NFC Inventory Management System

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INTRODUCTION

Today, modern-day memberships require plastic cards as a form of identification. Whether it be a bank card, gym membership, library card or even a points card, they often require people to tap or swipe their cards. It can be viewed as troublesome for some people as they often keep the cards in their wallets which can build up over time.

A solution would be to develop an android application that can be read over an NFC interface to a physical reader and be managed by a web interface with a database. Even though this type of solution is already being utilized today for transit and payments in proprietary formats, it has not yet been popularized in the areas mentioned above. To demonstrate the concept, the solution was based around the Humber Parts Crib, a campus facility that lends tools and equipment for students to use during their labs and projects. The facility previously held student IDs until the tools and equipment had been returned, but recently switched to RFID tags within bags.

The NFC Inventory Management System revolves around an application that was developed in Android Studio, currently exclusive to Android devices. It interacts with a hardware device that includes: a proximity sensor (VCNL 4010), an NFC controller (PN532) used as a reader, an Adafruit 16x2 LCD as a display, a Raspberry Pi 3 B+ and a PCB to connect the devices. Surrounding the hardware components includes a 3D printed enclosure with an acrylic top.

AIM

The goal of the system was to provide an interface for both client and employee users that is intuitive and simple to use as well as implementing the process utilizing methods used in modern technology.

The client side utilizes a mobile application developed for android that allows the user to interact with the system by creating transactions. Constant communication between the application and the database will provide the user with data to be informed on necessary information to ensure a pleasurable experience for each user.

The employee side uses a web interface with managerial functionality to the database. Data will be displayed and updated by the employee to relay back to clients. Using the structure of the current Humber Parts Crib system a new database was created using MySQL with portable PHP scripts that perform all respective functionality for both sides of users.

The point of interaction is when the client user places their mobile device over the NFC Reader. This is the hardware designed for the project that will be placed at the facility (Parts Crib) used to complete the communication to allow the acquisition and returning of equipment. The device contains two sensors and a display integrated to a Raspberry Pi microprocessor through a custom PCB (Printed Circuit Board) and enclosure designed through collaboration with the Humber College Prototype Lab.

Expenses and Resources

Expenses	Cost
Raspberry Pi 3B+	$45.75
VCNL4010	$7.50
PN532	$71.42
Smaller Assisting Components	$24.24
Tax	$19.36
Import Fees	$7.74
Total	**$176.01**

**Please visit the website provided above for more details.*

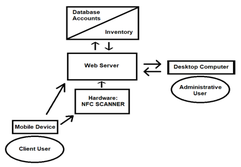
Humber Campus had provided facilities with equipment to make this project possible. The Prototype Lab was used to print the PCB, 3D-Print the enclosure and laser cut the acrylic top. The laboratories were equipped with soldering stations and multimeters for assembling the PCB , testing and the final assembly of the prototype.

Method

One of the most crucial components of this system is the hardware prototype. The internal hardware contains four main devices with supporting electronic parts to deliver the functionality. This included the Raspberry Pi 3 B+, the PN532 NFC Controller, the VCN4010 proximity sensor and the 16x2 LCD display. A PCB was designed and printed at the Humber Prototype Lab to connect the all the components together to limit the amount of wires needed. It was designed meet to the specifications of each device and most importantly wired in an I2C configuration, using the SDA and SCL lines, to allow communication amongst the devices.

Internal Hardware of the prototype with the LCD and proximity sensor connected with jumper wires.

Data Visualization between the server(database), mobile application, desktop application.

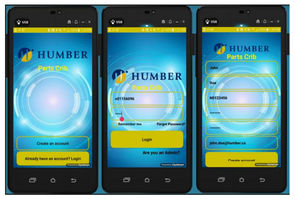


To instruct how the devices should operate firmware was written for each individual component. The firmware contains C and Python files that allow the electronic components to communicate based on given inputs. The main program, main.c, runs the proximity sensor, LCD screen, and the NFC reader. Main.c sets up the proximity sensor and the NFC reader using the wiringPi library to enable I2C communication. It then sets up the registers of each device so that data can be retrieved. When a presence is detected by the proximity sensor, it triggers the NFC into a read state to grab an NDEF encoded message from a mobile device. When a message is received, it processes the transaction ID of the message, passes it to a python script to check the database and outputs the information received onto the LCD.

RESULTS

The client side interface provides all functionality required to suit the needs of the user while limiting access to necessary actions pertaining to the user to protect the database along with personal data that is stored within.
Access to the application is granted and maintained through account services including:

- Login access
- Registering new accounts
- Account information update

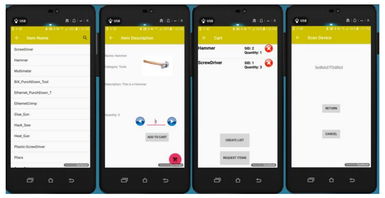


Application functionality dealing with accounts.

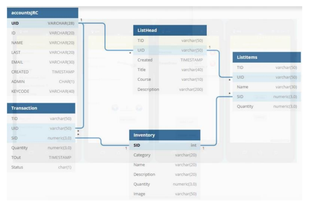
Upon gaining access the user is granted access to read entries from the necessary database tables to perform the functions granted to the user. The functions provided for efficient use include:

- Browsing inventory database to create a list of items
- Submitting a list of items to request provisioning
- Saving a list of items from inventory database as reference to others
- Retrieving saved lists from all users for efficient list creation
- Reviewing past transactions created by user for reference

Parts of the application dealing with signing out equipment.



Utilizing these functions will communicate with the database and return necessary data and prompt the user with instructions to complete the transaction process. Every request executed by the application is handled by PHP script stored server-side to prevent mishandling of information. The application upon use will store data to be transferred through android mobile devices with NFC (Near Field Communication) technology equipped. At the point of interaction between the mobile device and the NFC Reader designed for this project the client will be able to execute requests to acquire or return items that were requested from the inventory database.



Server-side database Schema for the Parts Crib.

Enclosure

To house all the hardware for this project it required an enclosure. The enclosure consists of an ABS 3D - printed main structure and a laser-cut acrylic top. The enclosure was designed to be as compact as possible but still leave enough room to insert screws, manage wires and mount devices on top of each other.

This enclosure has a length of 158mm, a width of 88 mm and a height of 61 mm.

The process to develop the device initially required careful measurements to retain functionalities such as when a phone is being sensed or scanned from a distance. They were then entered into CAD software such as AutoCAD, where the main base was drawn and holes were created to a specific size to accommodate heat-set threaded inserts. The CAD file was then exported into AutoDesk Inventor where the base and walls of the enclosure were extruded. 2 areas were then cut out to expose the I/O ports and micro USB port to make them more accessible. After, standoffs were created for the LCD, the proximity sensor and the top lid. These standoffs were designed with angles less than 45 degrees from the sidewalls. The file was then exported as an STL and sent off to the Prototype Lab to be printed. It took approximately 4-5 hours to be printed using a Stratasys printer and was picked up the next day. With it successfully printed, using the previous files as a reference the acrylic top was later created and laser cut within a day.

CONCLUSIONS

With the app in its final stages of troubleshooting and polishing, other applications of the NFC Inventory Management System needs to be found. Even though the project overall revolves around handling inventory, adjustments can be made to the system so that it can be applied to any industry that involves cards and/or memberships. To further the improvement of this system, it will be made open-sourced for anyone to contribute and/or use for their implementations of the system. Making it open sourced will allow the concept to gain popularity and be a more common concept in the near future.

ACKNOWLEDGEMENTS

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