automatically in fraction of seconds, no termination of card services and no basic minimum fee charges. The NFC payment apps is linking with bank account, bank will takes the responsibility for balance lost if memory failure occurs in Smartphone.

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1.3 Project Objectives

1. To study and investigate the possibility of applying NFC technology among commuters who use public transport frequently.
2. To develop an android application of program purposely for the Near Field Communication technology and procedures for the commuters.
3. To analyze the designed system in term of its functionality and performances.

1.4 Scopes and Limitations

The project was conducted to determine performances of NFC application in LRT station during the year of 2015. Performances of NFC include characteristics of NFC such as one way communication, two way communication, limited range, fast set up time, compatible with RFID module and survey on public awareness. The aspects of the project were waiting time during ticket purchasing, the smart card need to reload before the journey, robbery case, traffic jam occur during working hours and lunch hour. The target of using this application is worker or student who travels by LRT train. The focus on the method to develop the project is designing a new Android apps program. The apps program was built by MIT Software. The communication between NFC tag and NFC Smartphone will be demonstrated. NFC tag will act as electronic payment station while the NFC Smartphone will act as reader to read and write. The project will be carried out for about 6 month.

On the other hand, the limitations of project are:

1. not all Smartphone device have NFC.
2. not secure ;write data on the tag freely without authentication.
3. interference (similar to denial of service) and interception (man-in-the middle) can be countered simply by encryption.
4. time is not enough for build up the prototype and do analysis as well since there is other subject to study.

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1.5 Summary

NFC is an evolved form of Radio Frequency Identification (RFID) for electronic devices which allows them to communicate with each other by simply touching or bringing them very close to each other. NFC uses ISO/IEC 18092:2013 and operating under frequency of 13.56 MHz within the distance of 4cm and transfer in the slow rate of 424kbps. NFC is a power saving devices and environment friendly. NFC is just a subset of RFID in the form of features and specification. NFC was launched in 2002. The NFC Forum formed in 2004 by Nokia, Philips and Sony. Many researches are conducted by many companies and academic organizations in this field for continuous improvement. Although NFC device looks obtuse and complex, but it is actually super simple to use and understand. NFC has tons of potentials, and with backing from banks, hardware makers, and retail shops. Therefore, the quantity of people travels by LRT instead of driving maybe increase.

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CHAPTER 2

THEORETICAL BACKGROUND

2.0 Introduction

This chapter is evaluated about the current technologies on wireless communication such as Radio Frequency Identification (RFID), Bluetooth, WiFi and NFC. There were two basic operating system used in Smartphone available in market. The Android system is applied in every model of Smartphone. The iOS system is only available in Apple Smartphone. The structure of the project consists of software and hardware parts. The past related research also briefly discussed in this chapter.

2.1 Current technology on wireless communication

2.1.1 NFC Technology

NFC operates in around 22 meters long wavelength and 13.56MHz low frequency shows that it is a nice half wave dipole antenna. This results in radiation efficiency about 0. NFC works when electrical signal applied to a winding of transformer produces magnetic flux lines that link the primary reader antenna to the secondary tag antenna. The NFC consumes low power because the contactless energy transfer from reader antenna returns to the antenna whether there is a tag or not. If there is a tag, the modulating impedance disturbs the field that is already coupled through a return path to the reader antenna. This theory of operation is shown in **Figure 2.1**. (Stephen B.Miles, 2008) Actually, NFC antenna is literally a big inductor. It can be made by wrapping coil of wire as large as possible around the material. It generates a strong magnetic field within loop. The more the number of

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