DEVELOPMENT OF A NEAR FIELD COMMUNICATION-BASED ATTENDANCE AND COURSE VERIFICATION SYSTEM

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ABSTRACT

The task of taking class attendance using the conventional paper-based method can be a challenge with increased number of students' enrolment for a course. The method is time consuming, prone to errors and unfairness in the process. An NFC-based attendance and course verification system is presented in this study. The system reads student's data from the school ID card when brought in close proximity with an NFC module and sends the data to a web application where the attendance is taken and course(s) is verified as applicable. The technique is simple, cost effective and saves time. The developed system takes less than 3seconds to take a student's attendance while compared with the manual paper-based method which took an average of 17seconds

Keywords: Attendance system, Microcontroller, Near Field Communication

1 INTRODUCTION

Attendance taking in a university system holds significant importance in contributing to both the students' academic success and the overall functioning of the educational system (Mwangi, 2018). Attendance fosters a sense of community and collaboration within the classroom, instructors may use attendance as part of the overall assessment or grading system; monitoring attendance allows instructors and university administrators to identify students who may be struggling academically or facing personal challenges (Acasamoso *et al*., 2021; Vankayalapati *et al*., 2022).

The traditional method of taking attendance is a paper-based method where a register is being signed by students or having the lecturer do a roll call (Chakraborty et al., 2020; Patel and Priya, 2014). This manual method is however time consuming prone to erroneous transcription, falsification of signatures and the difficulty associated with updating the attendance records (Arulogun et al., 2013; Mery et al., 2019; Shoewu et al., 2022). The automated attendance taking system involves the use of technology to simplify the process of recording and managing attendance (Patel and Priya, 2014). It is also utilized in monitoring attendance of employees and conference participants, and so on (Mwangi, 2018).Automated attendance system provides several advantages compared to the traditional method; this includes improved accuracy, time saving, reduced administrative workload, and enhanced security (Samaddar et al., 2023).

2 RELATED WORKS

Among several technologies that have been incorporated into attendance taking systems are biometrics, Radio-Frequency Identification (RFID) (Al Hajri et al., 2019; Joshi et al., 2021; Samaddar et al., 2023), Smart Cards (Vinod et al., 2021), Mobile Apps, Barcode Scanning (Sudha et al., 2015), Internet of things, automated facial recognition and cloud-Based platforms. This study presents a Near Field Communication (NFC)-based attendance and course verification system. NFCs are set of short-range wireless technologies; they are proximity card technology requiring a separation of 10cm or less and are based on the principle of electromagnetic induction. It operates within the radio frequency of 13.56 MHz (Hamzah et al., 2019). Vinod et al. (2021) presented a smart card-based attendance system. The system was designed for use on a Personal Computer (PC) and mobile platform. An RFID-based attendance system was presented in Ula et al. (2021). In the work of a facial recognition based smart attendance system to eradicate proxy attendance was presented. The system uses viola-jones algorithm for training and detection of faces. Also presented a real-time face recognition and attendance system using Local binary pattern histogram algorithm.

3 METHODOLOGY

3.1 NFC-Based Attendance System Outline

The block diagram of the developed NFC-based attendance system is shown in Figure 1. The system is made up of the sensing unit (contactless object and the NFC module), the processing unit i.e. the microcontroller for processing the sensed data; the library which serves as the central programming interface and the driver utility which controls the NFC device to ensure appropriate communication with the web application.

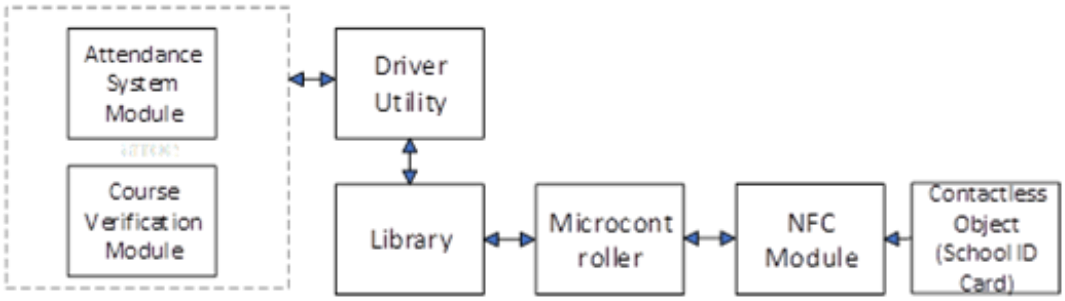

Figure 1: Block Diagram of the developed NFC-based attendance and course verification system

3.2 The Sensing Unit

The PN532 NFC module is the sensing module that has been selected for this study due to its high integration transceiver for contactless communication at a speed of 13.56 MHz. It also supports RFID reading and writing, P2P communication with peers, and NFC with Android phone. It supports plug in and play with an Arduino Sensor shield. The PN532 NFC Module has 4 pins - GND, VCC, SCL, SDA. These pins were connected to the GND(Ground), the 5V

supply, while its output pins are connected respectively to the analog input pins of the microcontroller as shown in Figure 2.

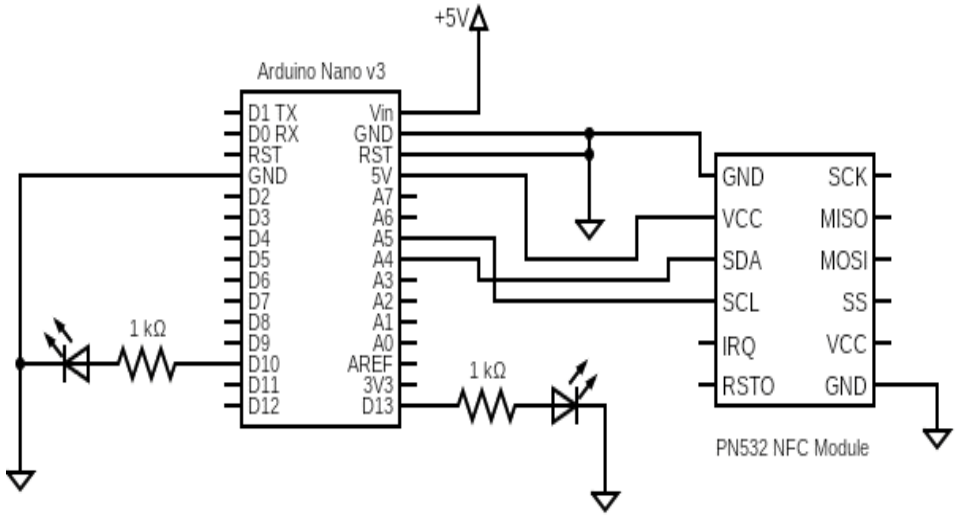

Figure 2: Component Connection for the developed NFC-based attendance and course verification system

3.3 Components Connection for the Developed NFC- Based Attendance System

The complete circuit representation of the input and processing unit of the developed system is as shown in Figure 2. The Arduino Nano microcontroller was powered by a 5volt battery source and the outputs of PN532 NFC (SDA & SCL) is connected to the analog input pins A4 and A5 of the microcontroller module respectively. The PN532 NFC module reads data from the NDEF Contactless MiFare card and sends the data to the Attendance and Course Verification System through the Microcontroller, Library and driver utility channel. The Mifare One S50 White Card and Mifare One S50 Key Card are the RFID contactless cards chosen for developed system. They are finely laminated blank cards, waterproof and dustproof with a resonance

3.4 System Software Description

The software system employed in the developed system is divided into four (4) categories: the software that runs on the Arduino Nano development board (to capture the data read from an NFC Card/Chip by the NFC RFID module), the driver utility, the SDK/Library and the web application.

The microcontroller was programmed using the Arduino Integrated Development Environment (IDE) as the editor software while the driver utility was developed using ElectronJS, Node Serialport and Socket.IO, this is to enable the Web Application communicate with the library using Serial and Socket communication.

A library was also developed using Socket.IO and EventEmitter library to ensure a communication medium exist between the driver utility and the Web Application.

Using NodeJS and Fastify, a backend for the web applications was developed which consisted of a web server that uses a RESTful API to communicate with the front-end of the web application and the MongoDB database. While a database system was setup using MongoDB. The DB contained the relevant data models - Student data, Courses data, Lecturers data, Faculties data and Departmental data.

The front end of the web application was developed using NuxtJS and Sass, which consisted of the Attendance System and Course Verification System.

The two web applications developed are the attendance system and the course verification system. The attendance system monitors the presence and movement of students in a lecture by the lecturer while the course verification system verifies the courses registered for by a student before such is cleared eligible to write examination. By coming within close perimeters of this device, this system will capture the student's data and query the database that holds student information to seamlessly validate courses registered for by the student. Figure 3 shows the system flow chart.

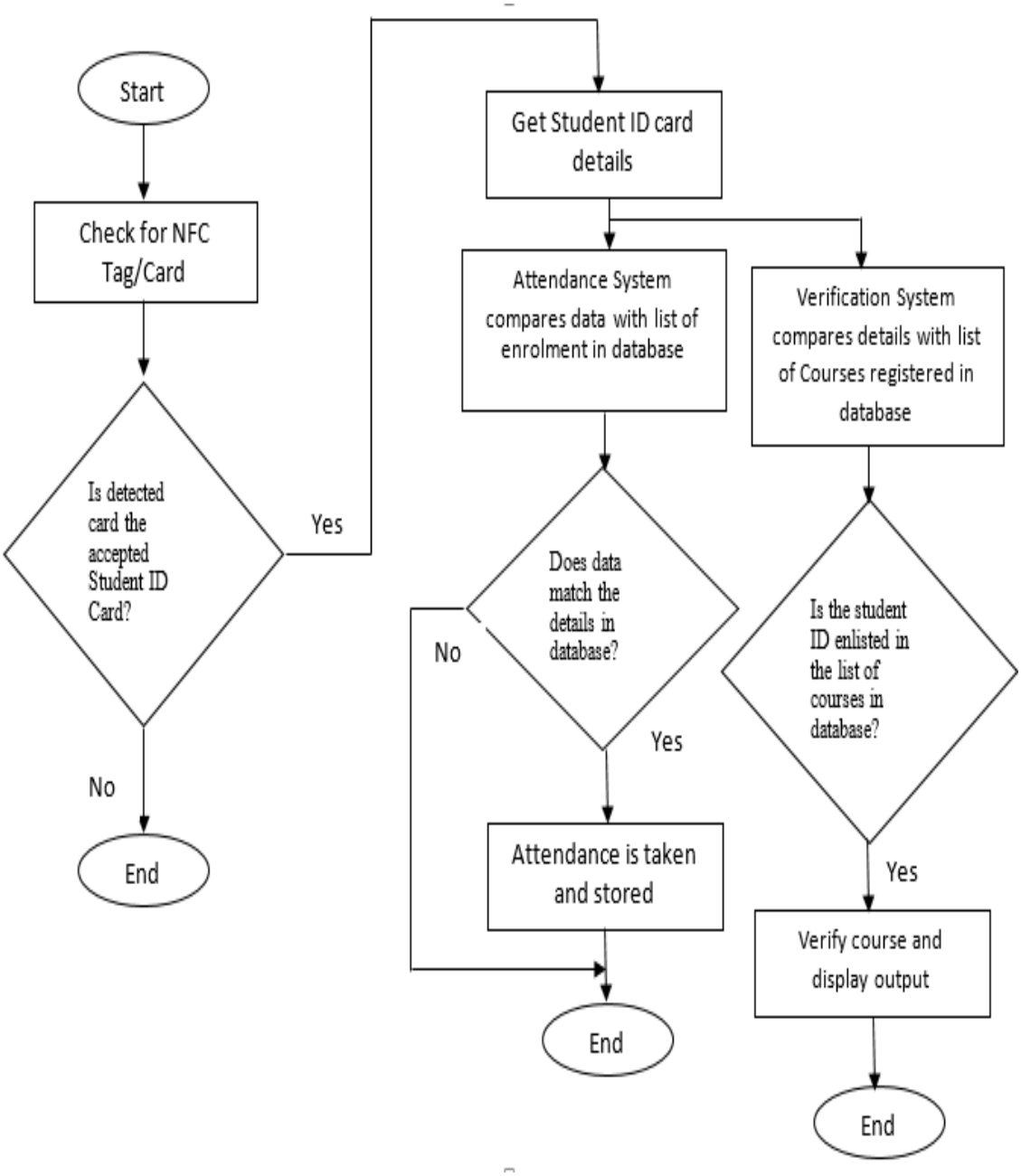

Figure 3: System Flow Chart

4 RESULTS AND DISCUSSION

4.1 The Developed Hardware

The hardware configuration of the NFC-based attendance and course verification system was packaged as shown in Figure 4.

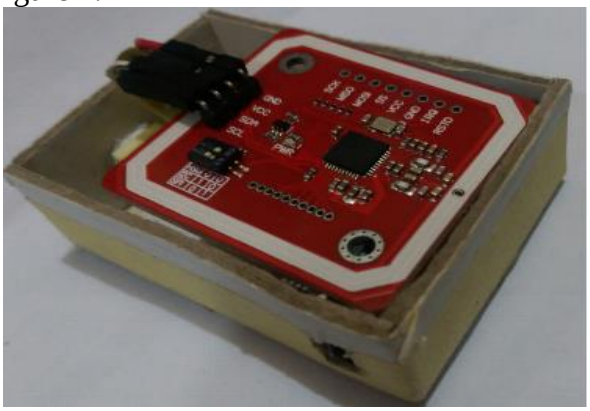

Figure 4: The packaged NFC reader consisting of NFC Module and Microcontroller

4.2 Database Management Structure

This is developed using the Mongodb. It is the home of the data models used in the development of the Web Application. The following models were created and utilized throughout the entire application - Departments, Courses, Lecturers, Students and Programmes. Figure 5 is the screenshots of the collection of courses including the course code, number of credit units, the level and the semester when the course(s) is taken.

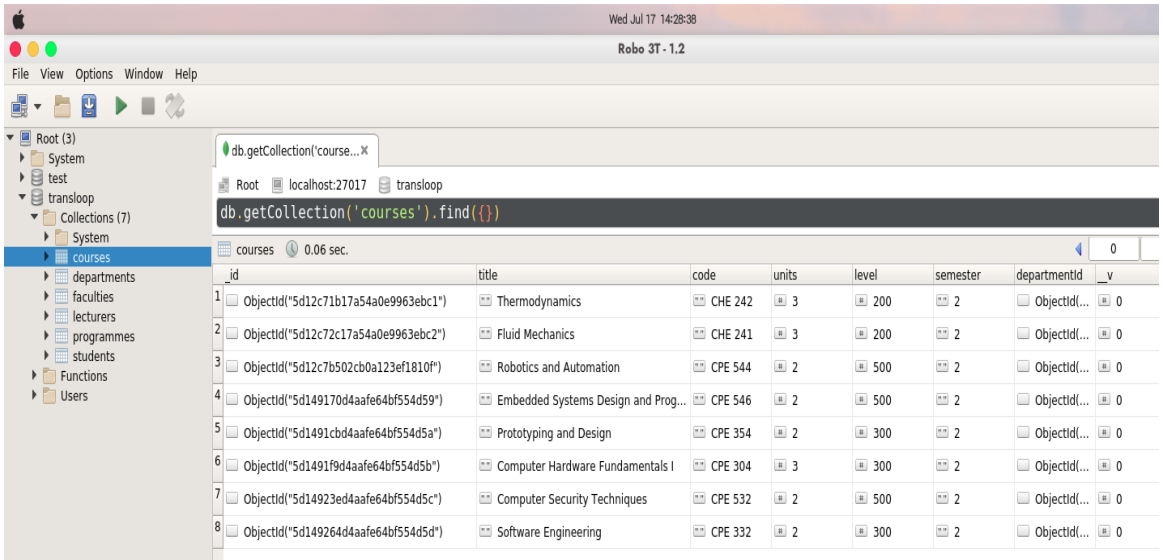

Figure 5: Home page of the developed database management system

4.3 The Developed Front-End Web Application

This is the view that the users interact with. It consists of the Courses Verification landing page and the list of Lecturer's courses.

4.4 Testing of the Developed NFC-Based Attendance System

The NFC-based Attendance and course verification system was tested following these steps:

i. The lecturer logs in to the system by providing the staff ID and password as shown in Figure 6.
ii. After login, the lecturer can view the list of all courses taken on the dashboard and can click on any course for which attendance is to be taken.
iii. The user then clicks on the "Take Attendance" button to begin taking students' attendance as shown in Figure 7. The process of taking attendance can be stopped by clicking the stop attendance button. The list of attendees for a lecture can as well be printed or exported to other file formats from this page.
iv. The Attendance System captures Student's ID card data and marks student present as shown in Figure 8.
v. For the course verification system, after a successful login to the portal, the Lecturer can view the list of all courses offered in the university, selects the courses he wishes to verify. The NFC module reads the student data from the ID card in close proximity which is displayed on the portal as shown in Figure 9.

The system will then show a dialog box that confirms the eligibility of the student to take exam for the verified course as shown in Figure 10.

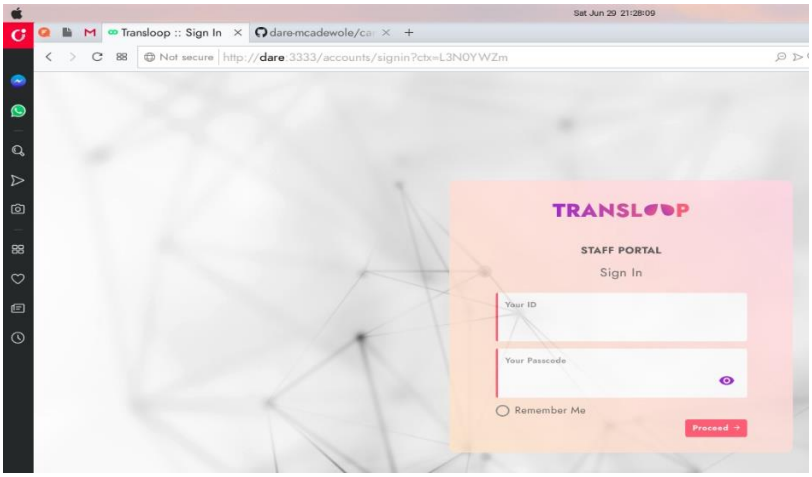

Figure 6: Screenshot of the user login Interface

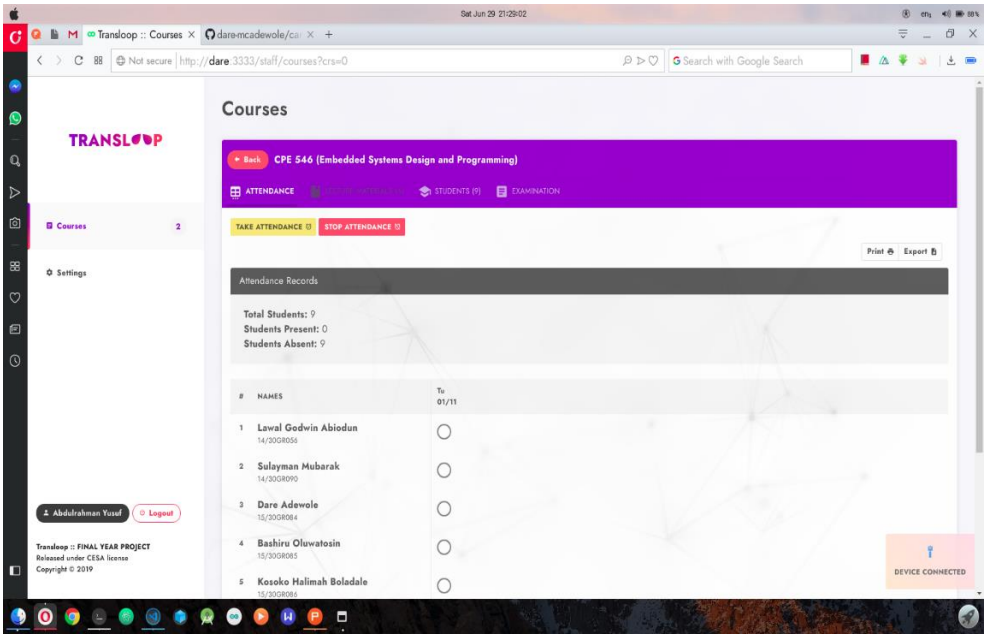

Figure 7: The user's attendance Interface

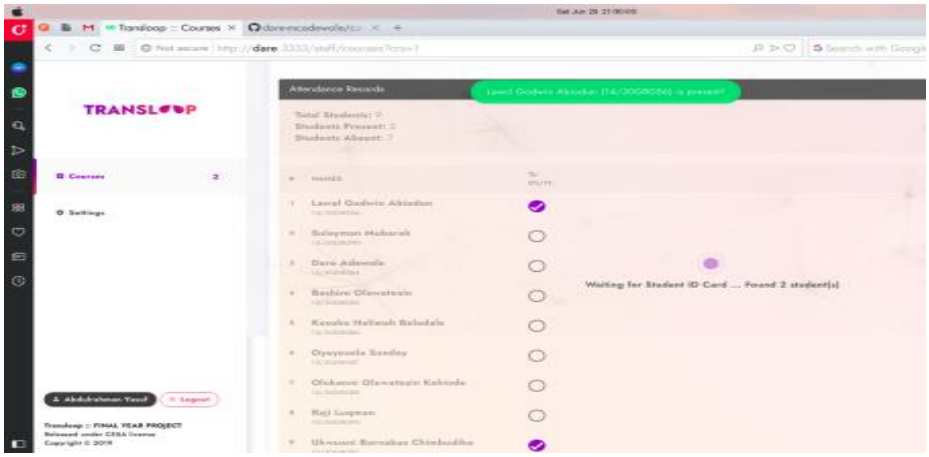

Figure 8: Sample of Attendance Taken

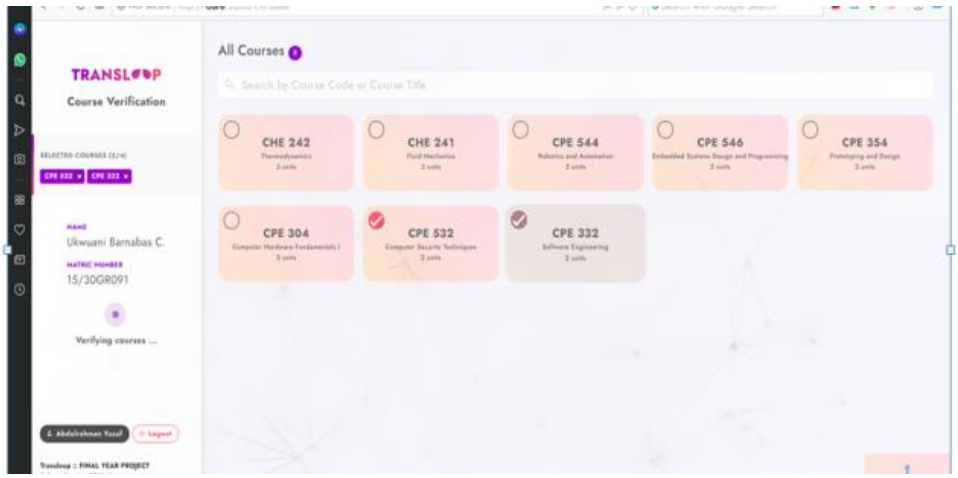

Figure 9: Student Course Verification Page

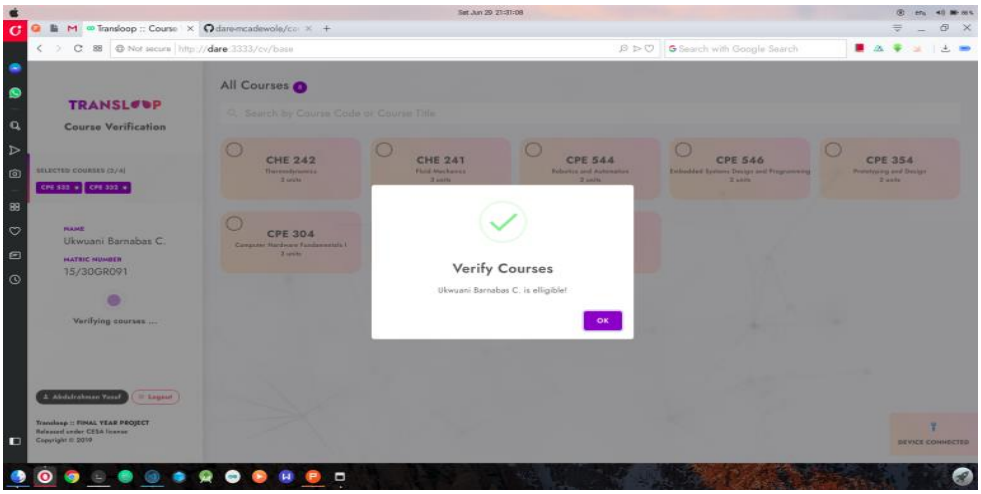

Figure 10: Sample Screenshot of Student Course Verification

4.4 Performance Evaluation

The time taken for the developed system to take a student's attendance was observed using a stopwatch; this was also observed with the conventional paper-based method. The time taken for the data retrieved from the card to reach the web application is less than 3 seconds. Also, the web application, with the help of the driver utility senses when the device is attached or detached from the system in less than a second and as soon as it senses that, the application disables all of the functionality that requires the device to operate.

5 CONCLUSION

A low-cost NFC-based Attendance and Course Verification system was developed. The time taken for the system to take a student's attendance was compared with the time taken by the conventional method using a stopwatch. The result showed that the developed system takes less than 3seconds while the conventional method took an average of 17 seconds. The developed system can be used for real time attendance taking in any educational institution. It can also be adapted for taking the attendance of employees in an establishment.

6 ACKNOWLEDGEMENTS

We give thanks to Almighty God for the success of this work.

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