Programming of NFC Chips: A University System Case Study

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***Abstract*— Global warming majorly caused by deforestation is taking its toll on the planet. Many technologies are being implemented to solve these problems of global warming, such are the concept of clean-green energy, solar powered projects, etc. We present in this project the programming and implementation of near field communication chips in supporting eco-friendliness and ensuring an effective information dissemination system in the University. This is achieved by embedding the chips with uniform resource locators (URL's) to access useful departmental websites. These chips were also embedded with posters/flyers or contact/business cards, for digital storage or to be viewed at designated locations. The inbuilt NFC chips makes it possible for the users to interact with the environment just by using an NFC enabled device. This technology requires a little nudge or tap for activation. Once tapped, the chip will automatically transmit or display the data already programmed on it unto the device. In this work, the website which allows students check for important information about staff such as lecture schedule, visiting hours, etc. and also route texts over to staff if the event arises is demonstrated.**

***Index Terms*— Eco-friendliness, Information dissemination, NFC, Programming.**

I. Introduction

NEAR field Communication, NFC, is a form of short-range (radio-frequency), low power, and wireless communication technology used to provide connectivity for electronic devices which enables them to communicate with each other by either tapping or bringing them to very close proximity [1]. It is based on RFID, but additionally has a unique set of standards which ensures interoperability of NFC-enabled equipment. NFC communication usually occurs between either two active devices, such as smart phones or may even exist between an active NFC device and a passive (unpowered) target. The first device (active) is sometimes called the initiator, it operates on the principle of inductive coupling to create a radio-wave which the target i.e. the second device can detect and access [1]. This connectivity permits small amounts of data to be transferred wirelessly over a relatively short distance. This distance generally in NFC should not be more than 4 inches.

It is important to review the basics of RFID. The RFID system contains three essential parts; the reader, tag and middleware [2]. The RFID reader or initiator is a device that transmits radio frequency signals continuously and waits for the tag to respond. The tags are sometimes called transponders; they are basically just microchips with an antenna. Readers can be moving (mobile RFID) and not-moving (fixed RFID). Tags can come in three varieties: Passive, active and battery assisted passive. Passive tags do not contain a battery, active tags contain battery and always broadcast signals continually while battery assisted passive tags has a battery which is only activated in the presence of an RF field. The tags can be stored in any small device or object according to their applications easily due to their small size. At the frequency range of 13.56MHz, RFID tags mostly use the theory of strongly coupled magnetic resonance. During the process of inductive coupling, other communication frequencies are pinioned which allows very fast communication between coupled resonances.

NFC plays a vital role in my project, it will play house to the vital information in which students, parents or fellow staff need access to. Hence it is the major component of the information station. The NFC chips are programmed with the URL of the website in which this information can be accessed. These chips will also be programmed to automatically turn on Wi-Fi on the accessing device, so it can be connected to the internet. Also, the doors to all offices will have NFC tags on them; these will be similar to the information stations, but will display primarily the basic information about the lecturer that stays in that particular office.

This work seeks to enable a healthier, more effective and less paper-intensive environment which contributes to building the foundation for a greener tomorrow.

II. Literature Review

Over the years, many technologies have been put in place to solve the problem of global warming, while some to ensure faster, easier information dissemination. NFC is one of the latest of these technologies which boasts specific but not numerous advantages above its predecessors, some of these are ZigBee, Bluetoth, and WiMax etc.

NFC technology was jointly developed by Philips and

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Sony in the later months of the year 2002 specifically for contactless communications [4]. NFC is also quite different from the far field Radio Frequency Communication which is being adopted in longer range wireless networks. NFC technology benefits from various elements such as smart cards, mobile phones, card readers, and payment systems. There are three distinct operating modes for NFC technology, which are:

i. Reader/Writer: This mode allows NFC mobile both read and modify data stored in passive RFID tags. E.g. watching movie trailers from a tag placed on a poster.
ii. Peer to Peer: This mode offers interaction between two active NFC mobiles such as phones.
iii. Card Emulation: This mode allows NFC handsets behave exactly like a standard smartcard. This is the most popular of all the modes.

A. NFC versus other Wireless transfer Technologies

It was back in 2002 that NFC was still a nascent technology, it came on board adding up to the existing groups of some of the greatest discoveries of the 20th century. Some of these like Infrared (IR), Bluetooth, RFID, Wi-Fi and ZigBee became very important parts of new age computing devices [5, 6]. It transfers data of up to 424kbps. Since NFC's transmission range is very short spanned, transactions involving the technology are very secure. Figure 1 and Table 1 below show a comparison of the different wireless information transfer technologies.

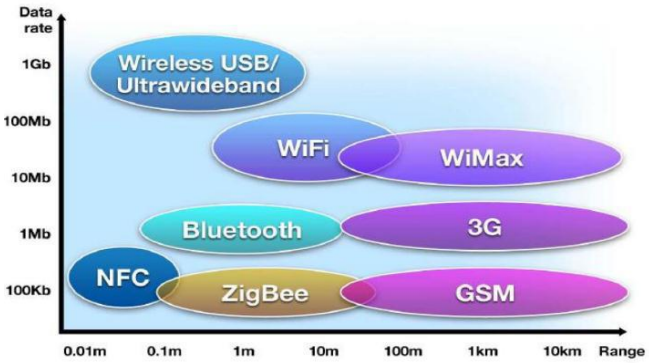

Fig. 1. Comparison of various wireless information transfer technologies.

TABLE I
NFC VERSUS OTHER WIRELESS TRANSFER TECHNOLOGIES

Parameters	NFC	RFID	IrDA	Bluetooth
Set-up time	<0.1 ms	<0.1 ms	~0.5s	~6s
Range	Up to 10cm	Up to 3m	Up to 5m	Up to 30m
Usability	Human centric, Easy, Fast, Intuitive.	Item centric, Easy.	Data centric, Easy.	Data centric.
Selectivity	High, given, security.	Partly given	Line of sight	Who are you?
Use Cases	Pay, get access, share, initiate service, easy set up.	Item tracking	Control & exchange data	Network for data exchange, headset
Consumer Experience	Touch, wave, and simply connect.	Get information	Easy	Configurat-ion needed

B. Advantages of NFC

It has a setup time which is less than 100 milliseconds, which makes communication instant in range. It consumes a mere 15mA of power, hence good for low powered cell phones and reduced impact on battery life. It also has backward compatibility with existing RFID just to state a few.

The advent of each technology comes with the measures to secure our information, unfortunately NFC is not excluded from this need especially as it is used in both ticketing and more importantly mobile banking. Some of the threats facing the NFC technology include; Data corruption and manipulation, Eavesdropping, Data Insertion, and Relay attack, spoofing. For example in the relay attack, the attacker intercepts a message sent to the victim and responds to the sender, pretending to be the intended receiver [6]. In sensitive areas where more security is required, asymmetric cryptography should be used despite its increased transaction property [3].

C. Related Work

In [2], NFC was implemented in a community to ease life. NFC technology was employed in three distinct areas which are; Automated attendance, E-wallet and Access control. Usually efficiency is associated with reduced human input or errors, and this is exactly what the NFC technology helps achieve. In the automated attendance, this technology was implemented to capture attendance in the classroom. The lecturer comes some minutes earlier and places his device where it can easily be accessed when in the classroom, due to its close range, students have to pass very close with their own devices and hence get their attendance captured. Since NFC has backward compatibility, students who don't own NFC enabled devices make use of their existing RFID cards. After the lecture, the attendance is uploaded to the server responsible to hold that.

III. System Design and Methodology

This project operates on the principle of inductive coupling which is comparable to that used in transformers.

In this work, NFC technology operates in two of the three distinct modes, i.e. peer to peer, and reader/writer mode.

The system requirements involved during the project design were:

Hardware

- Processor: AMD A8-6410 APU with AMD Radeon R5 Graphics 2.00GHz.
- Installed memory: 12.0 GB (6.94 usable).
- NFC chip.

Software

- Twilio API.
- An IDE (Webstorm).
- System type: 64-bit Operating system, x64-based processor.
- Operating System: Windows XP and later versions.
- Web browser
- FIREBASE

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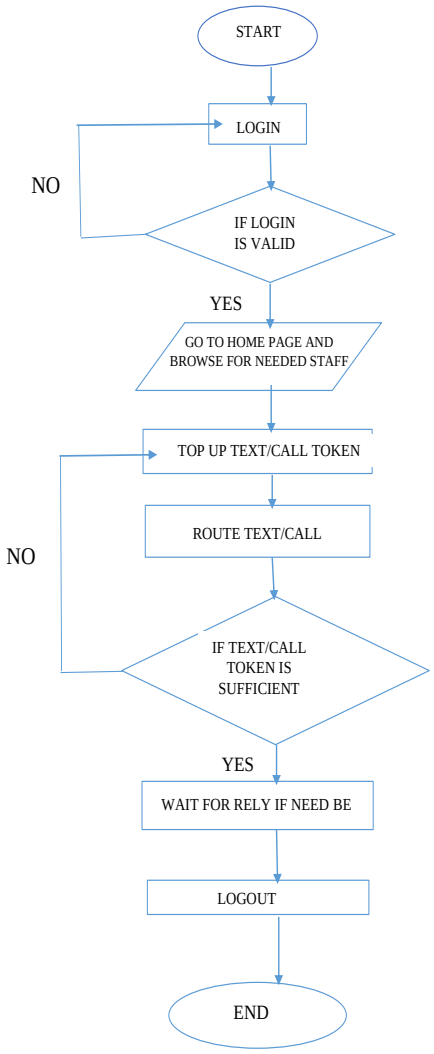

Fig 2. Flowchart of project.

Once all the necessary equipment are in place, start by nudging the NFC tag lightly with the device, the chip has prior being programmed to turn on Wi-Fi or data connection on the device to gain access to the internet. The website which has been programmed unto the chip is then loaded. The student logs into the portal with a valid identification which was done using FIREBASE, the homepage comes up and the student can search for the lecturer which needs to be contacted, either calls or messages can be routed via the TWILIO API which was used. If the available balance in the account is not able to complete the call, the student will be redirected to purchase more. After which the call or texting is possible, then the student logs out to prevent congestion on the hosting server. This process is represented by figure 2.

IV. Implementation and Testing

The implementation of this project work was done using sublime Webstorm IDE. The final display pages are shown in figures 3, 4, 5 and 6. The website interface was designed sing HTML 5, Cascading styling sheet (CSS), JavascriptES2016. The functionalities available in the backend were implemented using NodeJS and Express. While NodeJS is the runtime environment for the server-side, Express is a Node.js web application server framework. The backend was handled using FIREBASE. The portal was hosted on Heroku cloud hosting services with a web address Owoniyi.herokuapp.com.

During the testing phase due to the use of NFC technology, NFC tags were used as well as NFC enabled device. The device also ran an application to be able to program the chip.

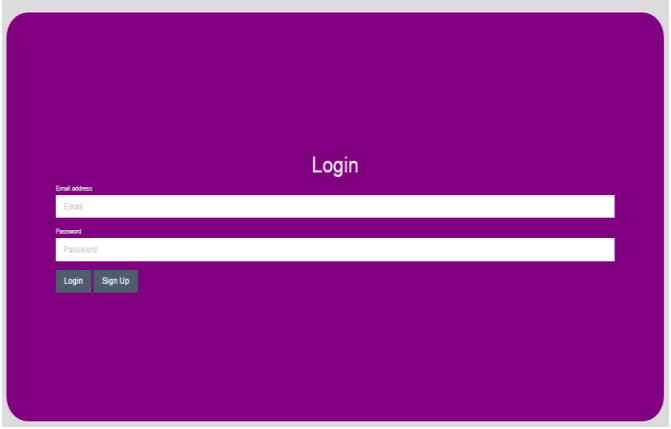

Fig 3. Student Login Page.

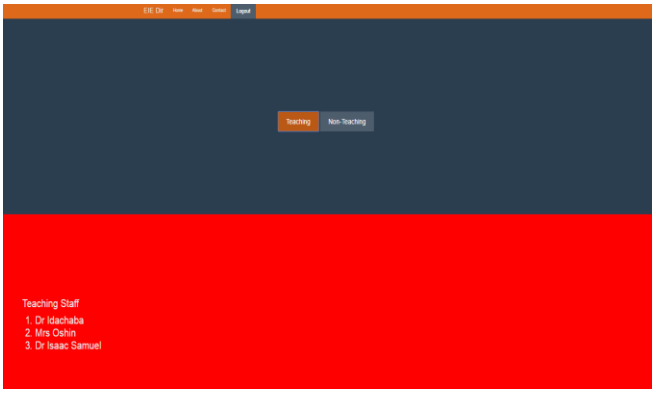

Fig 4. Teaching staff subpage prototype.

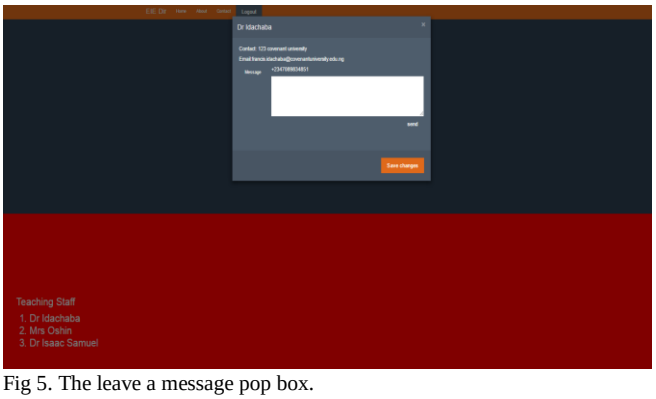

Fig 5. The leave a message pop box.

All of the above diagrams are joined together in the backend by the FIREBASE AUTH, which makes sure that only students with the appropriate identification are allowed contact.

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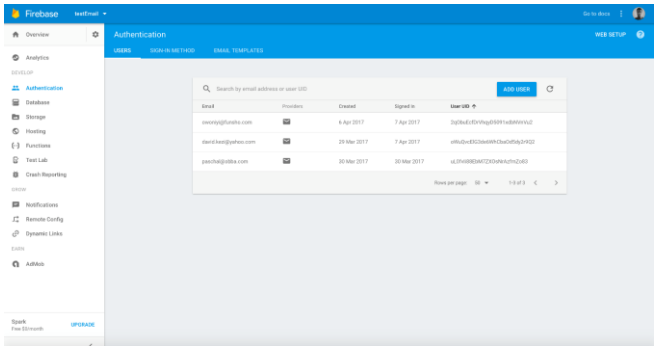

Fig 6. Firebase as a Service (FAAS).

V. Conclusion

This technology would not only allow members of the community embrace ecological friendliness, but it would also help bridge communication gaps existing between the faculty, staff and students of the university. Automating our environments and rebuilding our earth is an important and necessary developmental step. Systems have always existed idle, but maximizing the potential around us to solve our problems is the only way to achieve a truly sustainably developed Nation.

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