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An NFC Based Attendance System Using Fingerprint Authentication

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Abstract

Attendance has evolved to become a key requirement in educational institutions worldwide. With empirical evidences showing correlation between students' academic performance and attendances. Parents, guardians, lecturers and school administrations make effort to monitor attendance of students to classes and academic events.
The conventional method for recording attendance in the Kwame Nkrumah University of Science and Technology, KNUST is the manual system, where sheets are passed round for students to write their names, student ID numbers and then append their signatures. The current manual system was observed to be both inefficient and time-consuming. Hence there is a requirement for a faster, more efficient process of taking attendance and managing attendance records in the university.
In this project, we make use of NFC technology coupled with fingerprint verification technology, designed to work with an API and a web-based application to implement a more effective approach for recording and managing attendance in the university. The Department of Computer Engineering, KNUST was used as the scope of the project.

Keywords: **API, Attendance, Fingerprint, KNUST, NFC**.

1. Introduction

The concept of attendance and attendance monitoring has been in existence since man learned to count and keep records. Attendance monitoring has since evolved to become an integral part of every functional society. The activity of monitoring attendance is practiced by institutions such as schools, societal groups and business organizations to keep track of attendance and to monitor or manage attendance in these institutions.

Research has shown that there is a significant relationship between students' academic performance and levels of attendance (Newman-Ford, Fitzgibbon, Lloyd, & Thomas, 2008). In educational institutions, attendance has become both a requirement for institutions and a responsibility for students. Educational institutions keep track of students' attendance and set corrective measures to ensure students conform to the set rules relating to attendance.
In the Ghanaian educational system, attendance, regularity and punctuality are qualities that are programmed into the student from an early age. At the primary and junior high school levels, a teacher takes attendance in most schools by calling out a student's name and checking the corresponding date of attendance in a book known as an attendance register. In most senior high schools, prefects are given the mandate to record attendance of the colleagues. This trend of attendance taking has moved on into Ghanaian universities, with institutions practicing either the primary and junior high school or the senior high school way of taking attendance, or fusing both methods. In KNUST, a majority of lecturers take attendance between once and thrice per semester, while the school examination board takes attendance during examinations to monitor student turn-up.

During lectures and quizzes, lecturers pass sheets of papers during classes for students to enter their names, the student identification numbers and verify using their signature. In examination situations, the examination authorities come round to inspect student I.D. cards manually before handing the students a list for them to find their names and append their signature against them.
To make data obtained from monitoring attendance useful, there is a need to ensure quality of information in order to reflect the true attendance of the student, a need to ensure the activity of taking attendance does not disrupt the purpose for which the

presence of the individual, in this sense the student, is required. There is also a need to maintain records of attendance history. However, the current method of attendance taking in Ghanaian universities comes with drawbacks such as time wasting, problems of authentication, verification and the problems that come with the organization and storage of hard copies of attendance data and its analysis.
Considering the significance of attendance monitoring and management, study has gone into the advancement of ways to automate, improve the speed of taking attendance and authentication of the information gathered during the activity of attendance taking. Attendance taking has been made fast with embedded electrical systems and authentication as well as verification has been made possible using biometric sensors and systems. Studies into modes of electronic communications such as RFID and NFC are providing more convenient means and ways for automating the process of taking attendance. In Ghana, biometric information is being used for identification during registration for elections and passports processing. KNUST also uses biometric technology during the registration of students. An issue for KNUST is the application of these modern technologies to the process of attendance taking and the manipulation of such information.

2. Methodology

2.1 System Design Overview

The design overview of the system as shown in Figure 1, can be broken into two parts; the software design part, referred in this project as SwyftTapp LecturerPortal and the hardware design part also referred to as SwyftTapp Reader.

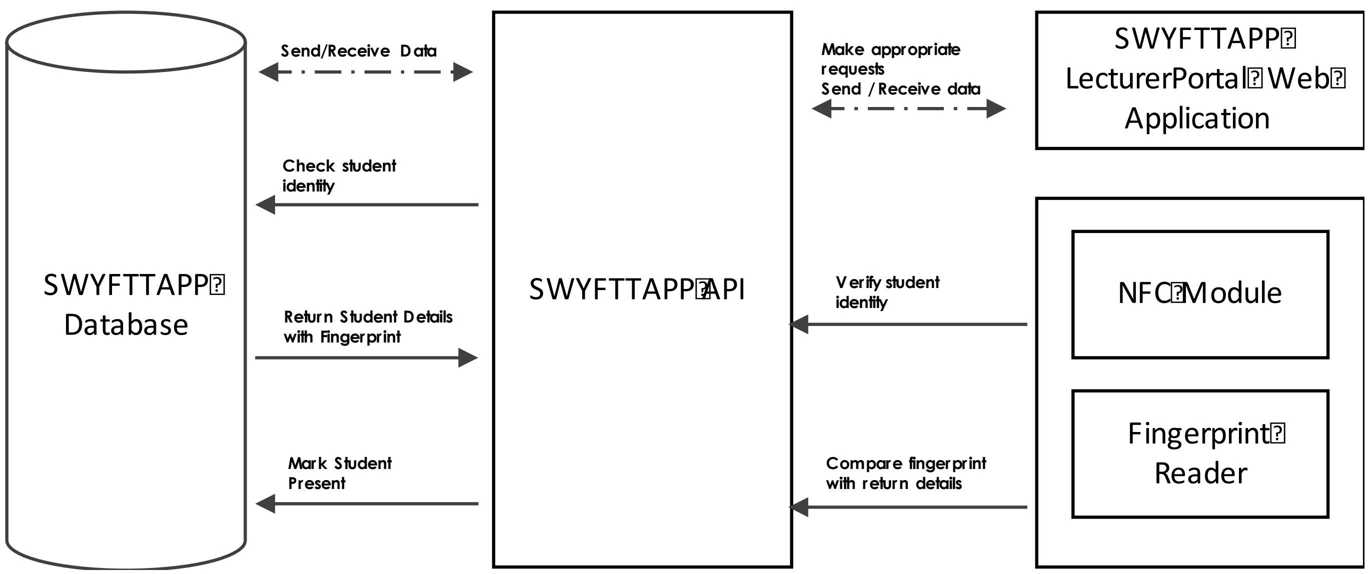

Figure 1: System Design Overview

The hardware design of this project which is the SwyftTapp Reader is a handheld device that enable lecturers to take attendance of students using NFC with biometric authentication. The SwyftTapp Reader has Wireless LAN capability, which enables it to communicate information over a Wi-Fi network to be able to authenticate a student's identity using a prepopulated database containing unique codes for the students NFC id card and fingerprint biometric information.

The SwyftTapp Reader was modelled with a basic BCM2836 as an underlying microcontroller as shown in Figure 2. The microcontroller system communicates serially over UART with an on-board NFC Module (PN531 NFC Module) designed by Philips. These modules, integrated, are then connected via GPIO pins to a fingerprint scanner; to register fingerprints from users (students) and an LCD Touch Screen for information display and user interaction. The on-board microcontroller draws it power from an inbuilt power management system that generates 5V supply from an external voltage source with voltage regulation.

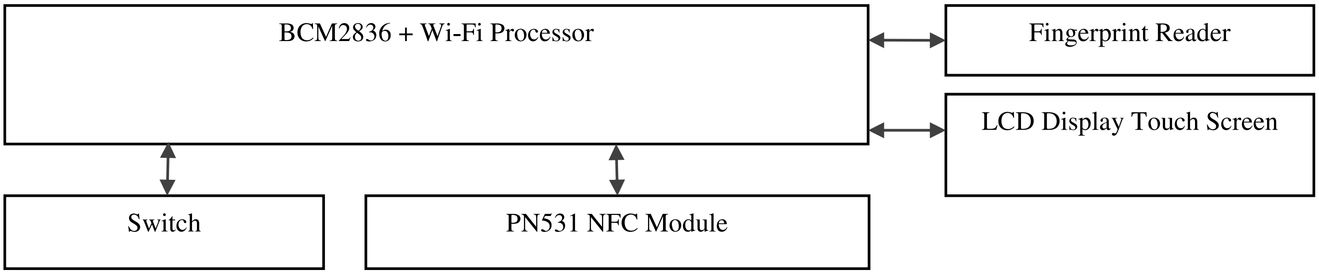

Figure 2: Hardware Design Overview

The software design of the project, as shown in Figure 3, involved three main components, a database, an API and a web application. The database is a MySQL relational database system which has been optimized for efficiency and security of data. The API, called SwyftTapp API is a RESTful API built using Java on the spring boot framework to facilitate communication with the SwyftTapp Reader and SwyftTapp LecturerPortal web application relaying information to and from the database. The SwyftTapp API is built to facilitate interaction through HTTP requests making it possible for connection from other applications such as mobile applications.

The SwyftTapp LecturerPortal serves as a portal for lecturers to view attendance data in a simple and intelligent environment. The SwyftTapp LecturerPortal is built using latest web technologies;

HTML 5, CSS and JavaScript using the AngularJS framework to communicate with the SwyftTapp Database via the SwyftTapp API through HTTP requests using JSON data.

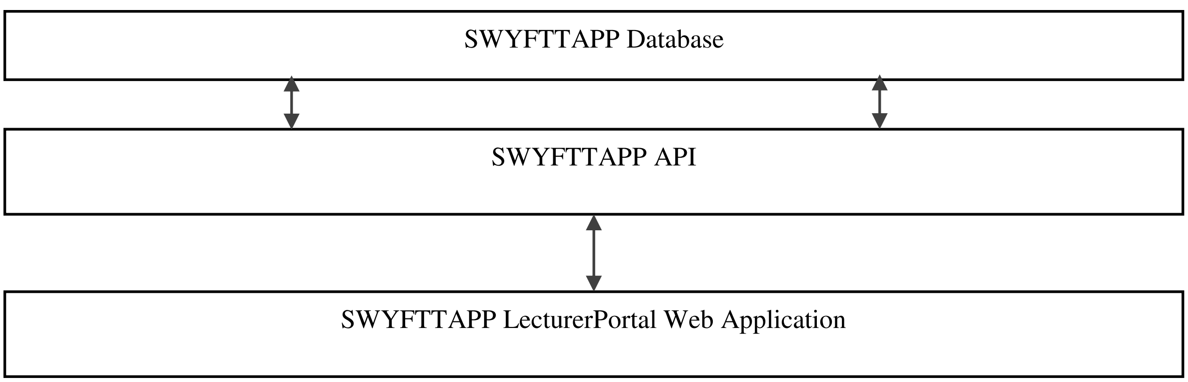

Figure 3: Software Design Overview

The hardware and the software system come together to form an integrated interactive system which provides an efficient, user-friendly and fast means of recording and viewing attendance data for the benefit of both the lecturer and the students in the class.

In using the SwyftTapp system, the lecturer or exam officer starts a new attendance event on the SwyftTapp reader. On starting the event, the reader sends a request to the API which send the list of students in the particular class. Students then take turns tapping the NFC Reader with their cards to identify themselves, and then use their fingerprints to authenticate their identity. After all students' present have gone through this process, the lecturer closes the attendance event. Optionally, the lecturer can decide to take another attendance for the same event by selecting the option to take a closing attendance. After the event- class, mid-semester or end-of-semester examinations and all attendances have been closed, the lecturer can then log into the SwyftTapp LecturerPortal to view data and statistics about the attendances taken

2.2 Software Design

The software for the application was designed as a distributed system comprising a front end web application (SwyftTapp LecturerPortal) which serves as the access point of the lecturer where he/she can login to view and manage attendance records and a back end API that handles all the business logic of the application.

To perform its tasks, the SwyftTapp LecturerPortal makes HTTP requests to the backend application (API) using RESTful protocols. The API then returns data as JSON objects which is then used by the frontend application to populate its views and perform other tasks. The user friendly GUI makes it easy to navigate the application and present data to the user in a clean easy-to-read format.

The SwyftTapp API serves as the brain of the application as it handles all the logic and database interactions. This reduces the load on the front end application, making it more efficient and provides a central access point for both the LecturerPortal and the reader applications. Its RESTful nature also means that it can be easily integrated with existing applications. To ensure that only authenticated users are allowed to access information, every request to the API requires a unique token without which access is denied.

2.2.1 Requirements Capturing and Analysis

In order to meet the expectations of the end users of the software, frequent communication was kept with users, in this case the students and lecturers, to capture their views and opinions of the prototype developed. The software was then developed using these specifications gathered as guidelines.

The main mode of gathering these requirements was by interviewing the target users i.e. the lecturers and students, and recording the observations made. After developing a working prototype of the SwyftTapp LecturerPortal, it was shown to a selected number of lecturers and students in the computer engineering department of KNUST which represents the scope for the project. The students, who are going to be users of the SwyftTapp reader were interviewed to discuss the present methods of attendance taking in Knust and their thoughts on the proposed solution.

The lecturers provided useful information on how they would like the app to work including the information they wanted to capture about the student in the attendance list, how they wanted to rate the attendance of students to their lecturers, and the details they wanted on the dashboard page of the application. After recording these specifications and their desired changes to the application, the lecturers were again interviewed and shown the improved prototype of the application to make sure their specifications were met.

Students in the scope of the project were also invited to answer a questionnaire hosted on Google Forms. This questionnaire was to access students' views on the state of attendance in the department. The questionnaire looked specifically at the class year, students' thought on how attendance is taken and the effectiveness of the rate at which it is taken. Students' also answered questions on whether they believed attendance was important, whether there was a need for a better system of taking attendance, and if they felt the scores being allocated for attendance reflected their actual attendance to class. The questionnaire received 109 responses in total. These responses were then analysed and represented in graphical form. The various charts below show a graphical representation of the results (Figures 4 – 7).

From Figure 4, it can be observed that the majority of respondents to the questionnaire were first (1^{st}) year students, with the least respondents being in the third year (year 3). Figure 6 shows that the majority of students who responded to the questionnaire were of the opinion that the current methods of attendance taking and the frequency at which attendance was being taken in the school was fair.

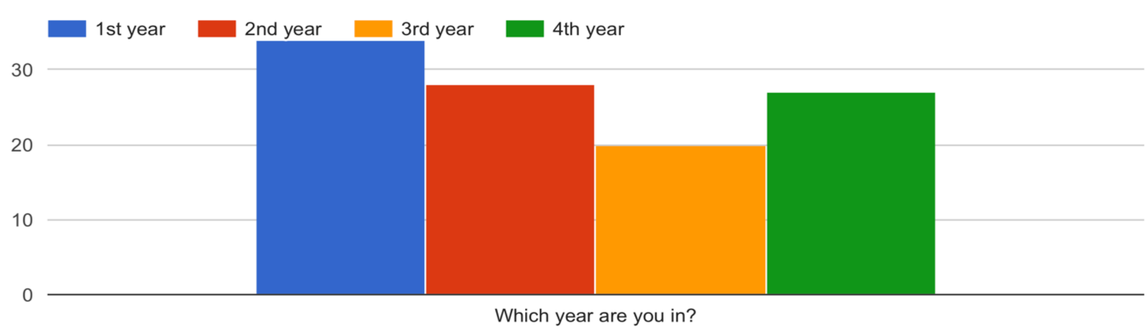

Figure 4: Distribution of Students Who Responded to the Questionnaire

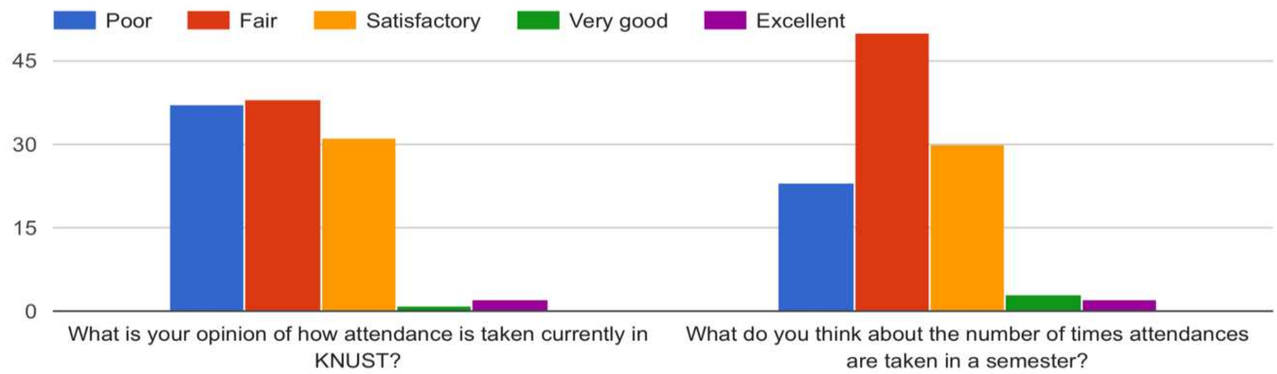

Figure 5: Students' Views on the Current State of Attendance I

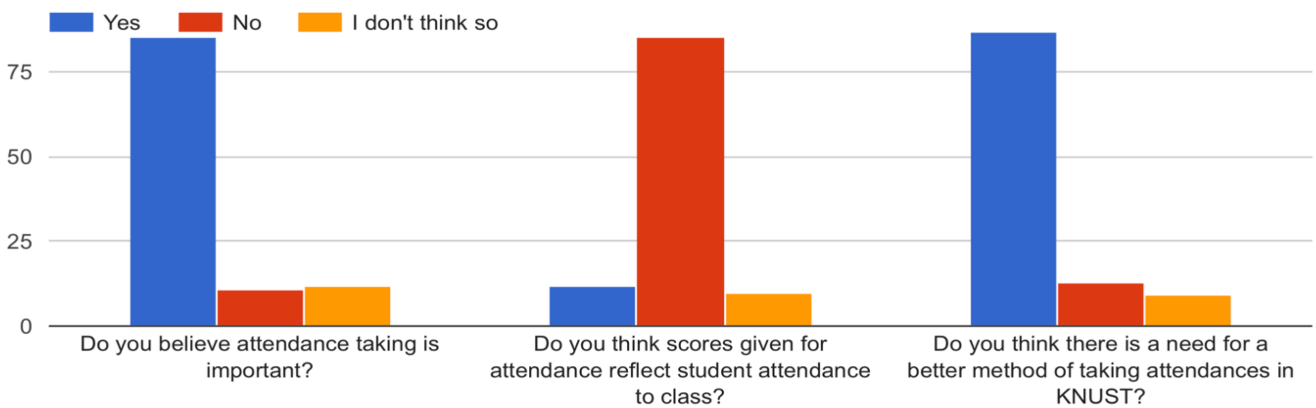

Figure 6: Students' Views on the Current State of Attendance II

From observations in Figure 6, it shows that the majority of respondents believed attendance taking was important, that the scores given for attendance did not actually reflect a student's attendance to the said course. It also shows that the majority of respondents also thought there was a need for a better method of taking attendance in KNUST

Figure 7: Methods of Taking Attendance by the Lecturers of the respondents

Figure 7 proves that majority of the attendance taken in the department was either by passing sheets around for students to sign or by a combination of the afore mentioned and the lecturer mentioning the names of the students.

2.3 Functional Requirements

The following functional requirements were gathered at the end of the requirements gathering process.

- On the LecturerPortal, the lecturer should be able to view attendance list, perform analysis on attendance data, class and course lists.
- On the reader, the lecturer or exam officer should be able to start, end or take a closing attendance
- On the reader the student should be able to verify his identity using his NFC card and authenticate his attendance by using his fingerprint.

2.4 Non-Functional Requirements

The non-functional requirements of this system, representing the system specifications, security requirements, and software and hardware quality constraints were gathered to produce an easy to use, secure, safe and fast system to provide the best user experience to the end users of the application.

2.5 Use Case Diagrams

The use case diagrams shown in the figures 8,9 and 10 below provide a pictorial representation of the actors and the actions they can perform in the two identified use cases of the system. Lecturers and exam officers represent the recognized actors for application.
Students also use the application through the reader. They can tap their school ID cards with NFC stickers on the reader and verify their identity using their finger print. If these steps are successful, the student is marked present in the database.

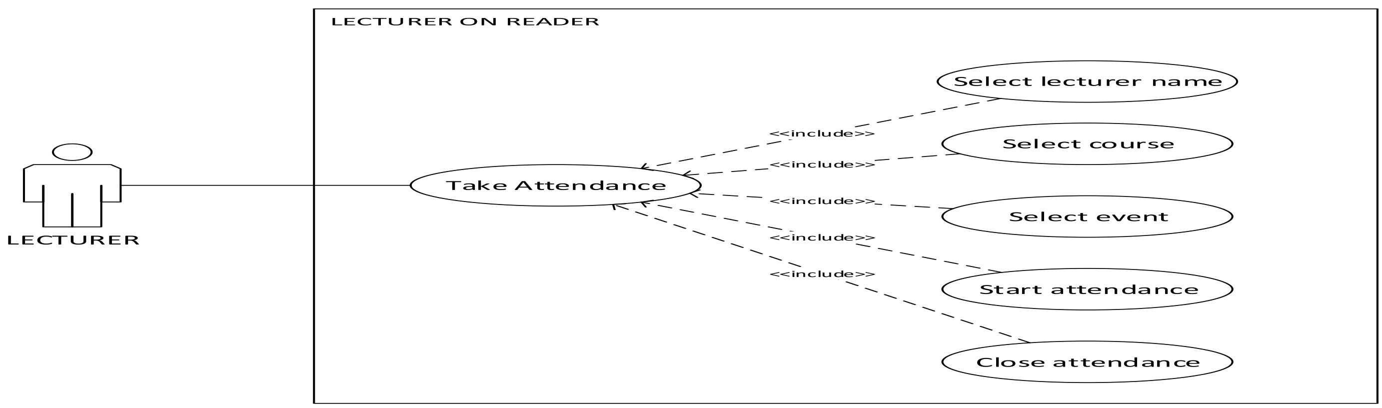

Figure 8: Lecturer on Reader

As shown on Figure 8, on the reader, the lecturer or exam officer should be able to:

- select a lecturer's name
- select a course
- select an event type (lecture, mid semester exam or final exam)
- start an attendance
- end the attendance

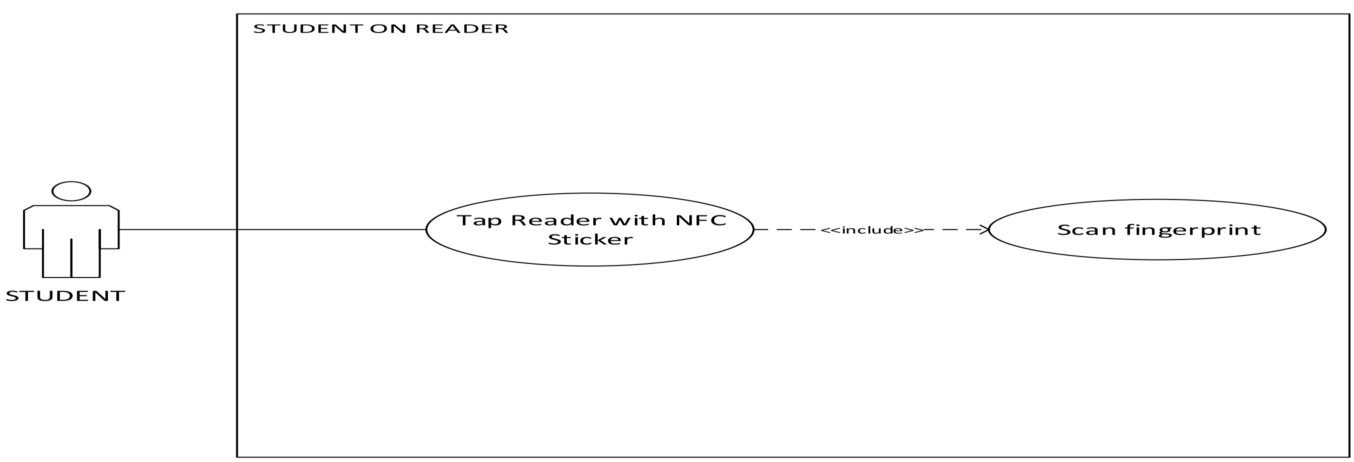

Figure 9: Student on Reader

As shown on Figure 9, on the reader, the student should be able to:

- identify him/herself by tapping with his NFC-enabled card
- authenticate his identity by scanning his fingerprint

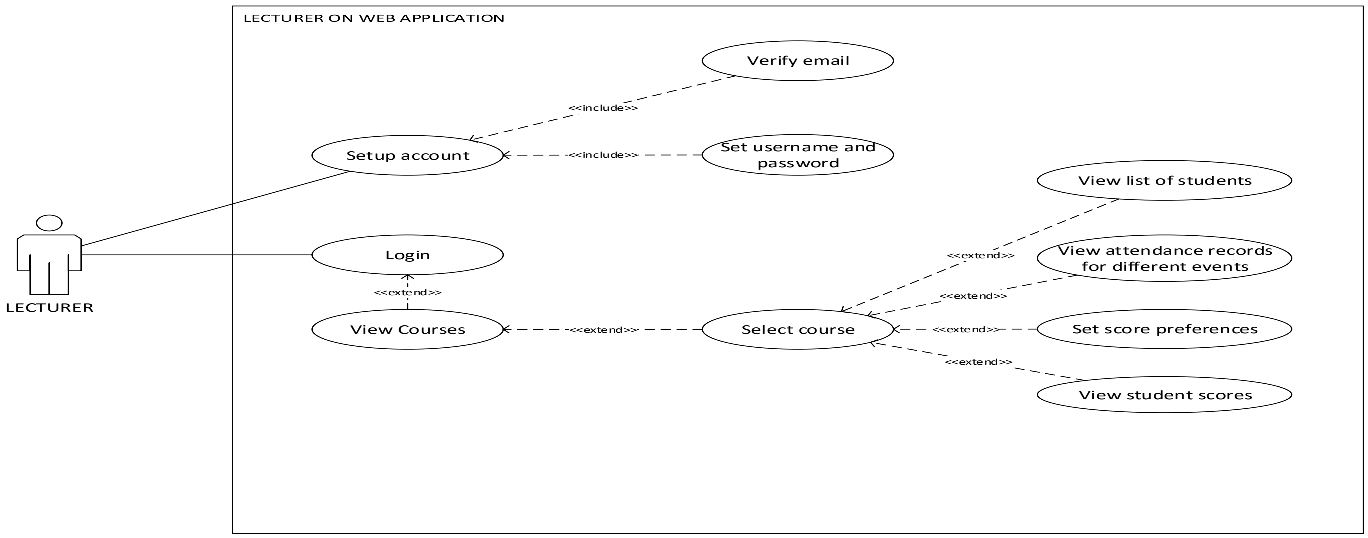

Figure 10: Lecturer on web application

On the LecturerPortal, Figure 10, the lecturer should be able to:

- verify his or her email
- set a username and password
- login to his account
- view his courses
- view attendance records for a course
- view attendance records for different events

2.6 SwyftTapp Database

To store and manage all the attendance records data and their related information, a relational database was designed and created in SQL. The database was designed to implement the functionalities of the application, taking efficient use of storage space and easy management into consideration. To add to the security of the application a token taken was created that stores all the valid tokens that the client applications can use to access the API. These tokens are created once a user logs in with a valid user name and password and are expired and deleted once a user logs out of the LecturerPortal. The SwyftTapp reader application also requires a token to access the API.

To easily manage attendance events a table called events was created to store the course for which the attendance was taken, the lecturer who takes that course, the type of attendance event (mid semester exam, end of semester exam or lecture) and a timestamp of when the attendance was started and ended. Attendances can be taken at the beginning of an event or at the end or both. To implement this a Boolean field is used to specify whether a particular attendance is a closing attendance or an opening attendance.

2.7 Database Schema

The database ER Diagram in Figure 11 represents the database on top of which the SwyftTapp API was built. In order to make the signup process secure, the details of lecturers are entered into the database leaving their user name and passwords null. To use the application, the lecturer first checks if he is eligible by verifying his college email address. If he is eligible, he then sets his user name and password using a link sent to his college mail. Once the username and password are set the lecturer has access to the application.

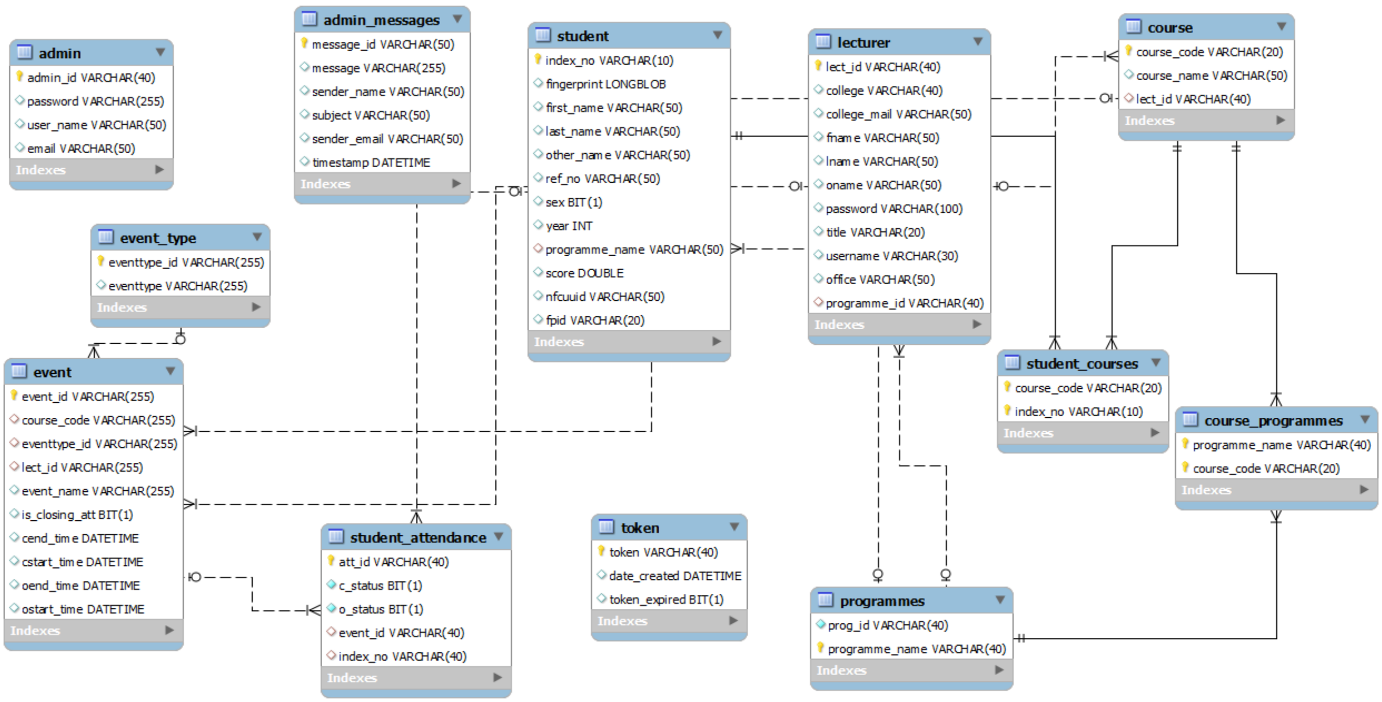

Figure 11: Database Schema

2.9 SwyftTapp API

Inputting and retrieving data from the database was achieved by creating an API. Classes were created to perform basic CRUD functions as well as other functionalities not related to the database. It then provides services to both the reader and the LecturerPortal applications using the data retrieved from the database.
The API is made accessible to the client applications over a network using a RESTful protocol. Each API call has a specific URL by which it can be accessed. Java and SpringBoot were used in its construction.

2.10 SwyftTapp LecturerPortal

With the correct credentials a lecturer can login to the LecturerPortal to view his attendance records, generate students' attendance marks as well as view statistics relating to courses the lecturer teaches. The user interface of the application is made simple and easy to use and presents information to the lecturer in a clean and easy to read format.

The signup process is made easier and very secure by pre-populating the database with the details of the lecturers in a department. The lecturer then has to verify that his or her college email exists and is authorized to use the application. Once the lecturer is eligible, an email is sent to the lecturer containing a link to a page where he can set his username and password. From there he has access to all the services provided by the portal through the API.
The LecturerPortal has a dashboard page which shows different chart and graph representations of statistics pertaining to the lecturer's attendance records. The lecturer can get information about the number of students he teaches in total, the number of students present and absent in his courses over the past five weeks, a ranking of his courses from best course to worst course based on student turn up and other very useful information. The API computes these statistics and feeds the LecturerPortal.

2.11 Hardware Design Block Diagram

The SwyftTapp Reader block diagram, as shown in Figure 12, illustrates the various selected functional components and the way they relate and communicate with each other to produce an efficient hardware system, with the necessary processing power, memory management and a small code footprint.
The block diagram also goes further to illustrate the embedded components pointed out in the hardware design overview (Figure. 12). It clearly shows each component and sub-components, the links and direction of information flow between them and certain particular specification.

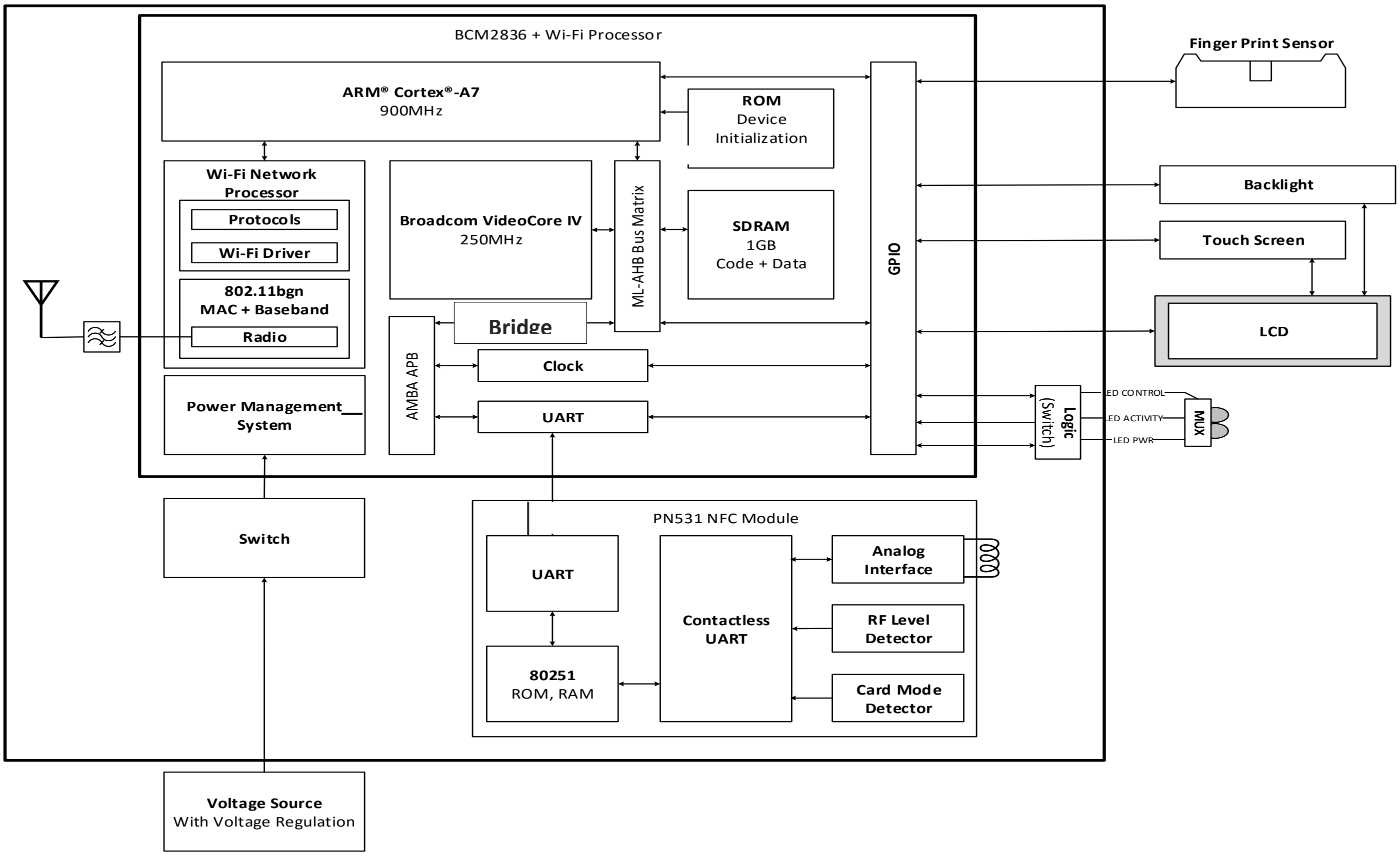

Figure 12: System Design Block Diagram

2.12 Functional Components

In the SwyftTapp system, the AMBA APB was used to connect the power management system to the UART, Clock and over a bridge to a Multilevel Advanced High-Performance Bus Matrix which interconnected the CPU, GPU, SDRAM and ROM. The AMBA AHB was chosen for this project due to its efficient usage in high-performance, high clock frequency system modules. The AHB acts as the high-performance system backbone bus. AHB supports the efficient connection of processors, on-chip memories and off-chip external memory interfaces with low-power peripheral macro cell functions. AHB is also specified to ensure ease of use in an efficient design flow using synthesis and automated test techniques. The ML-AHB Bus Matrix implements a multilevel AHB which abstracts a multipath master-slave bus system.

On the Broadcom BCM2836 there are 54 general-purpose I/O (GPIO) lines split into two banks which possess at least two alternative functions within the processor. The alternate functions; usually peripheral I/O and a single peripheral which appear in each bank to allow flexibility based on the chosen voltage. The GPIO peripheral has three dedicated interrupt lines with 32-bit accesses. The GPIO also has function select registers that are used to define the operation of the general-purpose I/O pins. In the development of SwyftTapp, The GPIO interface was used to connect the main board to the fingerprint reader and the LCD touch screen controller. The GPIO is also used to power LEDs to indicate power and operation.

In the SwyftTapp Reader the UART is used to bridge the AMBA APB and the GPIO interface. The UART is also used in the system to communicate with the PN531 NFC Module which requires serial data communication.
In building the SwyftTapp Reader device, the PN531 NFC Module was selected. The PN531 IC uses an 80C51 processor with 32 Kbytes ROM and 1 Kbytes RAM. It supports various industry standard read/write modes. The PN531 can act also as a smart card in combination with a security controller IC. Furthermore, the embedded firmware and internal hardware support the handling and the host protocols for USB 2.0, I2C, SPI and serial UART. The PN531 NFC Module communicates with the BCM2836 SoC integrated with the Wi-Fi Processor.
The transmission module combines an outstanding modulation and demodulation concept completely integrated for different kinds of contactless communication methods and protocols at 13.56 MHz with an easy to use firmware for the different supported modes and the required host interfaces.

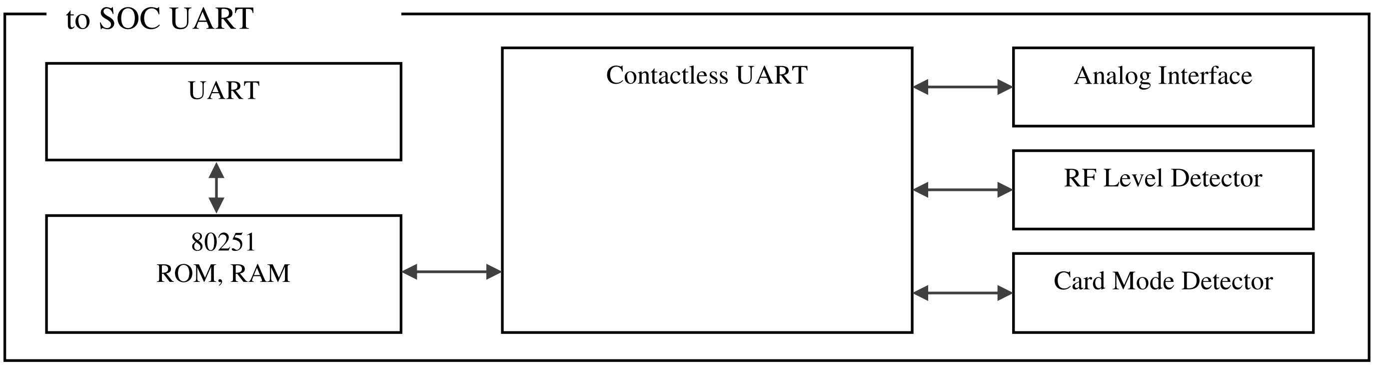

Figure 13 PN531 NFC Module Components

As shown in Figure 13, the PN531 NFC modules contains certain functional components that facilitates its operation. These include an analog circuitry interface, a radio frequency level and card mode detector, an 80251 microcontroller all connected to a contactless UART. The NFC module then communicates through microcontroller to the designed SoC via UART

- The analog circuitry interface handles the modulation and demodulation of the analog signals according to the card mode, reader /writer mode and NFC mode communication scheme.
- The RF level detector detects the presence of an external RF field at the NFC operating frequency - 13.56 MHz
- The card mode detector detects a MIFARE®, FeliCaTM or NFC coding of an incoming signal in order to prepare the internal receiver to demodulate signals that are sent to the PN531.
- The integrated contactless UART and the firmware handle the protocol requirements for the communication schemes including the RF based protocols as well as the protocols for host communication.
- The 80251 microcontroller with its embedded firmware allows autonomous management of communication both on the RF interface and with the host.
- The UART interface communicates information serially to the BCM2836 SoC through its UART interface.

2.13 Fingerprint Scanner

To authenticate a student's identity, biometric information is taken after NFC identification is verified. To build the SwyftTapp Reader to be compatible with the existing KNUST fingerprint database, the fingerprint reader selected to be used on the reader uses the same fingerprint recognition technology as the one used for student biometric registrations - the Futronic FS80 fingerprint scanner.

This scanner is a semiconductor type fingerprint reader which uses advanced CMOS sensor technology and precise optical system to deliver high quality fingerprint images in about 100ms relying on 4 infra-red LEDs behind a 14mm thick crown glass for illumination during scanning.
The SwyftTapp Reader, modelled after the FS80 has an optimum fingerprint scanning window of 16 x 24mm and stores images as 8-bit 256 grayscale images with a raw image file size of 150K bytes.

2.14 SwyftTapp Reader – Concept Design

In the development of a working concept for the SwyftTapp Reader, a concept design of the final look of the device was created. This design sought to meet modern design demands of simplicity and ease of use while fulfilling requirements for functionality.
The concept design developed for the SwyftTapp Reader looks at all views of the reader whiles placing the necessary ports or output devices that will be used to interact with the device.
From Figure 14:

- The reader could have a charging slot at its base.
- The back of the reader could optionally have a removable back cover.
- The right side will have a switch to turn the device on or off.
- The front side of the reader will then have the screen, space to use the NFC Module and ample space to access the on-system fingerprint reader.

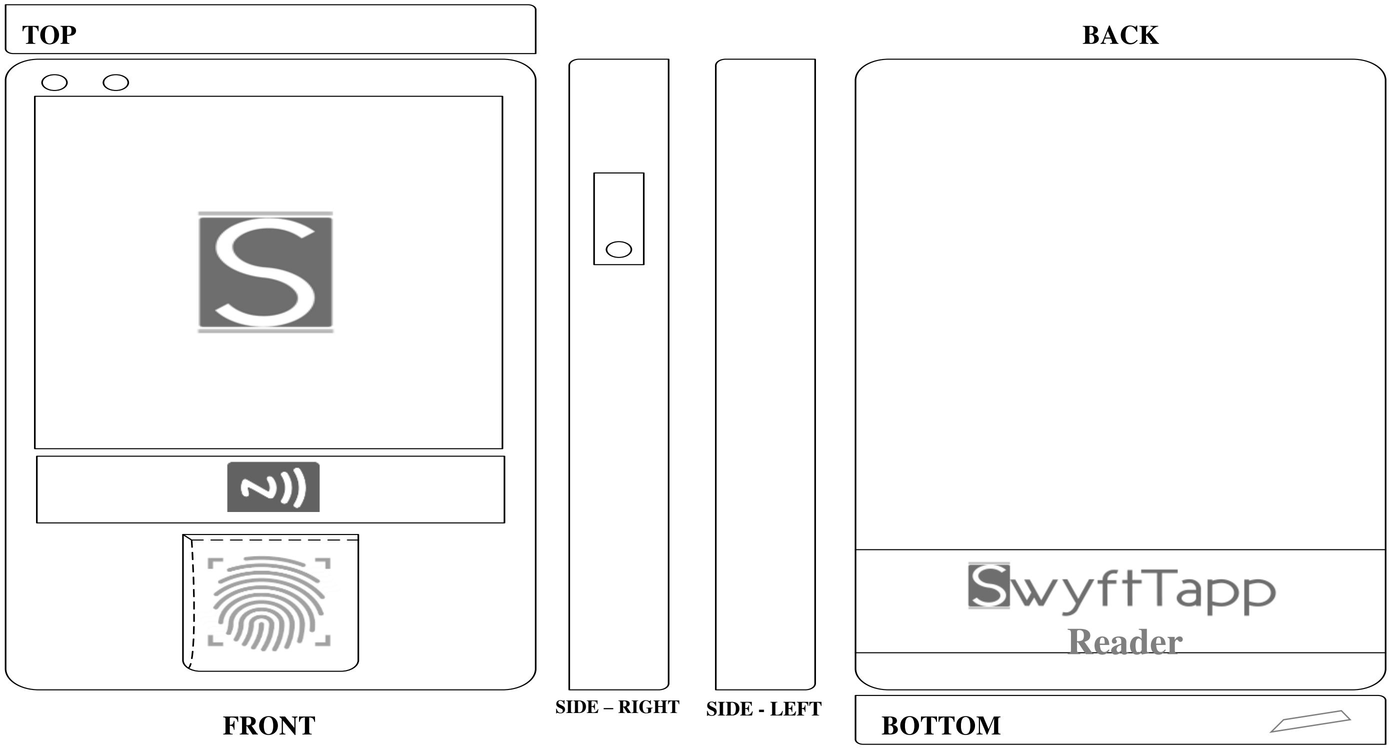

Figure 14: SwyftTapp Reader Package Design

3 Conclusion

This project was conceived in an effort to provide a solution to the problem statement - the need for a faster and more effective way of taking and monitoring the attendance of students and the provision of a platform to handle and analyse data collected from such attendances in KNUST.

Using the Computer Engineering department of KNUST as the scope for the project, a system named SwyftTapp was developed. SwyftTapp is comprised of 3 sub-components, namely SwyftTapp API, SwyftTapp Reader and SwyftTapp LecturerPortal.

- SwyftTapp API

SwyftTapp API was developed to be the processing center for all computationally intensive processes that were to be done in the background of the system. The SwyftTapp API formed the link between the database and both the Reader and LecturerPortal applications.

The SwyftTapp API was built to handle expansion and on the principle of the modularity, making it possible for the creation of other applications, such as mobile applications to tap into the SwyftTapp ecosystem.

- SwyftTapp Reader

The SwyftTapp Reader was developed as a concept design with functional components and block diagrams clearly explained. Also the rationale behind the selection of those components were broken down.

The SwyftTapp Reader was then prototyped using a raspberry pi, and MFRC522 RFID module and a fingerprint module to simulate the operation of the reader.

- SwyftTapp LecturerPortal

The LecturerPortal is a web application built for lecturers to be able to access first hand data obtained from attendances that are taken using the SwyftTapp Reader. The portal was built using modern web development technologies that promote modularity and ease of use without compromising on security.

References

Adewole, K. S., Abdusalam, S. O., Babatunde, R. S., Shittu, T. M., & Oleyede, M. O. (2014). Development of Fingerprint Biometric Attendance System for Non-Academic Staff in a Tertiary Institution. Computer Engineering and Intelligent Systems, 5 (2), 62-70.

Anil, K. J., Arun, R., & Salil, P. (2004). An Introduction To Biometric Recognition. *Appeared in IEEE Transactions on Circuits and Systems for Video Technology, Special Issue on Image and Video Based* Biometrics*, 14* (1).
Anugerah, M. A. (2014). TouchIn: An NFC Supported Attendance System in a University Environment. *International Journal of Information and Education Technology, 4* (5), 448-453.
Asante, M., Ohenebah-Amissah, F., & Osei, K. D. (2014). *Biometric Attendance Monitor.* Project Report, Kwame Nkrumah University of Science and Technology, Computer Engineering.
Bhise, A., Khichi, R., Korde, A., & Lokare, P. D. (2015). Attendance System Using NFC Technology with Embedded Camera on Mobile Device. *International Journal of Advanced Research in Computer and Communication Engineering, 4* (2), 350-353.
Cappelli, R., Maio, D., Lumini, A., & Maltoni, D. (2007). Fingerprint Image Reconstruction from Standard Templates. *IEEE Transactions on Pattern Analysis & Machine Intelligence, 29* (09), 1489-1503.
Chandrasekar, V., & Natarajan, T. S. (2014). Fingerprint Based Classroom Attendance Recording Device. *International Journal on Recent and Innovation Trends in Computing and Communication, 2* (9).
Coskun, V., Ok, K., & Ozdenizci, B. (2012). *Near Field Communication (NFC): From Theory to Practice.* John Wiley & Sons Ltd.
Dhiraj.R.Wani, Tushar.J.Khubani, & Thoutam, P. (2014). NFC Based Attendance Monitoring System with Facial Authorization. *International Journal of Innovative Research in Computer Science & Technology (IJIRCST), 2* (5), 35-38.
ECMA International. (2002, October). Near Field Communication. Geneva.
Gonnade, J. W., Deore, S. K., Rajput, A. V., & Chalgangje, S. V. (2013, March). An Efficient Biometric Attendance System using Fingerprint Verification Technique. *International Journal of Engineering Sciences & Research Technology*, 510-513.
Grant, H. (2014, April 29). *CSO*. Retrieved October 2015, from CSO Online: www.csoonline.com/article/2148491/physical-security/why-facial-recognition-isntthe-way-of-the-future-yet.html
Kalapala, A. (2013). *Analysis of Near Field Communication and Other Short Range Mobile Communication Technologies.* Indian Institute of Technology, Electronics and Communication Engineering.
Mayhew, S. (2015, January 14). *History of biometrics.* Retrieved from Biometric update web site: http://www.biometricupdate.com/201501/history-of-biometrics
Newman-Ford, L., Fitzgibbon, K., Lloyd, S., & Thomas, S. (2008). A large - scale investigation into the relationship between attendance and attainment: a study using an innovative, electronic attendance monitoring system. *Studies in Higher Education, 33* (6), 699-717.
NFC Forum. (n.d.). Retrieved October 2015, from http://nfc-forum.org/what-isnfc/what-it-does/
Opoku, S. K. (2013). An Automated Biometric Attendance Management System with Dual Authentication Mechanism Based on Bluetooth and NFC Technologies. *International Journal of Computer Science and Mobile Computing, 2* (3), 18-25.
Orozco, J., Chavira, G., Castro, I., Bolaños, J. F., Sánchez, R. A., & Cantú, J. F. (2014). Towards NFC and RFID Combination to Automatic Services. *International Journal of Engineering and Applied Sciences, Vol.4* (No.8), 35.
Pressman, R. S. (2010). *Software Engineeing: A Practioner's Approach* (7th Editioned.). McGraw-Hill.
Rao, S., & Satoa, P. K. (2013). An Attendance Monitoring System Using Biometrics Authentication. *International Journal of Advanced Research in Computer Science and Software Engineering, 3* (4).
SaskNetWork. *Managing Your Human Assets, Module 6: Renumeration Strategies.*Educational.
Seifedine, K., & Smaili, M. (2010). Wireless Attendance Management System Based on Iris Recognition. *Scientific Research and Essays, 5* (12), 1428-1435.
Spinella, E. (2003, May 28). Biometric Scanning Technologies: Finger, Facial, and Retinal Scanning. San Francisco.
Unnati, A. P., & Dr. Swaminarayan, R. P. (2014). Development of a Student Attendance Management System Using RFID and Face Recognition: A Review. *International Journal of Advance Research in Computer Science and Management Studies, 2* (8).
Vanderkay, J. (2004, March 18). Retrieved from NFC Forum: http://nfcforum. org/newsroom/nokia-philips-and-sony-establish-the-near-field-communicationnfc-forum/
Vishal, B., Tapodhan, S., Ankit, G., & Vijay, G. (2013). Bluetooth Based Attendance Management System. *International Journal of Innovations in Engineering and Technology (IJIET), 3* (2), 227-233.
Wozniaki, T. (n.d.). *NearField Communication NFC*. Retrieved October 2015, from http://www.nearfieldcommunicationnfc.net/benefits.html
Yusof, M. Z. (2006). *Capturing Student Attendance using Fingerprint Recognition in FTMSK.* Thesis, Universiti Teknologi MARA, Information Technology and Quantitative Sciences.

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