NFC and Fingerprint as Two-Factor Authentication for Attendance Monitoring and a Door Lock System via IoT Application

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***Abstract*---- As technology rises, digitalization leads to the world of automation gives an impactful change to many operations in production and other sides of industry. Traditional student's class records commonly encounter problems such as losses, editing challenges, time and cost inefficiencies and much more; so that with the introduction of digital recording these problems will be given a resolution that both professors and students might benefit. Nowadays, Near-Field Communication was one of the inclined and commonly used technology because of its wide-range application. A door lock system integrated with NFC technology is one of key solution for the present problems about record keeping of students' academic performance that took effective. Systematically With the help of Internet of Things that serve as backbone and connection of devices in a network, and data storage that was accessible using the developed mobile application. Generally, the system helps both professors and students to have secure and safe classroom by the support of failsafe-built door lock device. Beneficially, the entire system has a reliable attendance checking and academic classroom performance records which help and promotes progression to have an operative and fruitful educational system.**

***Keywords*---- Near Field Communication (NFC), Internet of Things (IoT), Logical Link Control Protocol (LLCP), Time Attendance Management System (TAMS).**

I. INTRODUCTION

Nowadays, class recording was still process manually even if technology gives tremendous impact to ease this process. In the past decades researchers and innovators tries many schematic and systematic algorithms to resolve this cumbersome task. However, traditional student's classroom performance records encounter vastly of problems.

Due to super typhoon Yolanda, 7300 public school students lost their school records in Eastern Visayas as Department of Education in 2013 [1]. This great loss of important documents is one of the worst problem records keeping had experience. In addition, traditional method of record keeping is practiced ever since it is well known but comes with some disadvantages. Collecting, sorting and organizing of these data is a cumbersome task, especially when it is done manually which affects its integrity. This approach is well known yet a tedious and time-consuming process [2] [3].

Nowadays, computer is efficient to use because of its great ease and flexibility to the creation and editing of documents in many countries. It is widely used for its versatility, as a result it is called the Computer Based. It could end up into many uses such as all components necessary to capture, process, transfer, store, display, and manage information. Digital records is a solution which mitigate risk like students' file losses and data entry errors that can help both instructors and students to make the process paperless, secure and efficient [4]. Currently, Industry benefited to wide-spread application of NFC technology in such that it is implemented to smart cards, e-wallet, smart ticketing, in field of medicine and healthcare, keyless access, smart inventory management theft control [5]. This technology introduce a new door of project innovation for the researchers to conduct a systematic way of class recording.

Mostly, experienced instructors and faculties classifies them through vision inspecting that could daunting. For that, using database and IoT was done. This proposed research focuses on determination of tracking records ensuring accurate and reliable information collection for systems in educational institutions through its upgraded technologies. In addition, the transparency for student to monitor their classroom performance using of

mobile application and classroom security using designed door lock system developed by the researchers.

II. RELATED LITERATURE

To develop NFC Framework for Monitoring Student's Classroom Performance and a Door Lock System with UPS via IoT Application, the researchers worked and studied from different perspectives.

In 2018, Technological University of the Philippines conducted a study about door lock system developed using NFC which it takes a lead role to executing authentication and access of a classroom by the authorized personnel. This study highlighted the used of sub-circuit breaker for conservation of energy and managing the device's power supply. Also, evaluating of NFC cards that is most suitable to the study [6]. As a same principle, a previous study used NFC in executing Data Exchange Format for software design and its main feature to access in a door lock system by means of logical link control protocol (LLCP). The main features of the system offer a tri-modal selective method for door locking and unlocking by the used of developed smartphone application [7]. On the other hand, the proponents develop a web application supported by Cloud which runs by NFC as employee's identification of employees' attendance tracking namely Time Attendance Management System (TAMS). The proposed system highlighted the used of NFC as attendance record, automatic working-hour computation, overtime checking and leave, time evaluation, updated real-time data access, and generating reports [8].

Due to wide range application of Internet of things and its capability to build a network infrastructure that can integrate and control physical environment a study about Attendance Management is conducted. This study highlighted the implementation of Internet of Things through Raspberry Pi 3 and RFID Technology allowing the automation of traditional way of daily attendance recording which is time and energy consuming. The proposed system is capable to operate in extended to more data collection for big number of students and classes with database generation and update. The proponents conclude that the developed system is secure, reliable, fast and efficient by evaluation the functionality of the system itself [9].

On the other hand, Internet of Things is used for attendance monitoring integrated to non-biometric identification. This system can be served as a recording student attendance tool. It also offers the history in a time efficient and digitalized manner where the students' personal data is more secure. The main challenge was to identify a single person without using any bio-metric sensors. So, the proponents come up with the used of unique factor, the W-H Fusion function in the proposed system.

The proposed system used load sensor in a platform where the student's name, height, and weight are collected and stored to the RFID as Non-Biometric Identification. The W-H function is capable to identify individual student accurately unless different students have same height and weight measurement [10]. These said researches inspires the proponents to develop a system by integrating class record and attendance system to classroom door lock.

III. METHODOLOGY

A. Hardware Developments

The main idea of this project study is to create a system where the smart door lock, attendance taking, class record keeping, and viewing of grades is integrated in to one by the help of NFC and IoT.

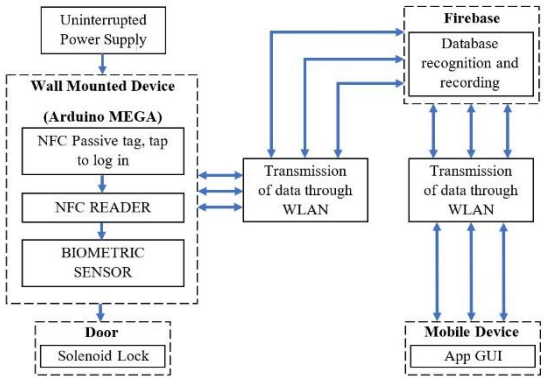

Fig. 1. The block diagram of the system.

The block diagram shows the three main sections of the system. The first section is the system that is mounted to the wall, this part will be the area where the attendance checking happens. Also, it is a system connected to a solenoid door lock which is activated by tapping an NFC card to the reader/writer, as an additional security a fingerprint is also needed. The second system is the part where the professor can record the students' classroom performance by importing an xls file using the mobile application provided. Students can also use this mobile application where they can see their personal class records. The last part is where all the data is collected and accessed, using Google Firebase.

i. Hardware Structure

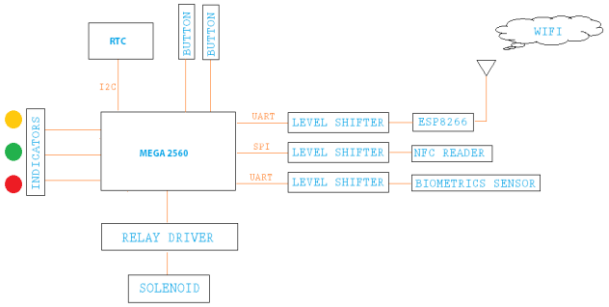

Fig. 2. The block diagram of the components used.

The block diagram shows the components used and how it's connected to each other.

B. Software Development

i. Programming Language

The proponents used four different programming language in this study; Arduino IDE is used for the ARDUINO MEGA which controls the door lock and integrate the whole system, while Android Studio is used for the GUI of the mobile application, for the database--- JavaScript has been used for Firebase SDK.

ii. Software Structure

The three major flowchart of the whole system is shown below:

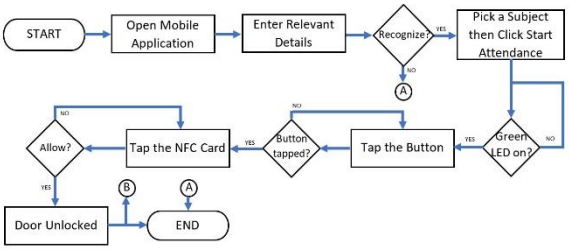

Fig. 3. The first flowchart of the system

At the beginning, the professor needs to open the mobile application and enter the necessary details required to begin the process; if the details entered are correct it then can proceed, if not, then just retry and input the correct information. In the proceeding block, after the authorization has been validated, the professor needs to select the subject that they want to collect the attendance for, when the green LED is on, the professor can proceed by tapping the button on the device, and after that they can then tapped their NFC card; if the card that is detected is authorized, the automated door lock will unlock, if not then just tapped the correct NFC card.

Fig. 4. The second flowchart of the system

After the professor, the students can then now start the attendance by; if the green LED is on, they need to tap their NFC card and wait for several seconds for the fingerprint scanner to light up and scan their finger. They can then enter the classroom just by that.

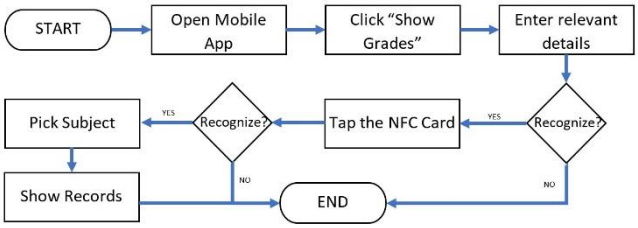

Fig. 5. The third flowchart of the system

If the students wish to view their scores or records, they need to open the mobile application and click the text 'Show Grades', entering the credentials needed, if the database recognize then proceed to tapping the NFC Card in the device near the door, if not then the process will end. In the proceeding block, after the authorization has been complete, pick the subject that want the data to be shown and by exiting the mobile application, the process will end.

C. Testing Procedure

Before testing the whole program for the NFC Framework, the researcher needs to test which NFC reader/writer were the most suitable for usage. The NFC reader were tested by its detection distance with the MIFARE Ultralight C card. Since Arduino MEGA is being used as the microcontroller, convenience of use in integrating the NFC reader/writer is also being considered for programming.

i. Testing the NFC Reader/Writer

The testing will be done to determine which NFC Reader/Writer is the most compatible with the Arduino MEGA microcontroller.

ii. Database Testing

The database stores the data coming from the ESP8266 client. Each classroom assigned will have its own client. The researcher will test its ability to communicate to the system.

iii. GUI Testing

The researcher will test the mobile application if the interface is user friendly. The group will also test whether it will successfully communicate with the database.

IV. RESULTS AND DISCUSSION

A. *Hardware Results*

i. NFC Controlled Door Lock Prototype

The front view of the device is shown; the function of its parts is also included.

Fig. 6. The front view of the parts with label

1. LED Indicator – There are three indicator LEDs that had different color and different function base on status feedback of the device such as:
    a. Yellow – Indicates that the device is on ready state to access.
    b. Green – Indicates that there is an ongoing class on the certain classroom
    c. Red – Indicates that the registration for a subject or attendance failed; also, after a successful attendance slot the red button lighted up in a mean of a seconds, meaning the recent slot was in overwrite state.
2. Initial Transaction Button – It is a lamp push button that lights up when the door lock successfully access, also it is used to opening a slot for attendance of every students.
3. Fingerprint scanner sensor – Biometric input requirement to authenticate every user's identification of security purposes.
4. NFC Reader Indicator – A sticker which the NFC reader was placed below; also, one of input requirement to access the door lock device.

B. *Testing Results*

i. Testing the NFC Reader

The proponents test different three NFC readers and have come to these results shown below.

NFC Reader	NFC tag/card	Orientation (Parallel to the module)	Mean of Range (cm)
ACR122U	NFC tag (MIFARE Classic 1k, 13.56MHz)	30° horizontal	2.7
		180° vertical	3.4
	NFC Card (NXP MIFARE Ultralight C)	30° horizontal	4.6
		180° vertical	5.3
RC522	NFC tag (MIFARE Classic 1k, 13.56MHz)	30° horizontal	2.4
		180° vertical	3.1
	NFC Card (NXP MIFARE Ultralight C)	30° horizontal	2.3
		180° vertical	3.4
R20C-USB-8H10D	NFC tag (MIFARE Classic 1k, 13.56MHz)	30° horizontal	1.4
		180° vertical	2.1
	NFC Card (NXP MIFARE Ultralight C)	30° horizontal	2.5
		180° vertical	3.3

TABLE I. NFC Reader Summary of Results

The RC522 RFID Reader perform sufficient sensitivity which was good enough to read and recognize NFC card/tag. It gives an excellent performance at database compatibility and easily configured. Unfortunately, ACR122U reader that was more sensitive and better to use in such application, it had difficulty performing because of database issues. On the other hand, R20C-USB-8H10D was the least sensitive of the three and performs poor at database compatibility though it is easy to configure.

Overall, the result of both tests executed to the NFC readers gives an opportunity to the proponents to conclude and resolve what reader was suitable for the project application.

ii. Database Testing

The database stores data coming from the ESP8266 client. Each device that was supposedly deployed to the four rooms of ECE department, which are the COE 23, COE 52, COE 43 and Accreditation room. The proponents tested the

ability of devices ability to communicate to the database together with the android application.

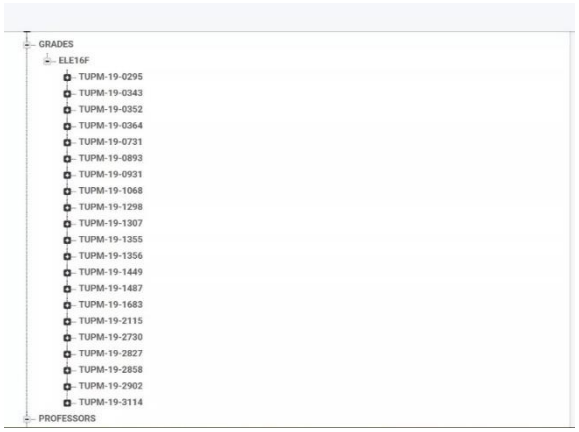

Fig. 10. Recorded Data of Uploaded Grades

Fig. 11. Recorded Data of Registered Students

Fig. 12. Sample Data of Subjects with Students Enrolled

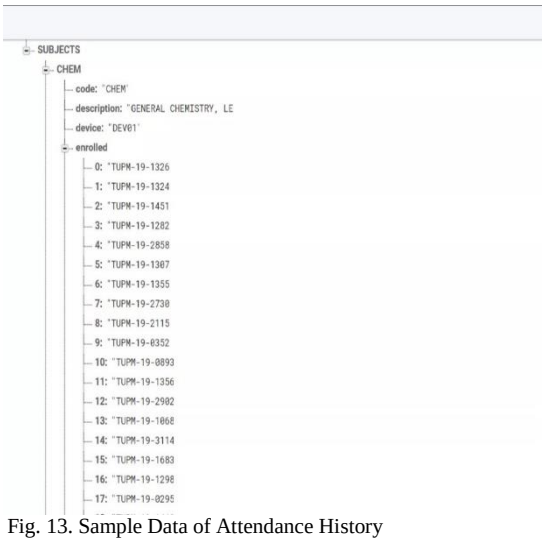

Fig. 13. Sample Data of Attendance History

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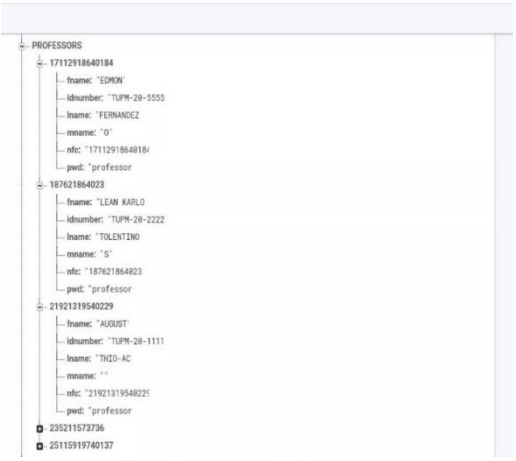

Figure 14. Professor’s Authentication Test

iii. Mobile Application

The proponents tested the response synchronization of built mobile application to the designed door lock in card registration and authentication in addition, the interface transition at user’s mobile device and communication with the database was also tested.

Figure 15: Viewfinder of Uploaded Grades in Professor's Interface on Built Mobile Application

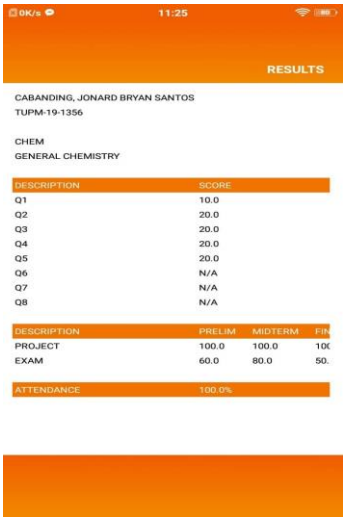

Figure 16. Display of Student own Grades on their Mobile Application

iv. Authentication Accuracy Test

The proponents tested the accuracy of the authentication ability of the nodeMCU. Due to the two-factor input requirements of the device before it completely accessed such as NFC card as initial input and fingerprint scanning as biometric authentication either the two that hasn't satisfied means that the device cannot be accessed. Furthermore, operation process of the device block the user's attempt to proceed to the database if NFC card and Fingerprint are not recognized. Overall, the functionality and authentication ability of the system is 100% working.

In addition, the process of first-time registration of the student from the device and response of mobile device application was also tested. Tabulation summary of the procedure and responses at time are shown below.

Steps for first time register of student	Occurrence in the mobile application and device	Time (sec)
Filling up the form	Requires information such as: First name Last name Middle name ID number	10-15
Setting of NFC card	Before yellow LED light up	2-4
	Yellow LED light up and read a card last	5
	Recognizing the NFC card	2
Setting of fingerprints	Before fingerprint scanner light up	3-5
	Fingerprint recognition	1-2
	Fingerprint recording	5-15

TABLE II. Summary Result of Door lock Device and Mobile Application Response

V. CONCLUSION

After the results are in, looking back on the objectives already set, the researchers conclude that:

The program developed and uploaded in the Arduino Mega 2560 is capable of controlling the door lock and integrating the entire system. This code includes the activation of PN522 NFC module, controls the solenoid lock through a relay driver, reading of the GT-512F32 fingerprint scanner, and the connection of the ESP8266 Wi-fi module.

The RC522 is an RF module composed of an RFID reader, an RFID card and a key chain that works seamlessly with the device and proved that the ESP8266 client could interact with the system. The module operates 13.56MHz which is an industrial band (ISM) and can therefore be used without any license issue. The module usually works at 3.3V and is most widely used in 3.3V designs RC522 RFID Reader performed enough sensitivity to read and recognize NFC card / tag to create a database that records all data through the lock door hardware done by NFC.

The free software Android Studio was used for creating the mobile application UI and used in ensuring the accuracy of the input data. Using the mobile application, the professor can upload and download the student

performance and, students can view their individual performance.

JavaScript was used for Firebase SDK database to record all data collected from the door lock hardware and mobile application.

The final handheld device, as checked, could evaluate data in the reliability of the database and easily configure the user activities and identity.

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