

Attendance Tracking System Based On Contactless Smartcard

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Abstract: Attendance for students in universities is important thus an attendance monitoring system is essential. The usual method for taking attendance is either by calling out student names or signing in attendance sheet. The conventional method will consume time in order get the student attendance, resulting in a reduction of actual teaching time. In order to save the time and also avoiding fake attendance, an Android app that uses Near Field Communication (NFC) is developed. NFC technology is the evolution of non-contact Radio Frequency Identification (RFID) and interconnection technology integration, combined with proximity readers, inductive card and point features on a single chip with a compatible device identification and data exchange. This application stores the attendance in the mobile internal database and the user can view and update the attendance whenever required. SQLite will be used in this project for database support and logging the student attendance. Database will contain the students information such as their name, unique ID, student ID and etc. The apps will be running on NFC able smartphone or tablet where students just need to tap their smart card to the lecturer's smart device to sign in their attendance.

Keywords: Android, Near Field Communication,

1.0 INTRODUCTION

Nowadays, the lifestyle of people becomes more organized and modern to complete their work in daily life. So, the idea to design something that can be used in order to accommodate this problem has been realized. This paper aim is to propose an attendance tracking system based on contactless smart card using an NFC technology to be utilize by users with android smart phone. This NFC technology will bring a new era in daily life of controlling something with using a smart phone via NFC application. Until now, the discussions reveal the various ways in which NFC is being used all over the world. From this point onwards, the focus of the proposal will shift towards the process of classroom that can be effective in UniKL British Malaysian Institute, especially on how NFC systems can be implemented here and whether they are feasible. The best place to start such an implementation would be in the classroom since student and lecturer can be part of it to increase the efficiency in their learning process.

The traditional method of attendance marking has some drawbacks. In most of the classroom, lecturer still use paper based attendance systems for tracking student attendance in the classroom. Paper consumes utilization of resources which contributed to inefficiency of tracking student. This method obviously not efficient as it wastes the time and quite slow in term of completion. For example, a class that uses attendance sheet method requires the students to pass the sheet to each

other to sign up the attendance. If there is a large amount of students, it will take time in order to complete the attendance marking. Besides that, there is possibility that some students might miss their turn to sign the attendance as they did not receive the attendance sheet. In term of organizing the attendance, there is also a possibility where the attendance sheet might be lost and this will cause difficulty to review the attendance. As a result, this will produce an inaccurate overall attendance counting. Furthermore, environment on the classroom need to adopt the new technology to advances new level of standard in efficiency of learning process. Technology such as NFC will help the achievement of the new standard of learning process.

1.1 NFC Technology

NFC is an integration of contactless smart card communication technology in mobile devices such as mobile phones. Generally, the NFC circuitry is built in the battery of the phone and not on the back plate. In order to share data between two NFC enabled phones, one has to bring the phones to touch each other ^{[1][2]}. This will send the selected data to the phone. This requires at least one transmitting device, and another to receive the signal. It is pretty remarkable- suppose you are watching a video on You Tube, the back of one phone has to be touched with the other and immediately the video are sent to the other phone. What happens is that it sends a link that

directs to an application on the market where it can download it. Thus, the advance features motivate to produce this project. NFC enables short range communication between compatible devices. A range of devices can use the NFC standard and can be considered either passive or active, depending on how the device works^[3].

Passive NFC devices include tags, and other small transmitters, that can send information to other NFC devices without the need for a power source of their own. However, they did not really process any information sent from other sources, and can't connect to other passive components. These often take the form of interactive signs on walls or advertisements. For active devices are able to both send and receive data, and can communicate with each other as well as with passive devices. Smartphones are by far the most common implementation of active NFC devices, but public transport card readers and touch payment terminals are also good examples of the technology^[3].

1.2 NFC on Android Smartphone

The concept of NFC technology is a short range high frequency wireless technology which facilitates the users to exchange data between the devices at certain limited range of distance. In order to determine what sort of information is to be exchanged between devices, the NFC standard currently has three distinct modes of operation for compliant devices^[4]. In the perspective of the use cases for the NFC, initially the three main modes are:

- i. Peer-to-Peer mode
- ii. Read/Write mode
- iii. Card emulation

The most common use in smartphones is the peer-to-peer mode, which allows two NFC-enabled devices to exchange various pieces of information between each other. This concept is based on the wireless communication between the two entities making the protocol more commonly called as the *Peer-to-Peer* communication protocol^[4]. The NFC devices communicate with each other in the way by exchanging information. In this scenario, the usage of android beam is done in order to communicate with each other. In this mode both devices switch between active, when sending data, and passive states when receiving. *Read/write* mode, on the other hand, is a one way data transmission, where the active device, possibly your smartphone, links up with another device in order to read information from it. This is the mode used when you interact with an NFC advert tag. In this mode, the NFC device will be active and also reads the passive RFID tag for interactive advertising and other initial issues. The final mode of operation is *card emulation*, which in this mode the NFC device acts as if an existing card with contactless in practice whereby the NFC device can be used like a smart or contactless credit card in order to make payments or tap into public transport systems^{[4][5]}.

Using NFC technology is where the two parties participating in the wireless communications are the computer peripherals and the customer electronic. NFC communicates in the wireless mode where it operates at the reasonable radio

frequencies like 13.56 MHz which indeed did not require any sort of permissions or licenses. In this mode of wireless transfer the communicating entities share the single RF channel making the communication scenario as half duplex – listen before talk policy. The device must talk or transmit the signal after listening to the signal transmitted by the other device and making the confirmation that the other devices are not transmitting. Thereby using android in this project could have the capability of gaining more access and having more flexibility with the recent technologies.

2.0 MATERIALS AND METHODS

This study describes the development of the device which consists of software and hardware development.

2.1 Hardware Requirement

These hardware requirements are very minimum requirements that need to develop the project. The hardware requirements are shown in Table 2.1.

Hardware		Description
Smartphone		Smartphone with Android Operating System, NFC card available to testing and debug the application for lecturer.
Laptop /Pc	Hard disk	The hard disk is the main storage in a computer where all the software installed on it.
	Memory (RAM)	Memory is defined as Random Access Memory (RAM) provides space for the computer to read and write data to be accessed by the CPU (central processing unit) or processor.
	Processor	The processor is the electronic component which is acting as “brain” for of a computer. The higher the processing speed is much better.
MIFARE Classic card		A series of chips widely used in contactless smart cards and proximity cards

Table 2.1: Hardware requirement

2.2 Software Requirement

Table 2.2 shows the list of software that is use to develop the application for Attendance Tracking System Application.

Software	Description
SQLite	Using DB Browser, SQLite is a visual, open source tool to create, design, and edit database files compatible with SQLite. Used to create databases, search, and edit data of the Students (Eg. Students name, ID, other information)
PHP	A programming language that allows you to process and react to user actions on your website. PHP requires that actions are processed on the server in which the website resides. Commonly used to access database on the server that hosts your website.
MySQL	A highly structured place you use to store information of any type. Organize information in a series of tables with rows and columns, like a spreadsheet. Used Structured Query Language to issue commands to MySQL.
Basic 4 Android (B4A)	B4A includes all the features needed to quickly develop any type of Android app.

Table 2.2: Software requirement

2.3 Database: MYSQL vs. SQLite

Relational databases have been in use for a long time. They became popular thanks to management systems that implement the relational model extremely well, which has proven to be a great way to work with data. Databases are logically modelled storage spaces for all kinds of different information or data. Each database, other than schema-less ones, has a model, which provides structure for the data being dealt with. Database management systems are applications (or libraries) which manage databases of various shapes, sizes, and sorts^[6].

In this section, differentiation between MYSQL and SQLite database will be discussed and conclude on which database will be use for this project. There are many types of database available, but only these two are considered since its application suitable for making the Attendance Tracking System project.

2.3.1 SQLite

SQLite is the most popular and commonly used Relational Database Management Systems (RDBMS). SQLite is an in-process library that implements a self-contained, **serverless**, zero-configuration, transactional SQL database engine. SQLite is the most widely deployed database in the world with more applications than we can count, including several high-profile projects. Unlike most other SQL databases, SQLite does not have a separate server process. SQLite reads and writes directly to ordinary disk files.

A complete SQL database with multiple tables, indices, triggers, and views, is contained in a single disk file. The database file format is cross-platform, which means you can freely copy a database between 32-bit and 64-bit systems. These features make SQLite a popular choice as an Application File Format. SQLite generally runs faster the more memory you give it. Nevertheless, performance is usually quite good even in low-memory environments.

2.3.2 MySQL

MySQL is a very powerful, embedded Relational Database Management Systems (RDBMS). MySQL is the most popular **open source** database system used with PHP, where you can connect to and manipulate databases. MySQL is a database system used on the web that **runs on a server**. MySQL is ideal for both small and large applications; MySQL is very fast, reliable, and easy to use. MySQL uses standard SQL, compiles on a number of platforms and on top of that MYSQL is free to download and use. Same as SQLite, the data in a MySQL database are stored in tables where in it is a collection of related data, and it consists of columns and rows. MySQL is one of all the large-scale database servers. It is a feature rich, open-source product that powers a lot of web-sites and applications online. Getting started with MySQL is relatively easy and developers have access to a massive array of information regarding the database on the internet.

SQLite's Supported Data Types	
NULL	NULL value.
INTEGER	Signed integer, stored in 1, 2, 3, 4, 6, or 8 bytes depending on the magnitude of the value.
REAL	Floating point value, stored as an 8-byte IEEE floating point number.
TEXT	Text string, stored using the database encoding (UTF-8, UTF-16BE or UTF-16LE).
BLOB	A blob of data, stored exactly as it was input.

Table 2.3: SQLite's Supported Data Types

MySQL's Supported Data Types	
TinyINT	A very small integer.
SmallINT	A small integer.
MediumINT	A medium-size integer.
INT or INTEGER	A normal-size integer.
BigINT	A large integer.
Float	A small (single-precision) floating-point number. Cannot be unsigned.
Double, double precision, real	A normal-size (double-precision) floating-point number. Cannot be unsigned.

Decimal, numeric	An unpacked floating-point number. Cannot be unsigned.
Datetime	A date and time combination.
Timestamp Time Year	A timestamp. A time. A year in 2- or 4- digit formats (default is 4-digit).
VARCHAR	A variable-length string.
TINYBLOB, TINYTEXT	A BLOB or TEXT column with a maximum length of 255 (2 ⁸ - 1) characters.
BLOB, TEXT	A BLOB or TEXT column with a maximum length of 65535 (2 ¹⁶ - 1) characters.
MEDIUMBLOB, MEDIUMTEXT	A BLOB or TEXT column with a maximum length of 16777215 (2 ²⁴ - 1) characters.
LONGBLOB, LONGTEXT	A BLOB or TEXT column with a maximum length of 4294967295 (2 ³² - 1) characters.
ENUM	An enumeration.
SET	A set.

Table 2.4: MySQL's Supported Data Types



Figure 2.1: MySQL and SQLite logo.

SQLite database software is used because SQLite makes a good database engine for use in teaching SQL. User can easily create as many databases as they like and can email databases to the instructor for comments or grading. Using SQLite will be good for user to experiment SQL language extensions. The simple, modular design of SQLite makes it a good platform for prototyping new, experimental database language features or ideas. However, PHP:MySQL will be used for the future Attendance Tracking System app during since it has more than what SQLite can offer. Just like any stand-alone database server, MySQL brings a lot of operational freedom together with some advanced features.

2.4 Basic 4 Android (B4A)



Figure 2.2: Basic4Android (B4A) logo.

Basic4Android (currently known as B4A) is a rapid application development tool for native Android applications. B4A includes all the features needed to quickly develop any type of Android app, suitable for Attendance Tracking System project. B4A is an alternative to programming with Java and the Android SDK. B4A includes a visual designer that simplifies the process of building user interfaces that target phones and tablets with different screen sizes. Compiled programs can be tested in AVD Manager Emulators or on real Android devices using B4A Bridge.

2.5 Smart Card (MIFARE)

A smart card is a device that includes an embedded integrated circuit that can be either a secure microcontroller or equivalent intelligence with internal memory or a memory chip alone. The card connects to a reader with direct physical contact or with a remote contactless radio frequency interface. A smart card is a plastic card about the size of a credit card, with an embedded microchip that can be loaded with data, used for telephone calling, electronic cash payments, and other applications, and then periodically refreshed for additional use. There are many types of smartcard available, but in this project a MIFARE Classic type of smartcard will be used simply because majority of the smartcard students used are MIFARE Classic type. The MIFARE name (derived from the term MIkron FARE Collection System) covers seven different kinds of contactless cards. This project will be focusing on MIFARE Classic cards.



Figure 2.3: MIFARE Classic 1k Card Layer.

MIFARE Classic employs a proprietary protocol compliant to parts (but not all) of ISO/IEC 14443-3 Type A, with an NXP proprietary security protocol for authentication and ciphering. The MIFARE Classic card is fundamentally just a memory storage device, where the memory is divided into segments and blocks with simple security mechanisms for access control. Thanks to their reliability and low cost, those cards are widely used for electronic wallet, access control, corporate or students ID cards, transportation or stadium ticketing. MIFARE applications also include onto NFC enabled mobile devices which is the main technology that will be used in this project.

2.5.1 Types of MIFARE CLASSIC

The MIFARE Classic 1K offers 1024 bytes of data storage, split into 16 sectors; each sector is protected by two different keys, called A and B. Each key can be programmed to allow operations such as reading, writing, increasing value blocks, etc. MIFARE Classic 4K offers 4096 bytes split into forty sectors, of which 32 are same size as in the 1K with eight more that are quadruple size sectors. MIFARE Classic mini offers 320 bytes split into five sectors. For each of these card types, 16 bytes per sector are reserved for the keys and access conditions and cannot normally be used for user data. Also, the very first 16 bytes contain the serial number of the card and certain other manufacturer data and are read only. That brings the net storage capacity of these cards down to 752 bytes for MIFARE Classic 1K, 3440 bytes for MIFARE Classic 4K, and 224 bytes for Mini. It uses an NXP proprietary security protocol (Crypto-1) for authentication and ciphering.

2.6 Block Diagram

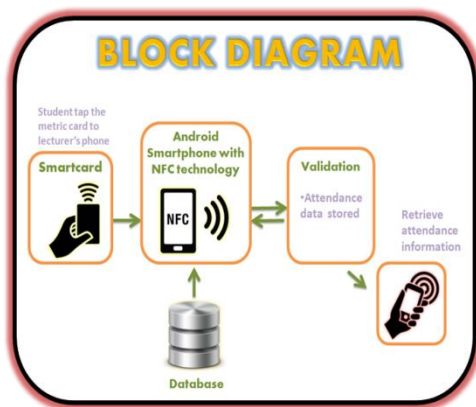


Figure 2.4: Attendance System block diagram.

Based on the block diagram in Figure 2.4, the first stage of the system is the student has to tap their smart card towards their lecturer NFC android Smartphone with the Attendance Tracking System apps and automatically the students data will be going through validation process. Assuming the students smart card has been registered by the universities administration, the validation process will recognise and save the data. The attendance of the students will be stored in the server. For the lecturers to check the attendance of the student, the system will retrieve the attendance information from the database to the Lecturer's Smartphone. The system also give the information to student's as well enable them to check for them whether the days they have attended and did not attend for their own record.

2.7 Flow Chart

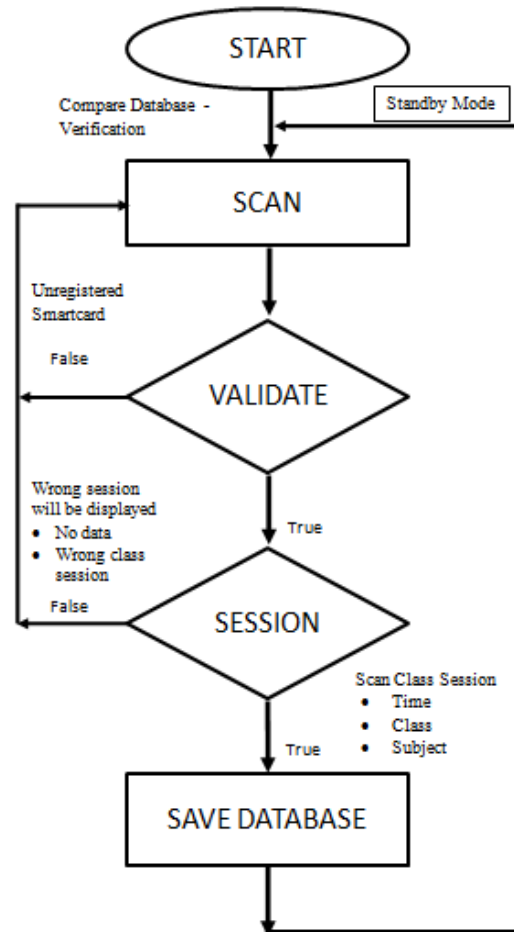


Figure 2.5: Flow Chart of the Attendance Tracking System (ATS) app.

3.0 RESULTS & DISCUSSION

An Attendance Tracking System (ATS) app has been created in order to obtain the idea of what the apps looks like and how it works. This section of the Attendance Tracking System based on contactless smart card is here to help to determine what it is that already found out and how to present this data in a structured and coherent manner.

3.1 Attendance Tracking System (ATS) Process

There are three major processes in order to create the ATS app. The hardware used is a Laptop, an android smart phone and smartcards (Mifare Classic). Software used is B4Android (B4A) and SQLite database software.

3.1.1 Process 1: Create Database Using SQLite (DB Browser)

Before creating database, information of the students is required and needs to be collected manually. Student information considered:

o Name	o Student NRIC
o Student ID	o Status
o Unique ID (Smartcard Serial Number)	o Image

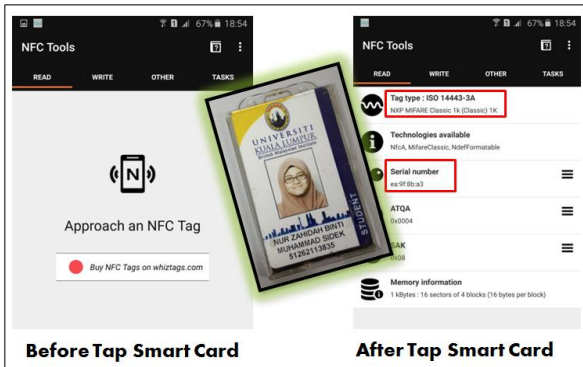


Figure 3.1: Using NFC tool to read the smartcard, obtaining its serial number.

The serial number of the Mifare card will be used as the unique number in the database. Unique number will act as tracking number of the student information in the database that will be created in the program.

Using DB Browser, SQLite will create, design, and edit database files of the students. SQLite Database will be consists of three main aspects;

1. Database Name – Name of the Database file created.
2. Table Name – Name saved for Table of the Database created.
3. Field – Elements contained in the table.

SQLite's Supported Data Types

- ✓ NULL: NULL value.
- ✓ INTEGER: Signed integer, stored in 1, 2, 3, 4, 6, or 8 bytes depending on the magnitude of the value.
- ✓ REAL: Floating point value, stored as an 8-byte IEEE floating point number.
- ✓ TEXT: Text string, stored using the database encoding (UTF-8, UTF-16BE or UTF-16LE).
- ✓ BLOB: A blob of data, stored exactly as it was input.

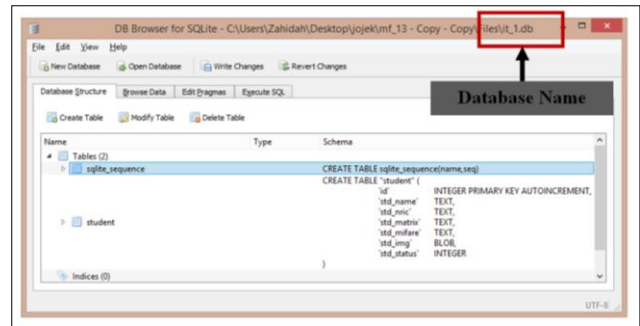


Figure 3.2: Creation of Table in SQLite Database.

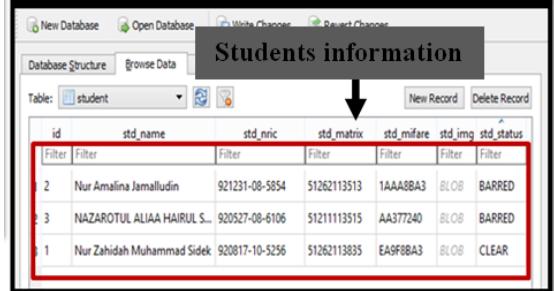
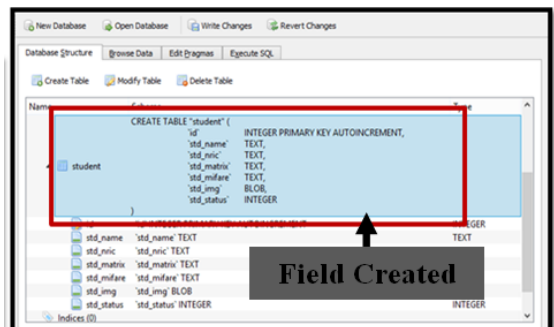
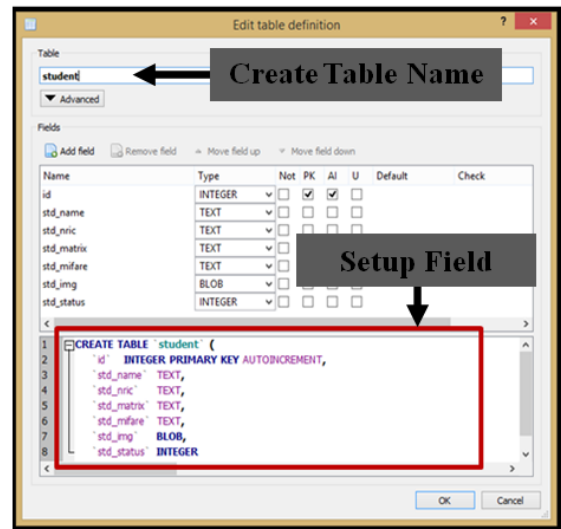


Figure 3.3: Data Entry into Table in SQLite Database.

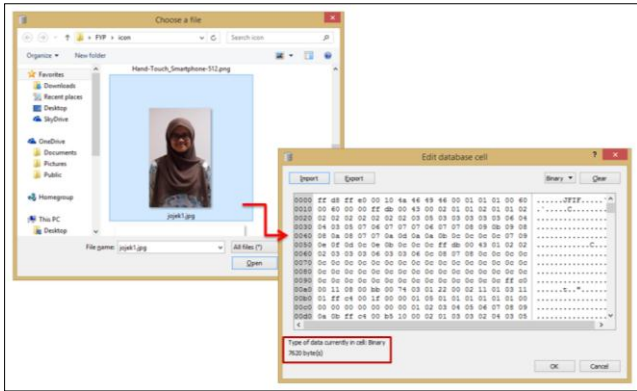


Figure 3.4: Student image Saved in Binary Large Object (BLOB) type.

Binary Large Object (BLOB)

A Binary Large Object (BLOB) is a collection of binary data stored as a single entity in a database management system. BLOB is a large file, typically an image or sound file, which must be handled (for example, uploaded, downloaded, or stored in a database), in a special way because of its size.

Field	Description
Id	Act as the Unique ID of the student
Student Mifare	Smartcard (Mifare type) Serial Number
Student ID	Students university ID number
Student Status	Status of the student; Clear or Barred
Student Image	Saved in Binary Large Object (BLOB) – The value is a blob of data, stored exactly as it was input

Table 3.1

Using SQLite

Creating the ATS app, SQLite software is used which an amazing library that gets embedded inside the application that makes use of. As a self-contained, file-based database, SQLite offers an amazing set of tools to handle all sorts of data with much less constraint and ease compared to hosted, process based (server) relational databases in creating the ATS app.

When an application uses SQLite, the integration works with functional and direct calls made to a file holding the data (i.e. SQLite database) instead of communicating through an interface of sorts (i.e. ports, sockets). This makes SQLite extremely fast and efficient, and also powerful thanks to the library's underlying technology.

During the development phase of most applications, for a majority of people it is extremely likely to need a solution that

can scale for concurrency. SQLite, with its rich feature base, can offer more than what is needed for development with the simplicity of working with a single file and a linked C based library. It is overkill for a large portion of applications to use an additional process for testing the business-logic (i.e. the application's main purpose: functionality).

3.1.2 Process 2: Design Apps Interface Using B4A Designer

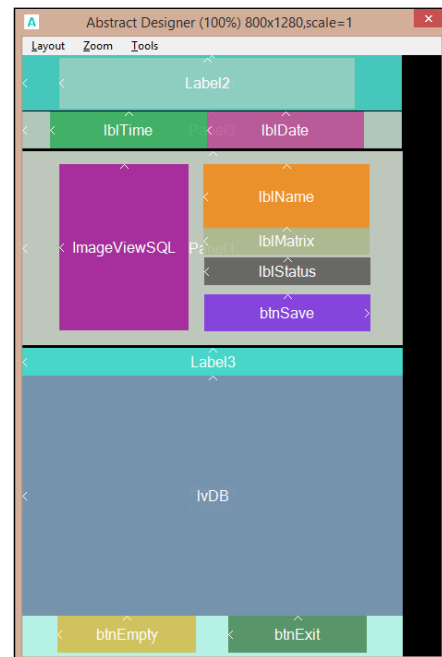
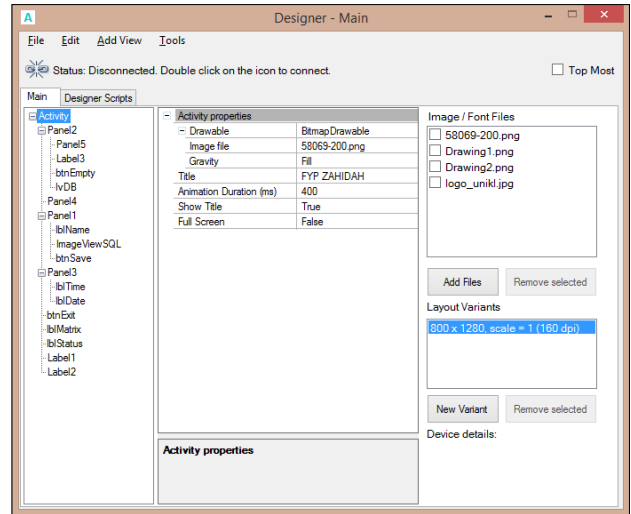


Figure 3.5: Design the apps interface using B4A designer.

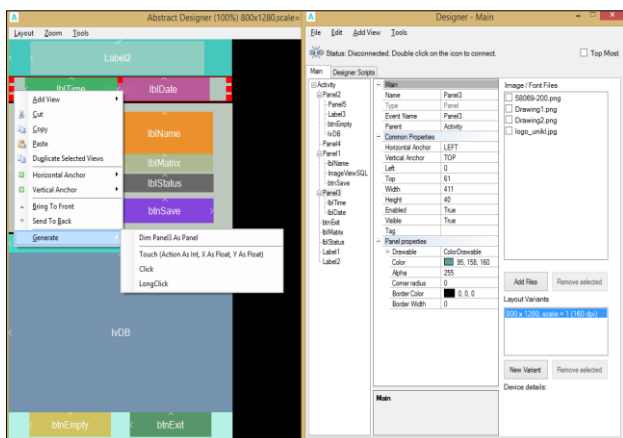


Figure 3.6: Generating each Event in the apps interface.

3.1.3 Process 3: Create Program Using B4A

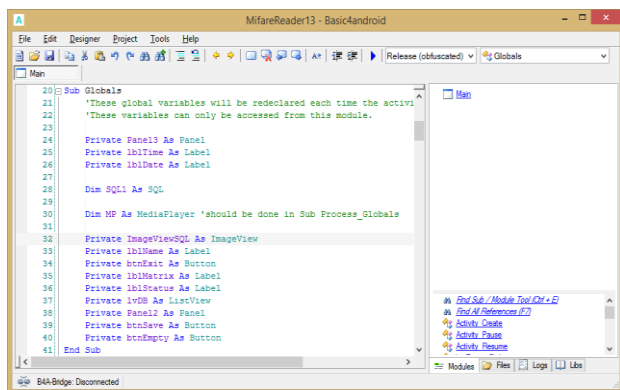


Figure 3.7

3.2 Result Obtained

Steps to obtain the final result:

1. Connectivity between Smartphone and B4A must be established, using Bluetooth or Wireless connection. Smartphone must contain B4A-Bridge app.
2. Run – Compile Files created in B4A.

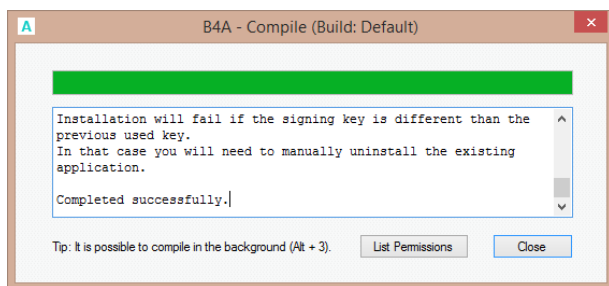


Figure 3.8: Successfully compile the ATS app program to the connected android smartphone.

3. Install the ATS app program in Smartphone
4. Run ATS app. Result shown in figure below.

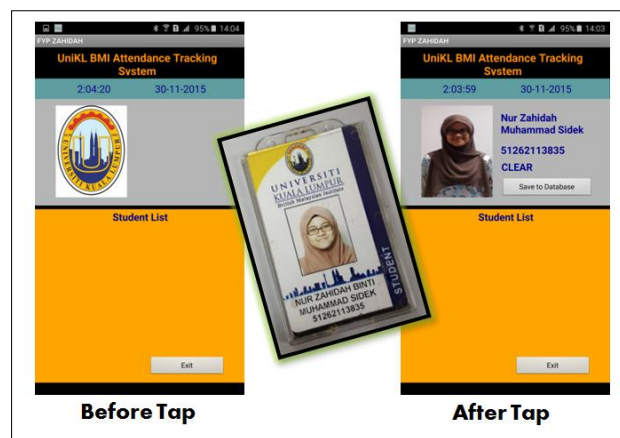


Figure 3.9: Attendance Tracking System interface before and after the tap of Smartcard.

4.0 CONCLUSION

Attendance Tracking System Based on Contactless Smart Card focuses on the elements of the user friendly system which is capable of having the student attendance records in a secured manner. The system used in this project is carried by the android NFC elements compressed with NFC tag and NFC reader as the element in the android smartphone. This android device enables the system to view the graphical user interface thereby creating the real android device functioning with the NFC tag. The system efficiency and handling costs are also some of the factors that are discussed in the feasibility study; explaining the easy access to the system and cost efficiency in the user's point of view. As discussed, the programming code fragments are executed in the database tool kit (SQLite and MySQL) and Android Sdk tool kit to get the output as the practical NFC tag-reader communication is demonstrated in a great way. This suite enhances the time factor efficiency in the aspect of taking and tracking the students attendance as well as develops an ease to integrate all the factors easily. This project can easily implement in android as it is rapidly growing technology and is easy to use.

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