A Near Field Communication (NFC) – Enabled System in Smart Posters for University Application

by

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14828

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Engineering (Hons)
(Electrical and Electronic)

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CERTIFICATION OF APPROVAL

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Approved by,

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(Dr. Azlan b. Awang)

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January 2015

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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RACHEL ROSE CHONG

ABSTRACT

This project involves the exploration and use of Near Field Communication (NFC) in the Education field. The goal is to design a new application for the use of NFC in the pretext of a university environment. This has been done by exploring the current application of NFC in the Education sector and looking into new possibilities for this upcoming technology. Upon research, the author is interested in the process of producing a tag that will contain URLs of references for smart posters. Through showing the capabilities of NFC in the form of a new application, this research proves the possibility of the expansion and successful application of NFC in the near future for the Education sector.

ACKNOWLEDGEMENT

This paper would not have been possible without God. I thank God for the good health that I was given to complete this thesis. I would like to thank my supervisor, Dr. Azlan bin Awang, for his guidance throughout this project. Thank you for the knowledge that you have shared with me. I would also like to thank my family and friends for their constant support and help. My sincerest gratitude to all who contributed to the success of this project.

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CHAPTER 1
INTRODUCTION

1. INTRODUCTION

1.1 Project Background

Near Field Communication (NFC) is a wireless technology that allows data transfer or communication between two congruent devices that are in close proximity [1]. NFC works only in a short range due to security reasons. The distance of this wireless range is about 10 cm or less. [1] NFC functions at a frequency of 13.56 MHz and has a data transfer rate up to 424 Kbps [1].

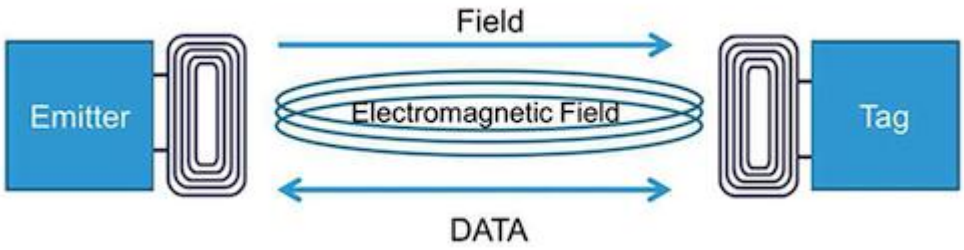


FIGURE 1. Emitter and Tag Interaction [2]

NFC technology functions on magnetic field induction and has two main interaction modes, whiHuman System Interactions, ch are active and passive. There are two modes because NFC-enabled devices are able to perform a bidirectional communication, to send as well as receive data. When NFC devices are in active mode, they will produce their own power supply and magnetic field for data transfer. In these cases, the NFC-enabled devices are behaving as an emitter. For the passive mode, however, one of the devices will be powered by current induction through another device's magnetic field.

The passive device is dependent on the active device for power and also magnetic field for the transfer of data [1] , [3]. NFC tags are passive mechanisms that store information that is read by an NFC-enabled device in active mode [4]. As mobile phones become a necessity in people's lives, NFC makes way to new situations where mobile-based platforms can be used. There are three modes of operation in which an NFC-enabled mobile phone can function. These three modes are explained through Table 1.

TABLE 1. NFC Operation Modes (Adapted from [1])

Operation Modes	Description
Reader/Writer	NFC device can either request information from the passive tag to be read, or change the data stored in the tag according to the user.
Peer to Peer	Two NFC-enabled devices are paired together automatically for the transfer of data from an established two-way connection.
Card Emulation	This mode changes the NFC device into a smart card system. The advantage of this is that different contactless smart card functions can be stored in one NFC mobile phone.

1.2 Problem Statement

Posters can only carry very limited information on a particular subject or topic. To compensate for this, Quick Response (QR) codes have been frequently used as a method to store the extra information on the product or topic as well as related links. However, QR codes require the use of the camera and also the application to run the code. It can prove to be cumbersome to unlock the phone and wait for the camera application to open, and also for the QR code to be processed by the application. Not only that, any form of dirt or printed layer between the code and user will affect the transfer of information, or prevent it altogether. This decreases the ease of use and adds significant delay in data transfer.

1.3 Objectives

The main aim of this project is to explore the capabilities of the NFC technology in the Education field, through NFC tags to NFC-enabled devices. The objectives are:

- To design and produce an NFC-enabled system in which there will be data exchange between the device and tag for a university environment.
- To assess the proposed design and evaluate the performance of the system.

1.4 Scope of Study

NFC has great potential in so many areas of applications. However, in this report, the focus will be in the Education Sector. The scope will be specifically regarding the transfer of information between the students and the smart posters, in terms of lecturer information, course information, references, or anything regarding a particular topic or subject. The NFC mode to be used for the tags would be the read/write mode.

CHAPTER 2
LITERATURE REVIEW

2. LITERATURE REVIEW

2.1 Evaluation of RFID

Radio Frequency Identification (RFID) is a wireless technology that detects and stores tag information of objects by means of radio waves over long distances. RFID has been present for the past 50 years and has been widely used in recent years. NFC, however, is a new technology, and is a subcategory of the RFID technology, which comprises of the high frequency band of the frequency of operation. The frequency used by the RFID technology is shown in the Figure 2.

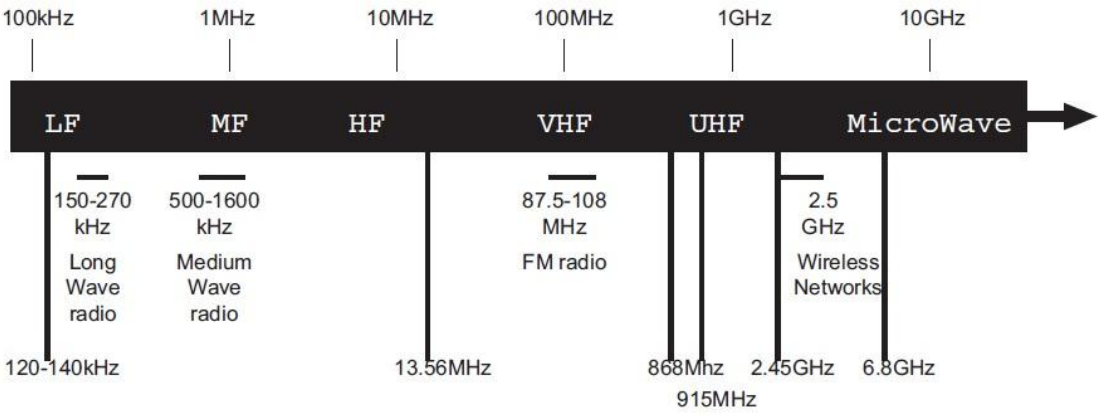


FIGURE 2. Frequencies of RFID [5]

NFC is also very much related to mobile devices and thus, can be recognized as an incorporation of RFID into these portable gadgets. [6]. The differences between the RFID technology and the NFC technology can be observed in the Table 2.

TABLE 2. RFID Vs. NFC(Adapted from [7])

Technology	RFID	NFC
Read/Write	Fixed points only	Mobile and flexible
Storage Capacity	Less	More
Server	Always required	Not always required
Signal Range	Far	Near
Security Control	Harder	Easier
Activation Method	Signal	Touch/Proximity
Cost	Expensive	Cheap
Communication	One-Way	Two-Way

The reading/writing position for RFID are only at static points whereas NFC is portable and adaptable so the tag reading/writing can be done anywhere at any time. The storage in NFC is more than RFID because it has extra storage capacity in the mobile phones. The server is not always required for NFC because it is incorporated in mobile phones which can handle some of the processes [7].

The signal range for the RFID is bigger compared to NFC. This is actually one of the reasons NFC was created, to improve on RFID's security level. NFC's security is more secure because it is easier to control a much smaller signal area range. This range relates back to the activation method as well, and there is a big difference for RFID and NFC, which are activated through signal and touch/proximity respectively.

Other than that, tag clashing was a common problem for the RFID technology. This clashing happens when there is more than one reader in the RFID signal area, causing the device to be in disarray, not knowing which device to read. This issue was brought into the creation of NFC in limiting the range of contact between reader and tag.

Another significant difference between NFC and RFID is the data communication. It is only one-way for RFID technology whereas for NFC, one can both send and receive data [8].

2.2 Quick Response Code

QR Code is a method to store data such as texts, messages, business cards or URLs in a two-dimensional barcode [9] [10]. QR codes stores information both horizontally and vertically and has a large data-to-print-size ratio [9]. The code has readability up to 360 degrees, which means it can be read from any direction [10].

QR codes are similar to NFC in their use of mobile phones. To read a QR code, a camera phone and a QR reader application is required [10]. QR codes are normally used in smart posters and are common in advertisements. However, NFC has also been introduced into these usages. The differences between these two are shown in the Figure 3.

FIGURE 3. NFC Vs. Barcode/QR Code [11]

The first obvious difference is that QR Codes require good lighting for the camera to capture the image of the 2D code while NFC is detected through its signal. NFC is more secure due to several factors. The first is the short range of detection which limits the exposure, the second is the coding of the NFC tag is inside the chip itself, whereas for the QR code, it can be duplicated as the code can be seen and captured easily. An NFC device does not require the internet to read the NFC tag like how the QR code software requires the internet to process the code. The NFC device has a built-in reader. Another major difference is that NFC is automatic in its pairing, unlike the QR code that requires the camera as well as the QR reader application. This causes NFC to be processed a lot faster compared to the QR code.

Other than the differences mentioned in the figure, QR codes are difficult to read if dirt or marks are present on the surface. NFC does not encounter this problem as the signal can still be detected easily. The downside to NFC is that it requires an NFC-enabled device, which not all mobile phones have, while the QR code can be read by any smartphone with a camera. However, majority of the smart phones in the market currently have NFC and is believed to continue to grow until all smartphones have this capability.

2.3 NFC Technology in Mobile Phones

Most mobile devices these days have NFC incorporated in them. These devices have two integrated circuits for this technology to work. The first is the NFC controller, where the analog to digital conversion (ADC) of the signals occur, when the device is brought close to the tag. The operating modes of the NFC are selected by the Host Controller.

The secure element is the second circuit which is used to simulate the tags. For further understanding of the architecture of NFC in a mobile device, refer to Figure 4.

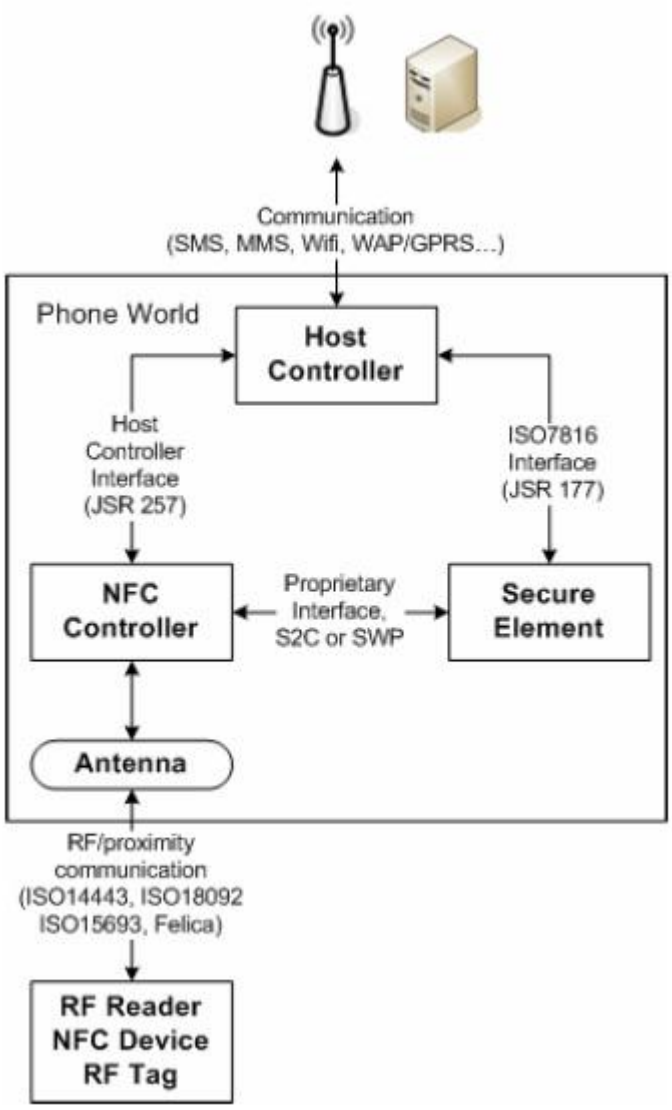


FIGURE 4. Structural Design of NFC Incorporated in a Mobile Phone [1]

2.4 Related Work in Education Field

The existing NFC applications implemented in real-time in the Education field is covered under this section.

2.4.1 NFC- Enabled Attendance System

One of the primary applications of NFC in the education sector would be the attendance system. There were several reasons for the implementation of this NFC-enabled system in schools. Firstly, it was to save time for the teachers to maximize their teaching hours in class as they did not have to manually roll-call each student. Another factor was the safety of the children. Parents would be able to monitor the real-time data of their children's movements to observe their child upon travelling to school and back. This would be able to prevent kidnapping cases and give the parents assurance of the child's safety and attendance in school [12].

The attendance system by Ervasti, Isomursu and Kinnula [12] was a reader and tag system, where by each of the students were given contactless smart cards. Their arrival and departure would be recorded at the tap of the card on a reader device. The information recorded by the device would include the child's name, the arrival or departure of the child, and time arrival. This record will be saved in a backend system, where a teacher can access to at any time. The parents would also be able to check on their children through online and also through text messages regarding the attendance and also time of arrival or departure, to and from school. This prevents students from skipping school.

On another hand, implementing this NFC-enabled system in universities would give somewhat different benefits. Time-saving is still a key factor, as attendance sheets do not need to be passed around, but students commonly sign attendance for their absent friends, and the attendance is not accurate. Therefore, this system will be able to solve that problem.

Due to the consideration of other factors for university students, the way the system works differs slightly from the attendance system implemented in schools. In this research, an NFC-enabled mobile phone is used to read the students' individual NFC tags and a picture of the student is taken at the same time. All this data is collected in the database of the lecturer's mobile device and over a time period, the lecturer will store all the information in a database server [13].

2.4.2 Smart Posters

Majority of smart posters are posters with QR codes printed on them. The QR Codes are used to store links or information regarding a merchandise or event. These QR Codes can be produced by anyone through websites with the QR Code generating software [4].

For NFC-based ones however, in the research by Miraz, Ruiz and Nieto [1], the tags used was the Mifare 4k adhesive card. The poster will provide extra information and related links to the subject on the poster when it is read by an NFC-enabled mobile device. This device is either waved in front of the poster or tapped gently which will autonomously transfer information from the NFC tag in the poster to the device [1] [14]. All these information was stored in VCard format.

CHAPTER 3
METHODOLOGY

3. METHODOLOGY

3.1 Flow Chart

Figure 5 shows the research methodology for FYP. The detailed procedure will be explained in the next section.

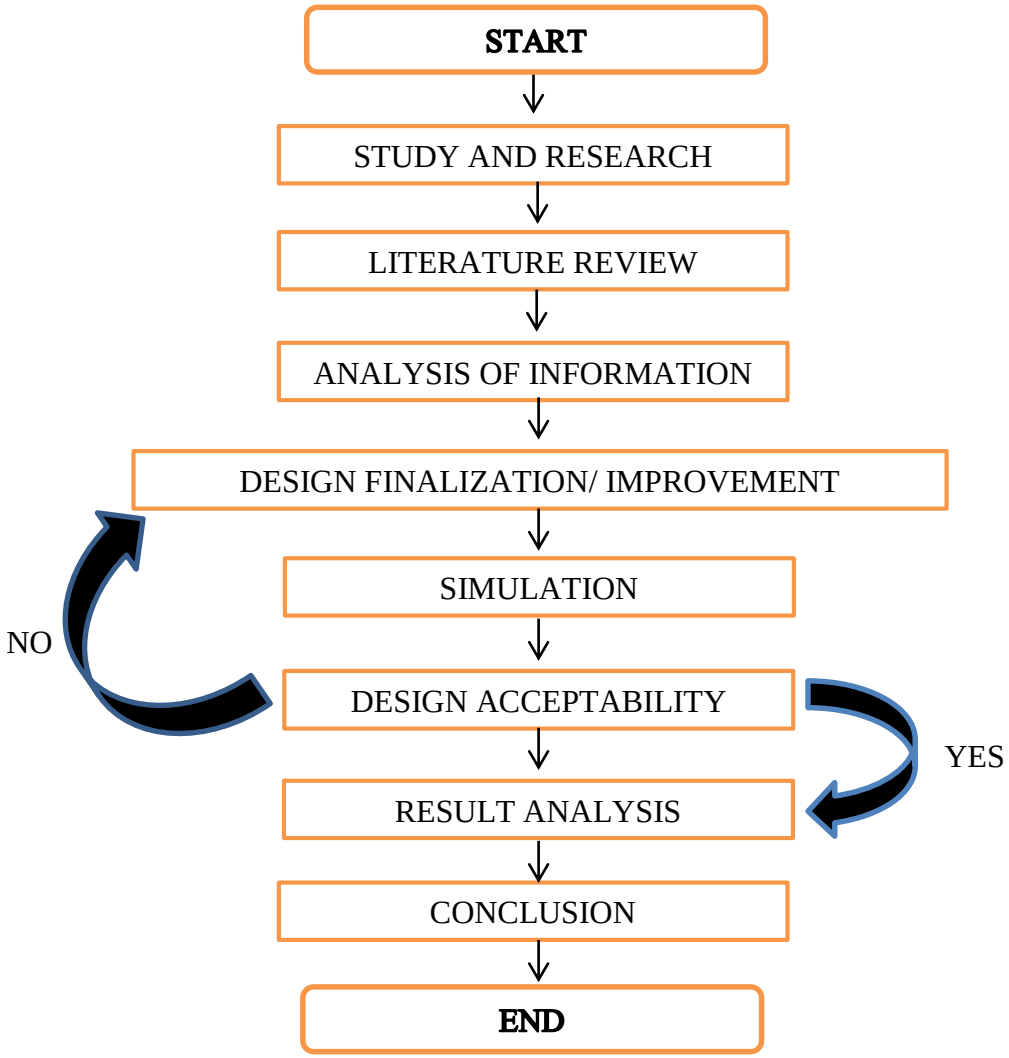


FIGURE 5. FYP Methodology Flow Chart

3.2 Gantt Chart and Project Key Milestones

3.2.1 FYP1

No	Activity	Week 1 22/9	2 29/9	3 6/10	4 13/10	5 20/10	6 27/10	7 3/11	8 10/11	9 17/11	10 24/11	11 1/12	12 8/12	13 15/12	14 22/12
1.0	Selection of project topic														
2.0	Preliminary research work														
2.1	Literature review														
2.1.1	Evaluation of RFID														
2.1.2	NFC Technology In Mobile Phones														
2.1.3	Related Work in Education Field														
2.1.3.1	NFC-enabled Attendance System														
2.1.3.2	Smart Posters														
3.0	Submission of extended proposal						▲								
4.0	Design of experiment														
4.1	Identifying components and parameters used														
4.2	Identifying software used														
4.2	Download and study the software														
5.0	Proposal defense														
6.0	Project work														
6.1	Purchasing required materials														
6.2	Coding Simulation														
6.3	Data compilation														
7.0	Submission of interim draft report													▲	
8.0	Submission of interim report														▲

▲ denotes Suggested Project Key Milestones

3.2.2 FYP2

No	Activity	Week														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.0	Project work															
1.1	Develop Application Using Different Software															
1.2	Data compilation															
2.0	Submission of progress report							▲								
3.0	Data analysis and discussion															
3.1	Results Comparison															
3.2	Review of data (discussion)															
4.0	Pre-SEDEX										▲					
5.0	Submission of draft of final report											▲				
6.0	Submission of dissertation (soft bound)												▲			
7.0	Submission of technical paper												▲			
8.0	Viva													▲		
9.0	Submission of project dissertation (hard bound)															▲

▲ denotes Suggested Project Key Milestones

3.3 Research Methodology

3.3.1 Proposed Experimental Procedure

1. To study about NFC in terms of how it works and its characteristics.
2. Research on NFC and understand the global view, as well as industry applications for the literature review.
3. Observation of methods used in all this applications.
4. To choose what is necessary to the project in the problem statement and objectives, and also to decide on the scope in the education field.
5. To finalize the design approach for the project and construct an outline to achieve the objectives.
6. To gather data on the design approach and acquire parameters involved for the coding of the program.
7. Mobile application is developed using Android SDK to write into tags.
8. To analyze results obtained. The design is improved if there is any difference from the expected results.
9. To conclude the progress made and information is analyzed to produce recommendations for further improvement.

3.3.2 Design Procedure

1. Install driver for the NFC-enabled device, which in this paper, is the driver for Samsung Galaxy Note 2.
2. Install Android SDK
3. Choose and purchase suitable NFC tags
4. Program and develop required application using Android SDK
5. Connect NFC-enabled device to the laptop and run the application through the USB driver.
6. Use NFC-enabled device to encode the tag.
7. Use a different NFC-enabled device to read the tag.

3.3.3 Procedure to Use Available Applications

For other ways of testing, the author has downloaded the NXP Tagwriter application on an NFC-enabled device. This application can be used by any users to encode the links or reference URLs into the NFC tags. There are many other applications that are available in the android app store, such as Trigger, PonPonTile and etc that can also be used by anyone without prior programming experience to encode the NFC tags. The application interface and the sequence of the encoding is shown in Figure 6.

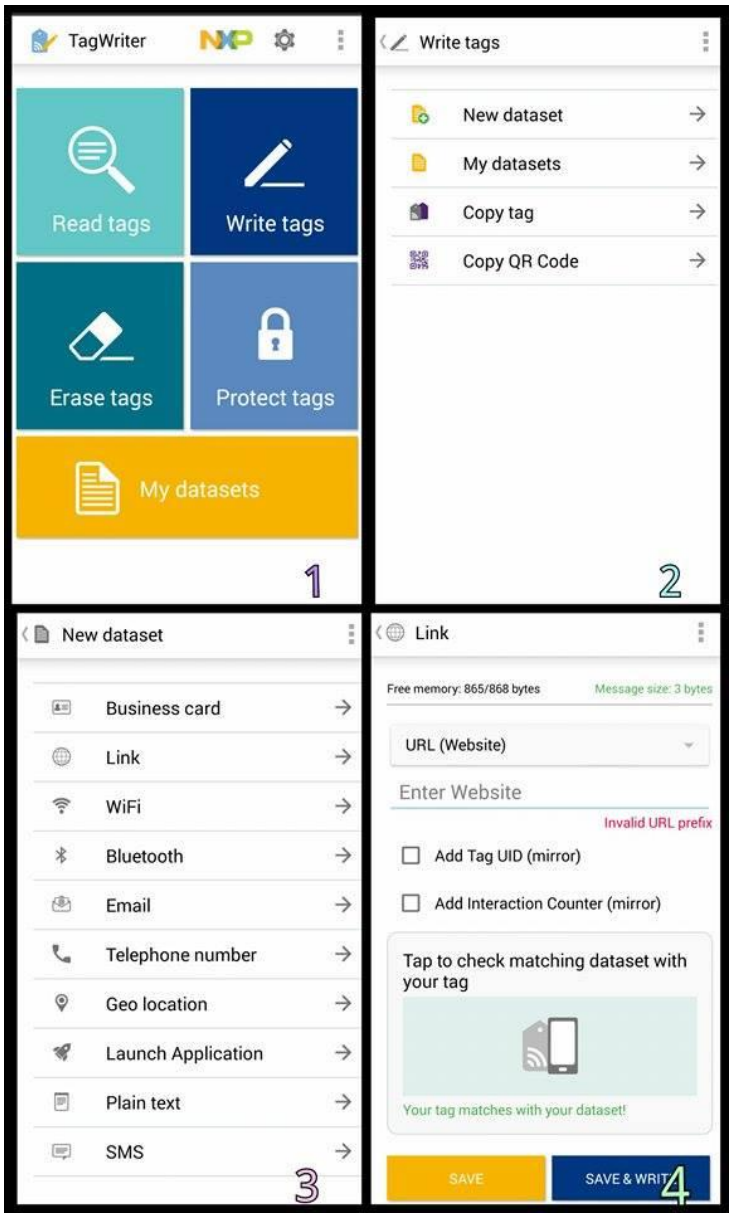
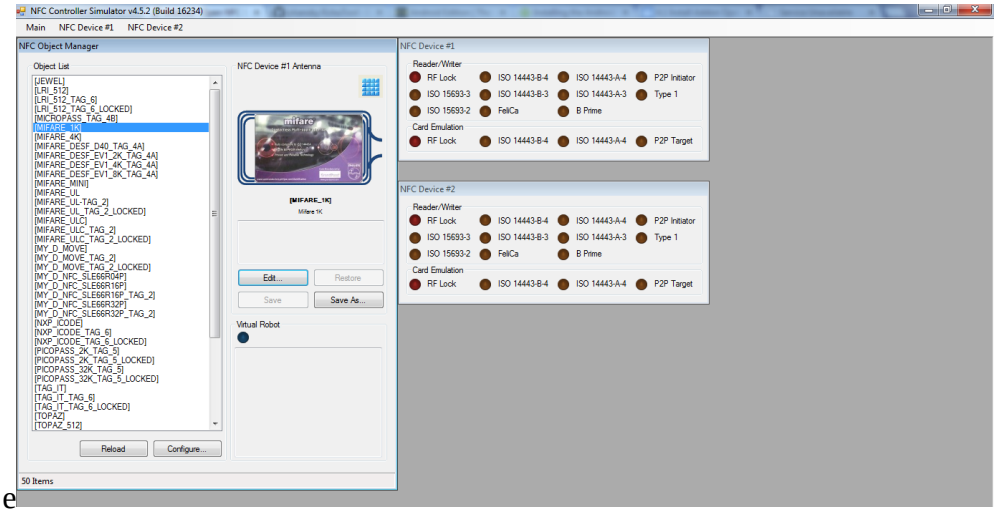


FIGURE 6. NFC Tagwriter by NXP [15]

First, ‘Write tags’ is clicked, followed by the ‘New dataset’ option. Under ‘New dataset’, ‘Link’ is chosen to write an URL into the NFC tag. A tag is placed close to the NFC-enabled device and the application determines if it matches the dataset. If yes, press ‘SAVE & WRITE’ and then the tag is successfully encoded and ready to be used.

Figure 7 shows the NFCC Simulator which helps to simulate the reader if the author does not have an NFC-enabled device for testing.



e

FIGURE 7. NFCC Simulator

3.2.1 Tools and Equipment

These are the expected software and tools that will be used in this project.

- NFC-enabled device/reader
- NFC IC (NTAG203)
- Android SDK
- Android driver

CHAPTER 4
RESULTS AND DISCUSSION

4. RESULTS AND DISCUSSION

4.1 New NFC Android Application

Following the successful installation of the Android SDK, the author worked on building the application for the mobile phone. This application was to encode an URL into the NFC tag. The purpose was so that users could input the URL which they wanted the public to obtain through the smart poster. The code was modified and adapted from 'Tap Into NFC' website [16].

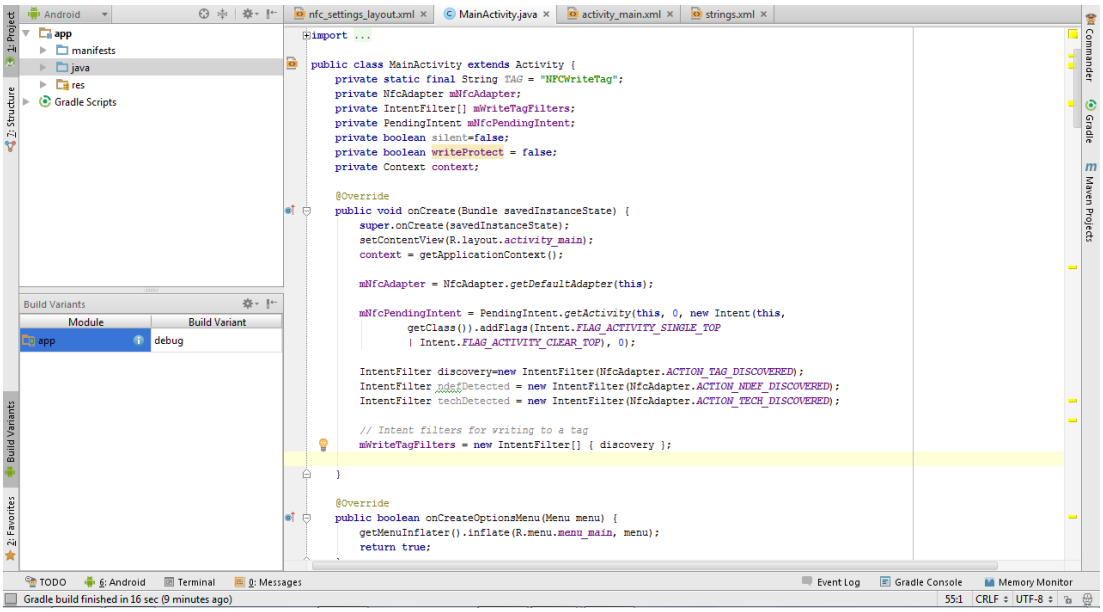


FIGURE 8. Application Coding (adapted from [16])

After the coding was built and run, the author modified the layout to make the interface look more appealing, and the output is shown in Figure 9, followed by Figure 10 which shows the actual application interface in the mobile phone.

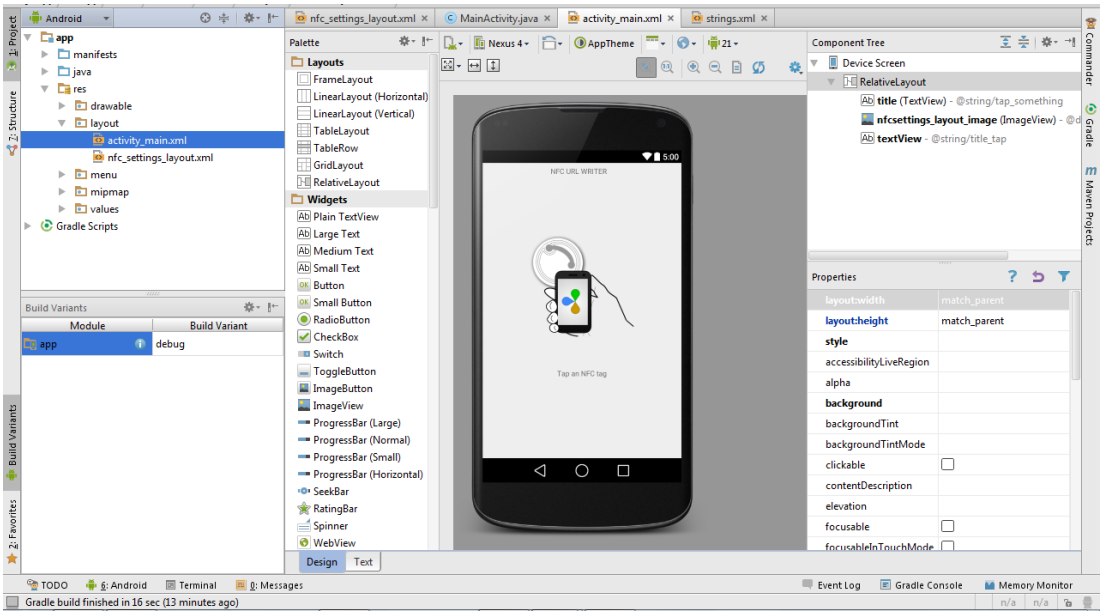


FIGURE 9. Interface design in software

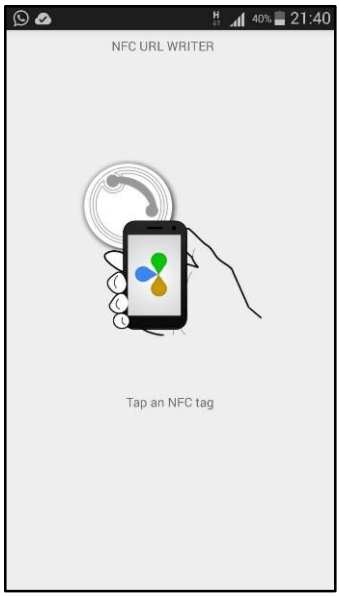


FIGURE 10. Actual application interface in mobile phone.

When the application is first connected to the mobile phone, the application checks whether the phone has NFC capabilities. If yes, it will be installed in the mobile phone. Then, when the application is run, this application would check whether NFC is enabled in the mobile phone's settings. If not, the interface would display as in Figure 11.

FIGURE 11. NFC Enable Check

After that, when a tag is placed near to the mobile phone, the application checks for compatibility in terms of format, space capacity and also tag type. In Figure 12, on the left is when NTAG216 was placed near the phone, and on the right was when the NTAG203 was not yet pre-formatted.

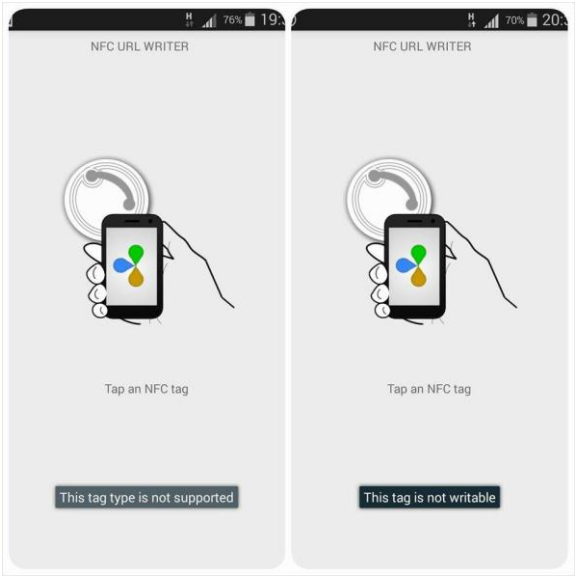


FIGURE 12. Different Notifications for different incompatibility reasons.

When the tag is found to be formatted and compatible with all the requirements, the application will write the URL into the tag. The tag is now encoded and ready to be used. The interface will display a notification indicating success as shown in Figure 13.

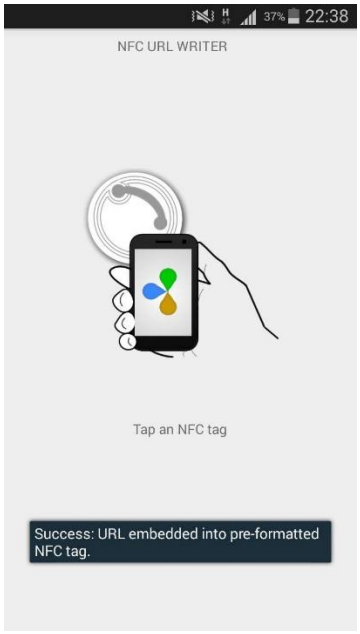


FIGURE 13. Successfully encoded tag

After the encoding, the user can then attach this tag on relevant smart posters and whenever interested people place their NFC-enabled phone near the tag, they will receive the URL. In Figure 14, on the left, the app will ask for the user to choose a browser, and then immediately the URL will be opened, as seen on the right.

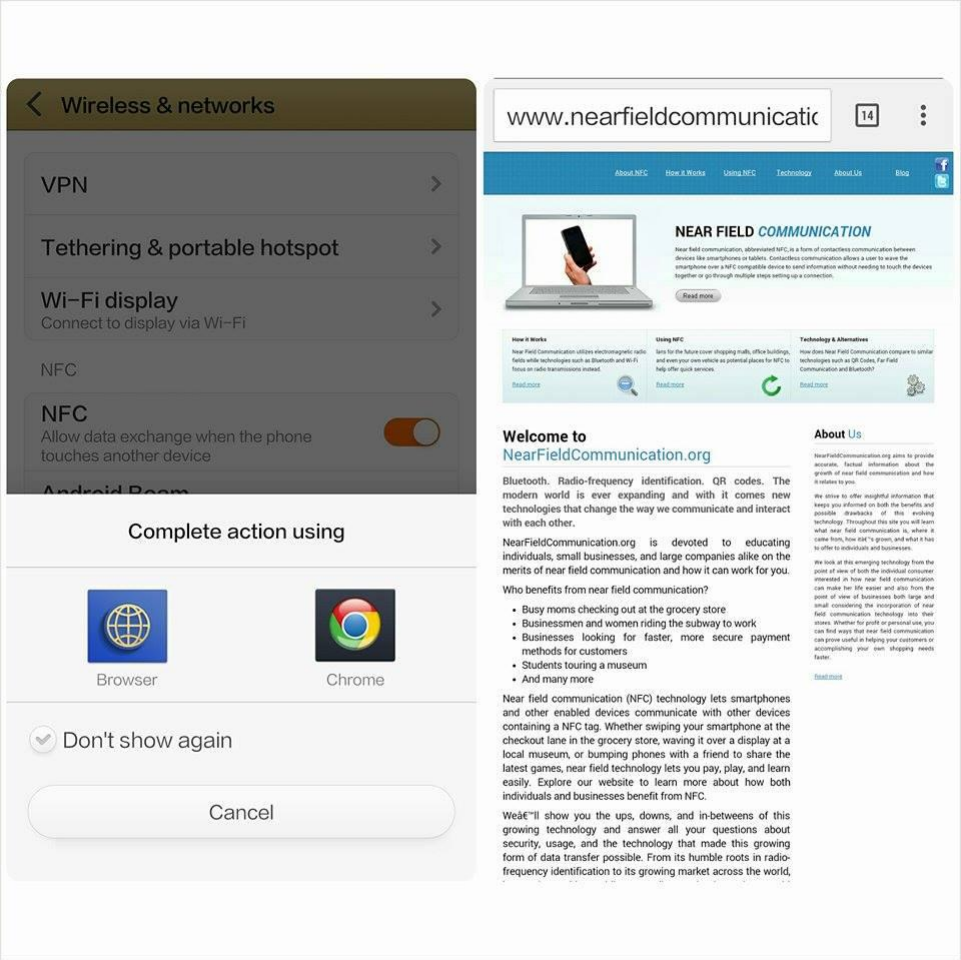


FIGURE 14. Output from tag

4.2 Current Limitations in New Application

The current limitation in the new application is that the user cannot input a new URL to write into the tag using the mobile phone, but has to write the URL through the programming in the Android SDK in the MainActivity.java. Then, this is transferred to the phone to write on the tag. It is not yet a user-friendly application.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5. CONCLUSION AND RECOMMENDATION

The capabilities of NFC technology has been explored in the Education field. This was met through the creation of a working prototype consisting of a mobile application that could write an URL into an NFC tag, which will be placed on a poster for students to read, using their NFC-enabled devices. The proposed design can be further improved by fine-tuning the application to write more than one URL into a single tag, as well as improving it to become a more user-friendly application. This idea can be used and implemented into more areas in the university in the future, as in libraries and so on. In the future, another application that could be looked into would be using NFC to transfer lecture information from lecturer to students, as well as students submitting assignments to lecturers. The possibilities are endless.

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