This is my Thesis Title:

Using NFC/RFID to improve Home Security.

John Ugwu

BSc (Hons) in 2019/2020



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This is my Thesis Title:

Using NFC/RFID to improve Home Security.

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A thesis submitted in partial fulfilment of the requirements for “Research in Computing with Emerging Technologies” and “Project Development”

BSc (Hons) in Computing in ………….

Submitted to Quality and Qualifications Ireland (QQI)  
Dearbhú Cáilíochta agus Cáilíochtaí Éireann May 2020

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# Acknowledgements

I would like to thank, my lectures for this project for directing in the right path to complete this project.

# Abstract

When in a house/shared apartment, security is an important factor. Keys are an essential part of security in a normal household. It provides a way to lock your house or room. However, there are cases when keys can be easily lost or forgotten to close. Another factor is not being able to know who comes in your bedroom or house 24/7. A solution for this is using NFC via mobile device and RFID reader as the smart lock to improve home security, use data analytics to collect information on who enters the room and post notifications to the user for failed attempts to enter. Home security can be easily improved using these methods, although there are many other projects that have been done with regards to smart locks, like in hotels and smart home tech found on amazon. The added data analytics and notifications is my added twist to an already secure solution.

# Acronyms

|  |  |  |
| --- | --- | --- |
| Acronym | Definition | Page |
| SSA | Some Silly Acronym | 12 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

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# Introduction

Houses are a place of shelter normally occupied by a group of people, normally a family or student. All homes have the basics of security, all with rooms and bathrooms that contain a locked system to enclose and area. A way to access these rooms is with a physical key. This method has been this way and has greatly improved in the type of locks that can be available. However, these methods are still vulnerable to security risk (Smartlocksmith.com, 2019). For example, security risks such as loss of key, broken down the shape of key causing doors to be unable to lock and the ignorance of not knowing who enters a room (Smartlocksmith.com, 2019). A solution for this problem is “Smart Locks”, more specifically an IoT lock that uses NFC/RFID as a way of unlocking and locking a door and using NFC as a key, which is possible using a smartphone. This solution will eliminate issues relating to losing keys and broken-down shapes won’t be a problem. The benefits of using an NFC/RFID for a smart lock is that NFC is secure and easy to use. NFC acts as communication with other devices and data transfer is fast. (Hoffman, 2018)

The project will involve the use of panda data analytics, which will collect log data, working together with the devices to collect data and display information for the admin to know those who had entered the room, allowing for a more secure smart lock.

## 1 Purpose of the Research

The purpose of this thesis is to find an improvement to home security using IoT and allow the owner to be more in control of their room. The process that will be outlined in the thesis will allow for a more flexible and easier to use access. What this means for the owner is through IoT and Data analytics a more secure home will be possible. By implementing data analytics, a researcher will use My SQL for the collection of data of the users who use the NFC device on the RFID reader and by using NFCs ability to communicate to devices and data transfer. Information can be collected to provide a necessary period of when a user entered and left. For example, the owner, using the interface that displays the information will be able to visually see who entered the room and who has access to the room. This allows for a more efficient way of security; the owner will be able to tell who took any item from the room if items are missing. The interface will be made using web development languages like PHP, Bootstrap, CSS and HTML. Python will help with the raspberry pi and the implementation of granting and denying a user. Twilio API will provide a way for an owner to get notifications of unauthorised access.

## 1.2 Research Background

Upon research, a requirement for following up the thesis and project, general knowledge of the technologies involved as needed. With the studies given, the meaning of IoT is a system of interrelated computing device, digital machines, people, object and animals which provide unique ID that have the ability of data transfer over a network without the traditional way of human to human or human to computer interaction. Hence what the NFC/RFID operates as. NFC (Near Field Communication) which follow the realm of IoT provides communication through devices and mobile phones contain NFC chips which allow for many benefits. Contactless payment is now possible through Apple pay and Google pay. With NFC and it's short-range allows for secure transactions. Two students were able to use the NFC device to replace customer loyalty cards, the application was called Eclectyk and was submitted in the NFC forum in 2009(Kessler, 2010). Health Care is another benefit, which allows medical professionals to have access to information about the treatment required for a patient but also enabled the possibility to keep track of nurses and doctors who checked in with the patients and when. (Kessler, 2010)

Through research, other projects like the proposed project has been discovered. The studies found were two sources, one involving in-home security concerning damage and thief, it adopted the same core principles of making an IoT home security but involved many sensors like fire detectors PIR sensors etc (Anvekar and Banakar, 2017). Another source which involved the same process but involves Bluetooth as supposed to RFID/NFC (Kavde et al., 2017). The thesis project, although follows some similarities of the studies, it is done differently for starters when comparing Bluetooth and NFC. NFC would be more secure and ease of use (NFC.org, 2017). Communication with other devices is faster and with the short range of NFC, it doesn't have to worry about crowd interference. Another benefit is also less power is consumed = less cost in electricity.

## 1.3 Research Question

This thesis will serve to answer the following question: How does Data analytics enhance the reliability of IoT concerning smart locks and home security?

### **1.3.1 Aims 1**

1. To improve the security of a home.

2. To integrate data analytics to further improve the security of the home using IoT.

3. To gain more knowledge of IoT technology and the functions involved in making it.

**1.3.2 Objectives**

1. To develop an interface that will display the data collected from the database.

2. To use another database like, MySQL to collect information about who enters the room and Twilio API to notify Admin of unauthorised access.

3. Create a web-based service that will act as a GUI to display the data being collected.

4. Use python to code the functions needed for the admin such as granting access and denying access.

## 1.4 Report Outline

This thesis will be broken down into 6 main chapters: Chapter 1 – Introduction: The introduction to the thesis. Chapter 2 – Literature Review: Assesses the background of the applicable technologies, standards and guidelines. Chapter 3 – Requirements and Prototype: Details of requirements for the artefact and documentation required to design a prototype. Chapter 4 – Implementation: Details how the artefact will be created. Chapter 5 – Testing: Conducting tests on the artefact. Chapter 6 – Conclusion: Conclusion of the thesis and summary of the research.

# 2. Literature Review

This chapters will examine and document existing literature on smart lock concerning home automation. It will also investigate IoT devices such as Raspberry Pi concerning home security, in addition to also discussing the uses of NFC/RFID, exploring the advantages and the limitation of the use of home security.

## 2.1 Home Security

According to the central statistics office the amount of burglary and related offences. That occurred in 2018 was 18,416 and in 2019, 16,617. This figure shows a -9.8% decrease between 2018 and 2019. (CSO.ie, 2019). In the previous years, burglary and related offences around 2003 was much higher. For example, in 2003, the figure documented by the Ireland and Central Statistics office was 25,756. This is a big gap as opposed to the aforementioned current figures documented in recent years (Ireland and Central Statistics Office, 2008).

Smart home devices, began to increase in popularity around 1998-early 2000s, a variety of technologies began to emerge. Such as gadgets, like amazon echo, amazon fire tv, home networking and domestic technologies. It has become the standard and offers more affordability in the household of today. (afcdud.com, 2015).

The first known example of a home security system was in 1966 which was a burglar alarm. The use of burglar alarms helped decrease burglary and improve home security (Hall, 2019). Although the creation of burglar alarms decreased the percentage of home invasions, it still had some drawbacks. Examples would be the adaption of humans, with every solution to a problem there are also new issues that arise. Burglars become more skilled and can avoid the motion detectors setting off the alarm, burglars can also disable these alarms. One of the biggest faults is also the speed in which it relays information to police, every second is valuable in a burglary. In 2010, New York Times reported that the response time in big cities tends to be longer than 45 minutes to relay information and 2-4 hours for police to arrive (Nick, 2016). Which leads to another issue, which is a false alarm. Garda Siochána receives 120k notifications of activated alarms and over 95% of those are false alarms.

(counsel, 2010) Smart home automation improves upon the traditional methods of home security. Using IoT systems catering to home automation, like Ring Alarm security kit and simplisafe home security system.

## 2.2 Raspberry Pi

Raspberry Pi is a significant part of the creation of a smart lock security system using RFID/NFC. What essentially raspberry pi is, is a functional computer with the size of a credit card. It has all the inklings of a computer, processor, memory and graphic card for HDMI output. Advantages of raspberry pi would be its easy connection ability to the internet and can be programmed in a variety of programming languages ((“Differences between Arduino and Raspberry Pi,” 2016)). These advantages are the main reason why raspberry pi is used with IoT like home automation. Generally, if projects require less hardware and more software then raspberry pi is essential.

Raspberry Pi is diverse in usability, it offers a range of tasks. It's best used for projects that require computer requirements but not much processing power. For example, it can be used to construct movement seize safety digital cameras, make retro games and digital cameras with a digital camera module. (D. Team, 2018)

### **2.2.1 Alternatives**

An alternative to Raspberry Pi is Arduino, Arduino is a microcontroller, meaning it runs one program repetitively at a time. It’s best used for loop tasks like opening doors, reading temperatures and reporting it to social media sites like twitter and driving robots. Raspberry pi was the preferred option for the project because of its ability to do the intensive calculation, multi-tasking and its more suitable for IoT based projects(Di Justo, 2015). Arduino is hardware-based while raspberry pi is more focused on software. (elprocus, 2016)

Table

|  |  |  |
| --- | --- | --- |
| **Feature** | **Raspberry Pi** | **Arduino** |
| Programming Language | No limit | Arduini, C/C++ |
| Processor Speed | 700 MHz, | 16MHz |
| Internet connection very easy | Not easy | Doable |
| Hardware design | Closed source | Open-source |
| Real-time | Hardware Realtime | In real-time |
| Analogue to Digital | No | Yes |

(elprocus, 2016)

## 2.3 Internet of Things

Smart home automation is one of the various features possible using IoT. Internet of things is a system of interrelated devices that are mechanical digital machines, computer, objects, people or animals that are provided with unique identifiers. They have the ability for data transfer over a network without the need of a human to human or human to computer interaction. IoT services as an enhancement of customer services and improved decision-making to better understand the customer (Rouse, 2019). Traditional methods of security offered control to the device based on how well it works. However, IoT enables real-time, reduced waste and energy consumption and cost-efficient. These features are essential for home security automation. Burglar alarms had a delay in relaying information to garda IoT based devices as improved communication and data transfer and the ability to access information anywhere and anytime all in one device. (Rouse, 2019)

## 2.4 Near Field Communication

NFC is seen as a contactless communication technology. Using RFID techniques for communication with other NFC devices, most smartphones and tablet are NFC enabled. Its short distance (10cm) helps for a better security system. Most NFC is used as a way of identification, tickets and room access via hotel rooms. Nowadays they are used for mobile payments. The operation of NFC is at 13.56 MHz and has stated previously uses RFID technology for communication. Two sources of power, passive and active, passive focuses on the dependence of the electromagnetic field produced by NFC reader. Whereas the action generates the electromagnetic fields that power passive devices for communication. Privacy of an NFC relies heavily on the application design. An example of this would be default settings, NFC communication is inactive when a smartphone is locked or inactive. Another example of privacy with NFC is informing a user of the actions the user is about to commit. One advantage of NFC is the transaction privacy, the independency of NFC for GPS activation in the phone and its independency of the cellular network. This assists users to be more anonymous with privacy (Kavde et al., 2017).

### **2.4.1 Security**

Security in any systems is required, and at the top priority for any product. The priority is increased with the importance of privacy. Smartphone-based payment is an example of an NFC based system that security is at topmost priority. Apple Pay and Google Pay offer additional security layers to existing NFC framework. One of the security layers that are offered is both google, and apple pay don't store the card details to a device or cloud but instead send the details to the bank the user is connected to. Card issuers send back token generated via a non-reversible cryptographic has a function. This ends up being the only number stored to a user’s device with a unique id. Security goals are to be met when it comes to making a system. Confidentiality, integrity and availability. (Giese et al., 2018)

### **2.4.2 Radio Frequency identification**

A radio-frequency identification, a technology that use a reader (radio waves) to capture digital data encoded in RFID tags. RFID process is like barcoding in relation data from a tag that is captured by a device which stores data in a database. The only difference is that RFID offers more advantages like the ability to read outside the line-of-sight. RFID is part of a group called Automatic Identification and Data Capture. This identifies objects automatically, collects the data then enters those data directly into the computer systems, all this with minimal human intervention. This is achievable using radio waves. RFID contains three components that make it all work, tag, RFID reader and antenna. The tags contain an integrated circuit and an antenna, they are used to transmit the data to the RFID reader. Radio waves are converted by the reader for a more usable form of data. The information collected then gets transferred through an interface communication to host the computer system, where it can be stored and analysed. (abr.com, 2019)

## 2.5 Data analytics

The data analytics that will be used is panda data analytics that will be collecting and displaying pattern recognition. Pattern recognition is classifying data based on a model created by training data. That then detects the characteristics and patterns. The features pattern recognition has that can be beneficial to the collection of data concerning home automation and NFC would be its ability to learn from data. The data it collects can be used to determine the pattern of a user that is allowed access to the room. (edureka, 2019)

## 2.5.1 Database

My SQL is the database will be the database that will be used for the project. MySQL is a framework utilized for the creation of web programming apps and is used for little and large applications. This is also relational database. The benefits of MYSQL is adaptable, dependable quick and open source. Other research was done, like oracle. With MYSQL its benefits suit the project. (U. Singh, 2019)

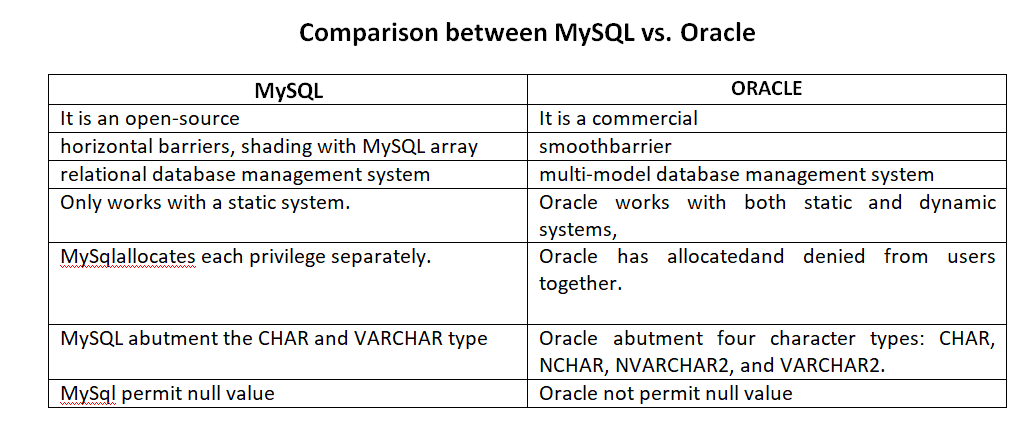


Figure 1:oracle vs MySQL

(U. Singh, 2019)

## 2.6 smart locking system for home

A study carried out by Sundaram (2016) explored a smart locking system. This study examined and purposed a solution to a common problem relating to home security with regards to lost keys and burglary. Sundaram prosed a method to solve these issues by introducing the use of a smart lock door access system that unlocked and locked doors from a smartphone via the Internet or Bluetooth access. He used facial recognition to grant access to the door and used the data collected. (Sundaram, 2016)

The incorporation facial recognition to unlock a door provides benefits that couldn’t be available using another form such as a card or phone. The advantages of facial recognition are high accuracy rates, automation and smart integration. Facial recognition can accurately determine a user trying to gain access to a home. Some software programs are more accurate than others when detecting faces from different angles. The tools involved can also be integrated into an API or SDK and other existing systems (Roux, 2019). With the automation, there is no need to answer the door because the door would be open as soon as a user with access has his/her face detected. With these advantages, it also has some disadvantages attached to it. For example, data storage and camera angels. High-quality images are required for proper facial recognition and it takes up a lot of storage to store high-quality images. With a camera, angels can result in a slower response to access room or denial of room due to how you are positioned. (R. T. I. Team, 2018).

## 2.7 Conclusion

In conclusion, with the research completed, home security has vastly improved and decreased the burglary rate. With help from IoT and its addition to home automation, this resulted with increase efficiency of home security. However smart lock projects that's been previously done, there are still features it lacks and different methods that are more effective for better security as outlined in the literature review. The research done for this project suggest that Raspberry pi would be better suited than Arduino would, as its hardware based then software based. Panda Analytics will focus on pattern recognition and SQL will be the database used to assist in the project. When examining the project, inspiration and extensive research are required when attempting to do a project of this magnitude. The purpose of this research was to expand on what has already been made. The rise of technology, many companies and final year students in the computing field have explored IoT, more specifically smart home automation for security purposes.

# Design

## 3.1 Introduction

This chapter will explore visually how the project will look. The non-functional and functional requirement will be outlined in this chapter and the relevant UML diagrams associated with the project. Storyboards will also be made for the design of the web interface.

## 3.2 Requirements

Two types of requirements exist, functional requirements and non-functional requirements. Functional requirements are features that must be implemented by a developer for the users to use. Non-functional requirements are non-mandatory features implemented by a developer.

### **3.2.1 functional requirements**

1. RFID reader must catch the NFC key.

2. The reader should collect the data into the database.

3. Admin should be able to view data of users who entered a room.

4. Admin should deny and allow access to certain users.

5. Admin should get a text message when a user attempts to access the room 3 times.

6.The web interface can only be accessed by users who have a code.

7. Led light should light green to indicate the door is opened.

### **3.2.2 non-functional requirements**

1. A buzzer will activate to indicate the door is open.

2.The web interface is visually appealing.

### **3.2.3 Hardware/Software**

Table 2

|  |  |
| --- | --- |
| Hardware | Software |
| Raspberry Pi | Python |
| LED Lights | Panda Data Analytics |
| Relay (5V, have GND, IN, PWR IOs) | MySQL |
| Speaker/buzzer | Web Development (PHP, HTML, etc) |
| RFID Reader |  |
| NFC tag & key |  |

## 3.3 UML Diagram

Unified Modelling Language, this helps visualise the architecture of a software system implementation. There is a difficulty level of writing thousands of lines of code in an application and keeping track with the relationships and hierarchies within the system. With UML diagrams divide this into subcomponents and components. (Content Team, 2019)

The benefits of UML diagrams:

1. Plan new features before programming.
2. Technical and non-technical communication is easier.
3. Navigate source code.

There are three types of UML Diagrams Behavioural Diagram, Sequence Diagram and Structural.

**Behavioural Diagram**

This focuses on the visualisation of how the system behaves and interacts with itself, users, other systems and entities. (Content Team, 2019)

**Sequence diagram**

Focuses on showing the order to which objects interact, this helps with visualising the runtime scenarios. (Content Team, 2019)

**Structural Diagram**

It focuses on how the system is structured, like classes, objects, package, etc. With the system and relationship between those elements.

From onwards the chapter will explore and display examples of the three times using the project as a base.(Content Team, 2019)

### **3.3.1 UML Case Diagram**

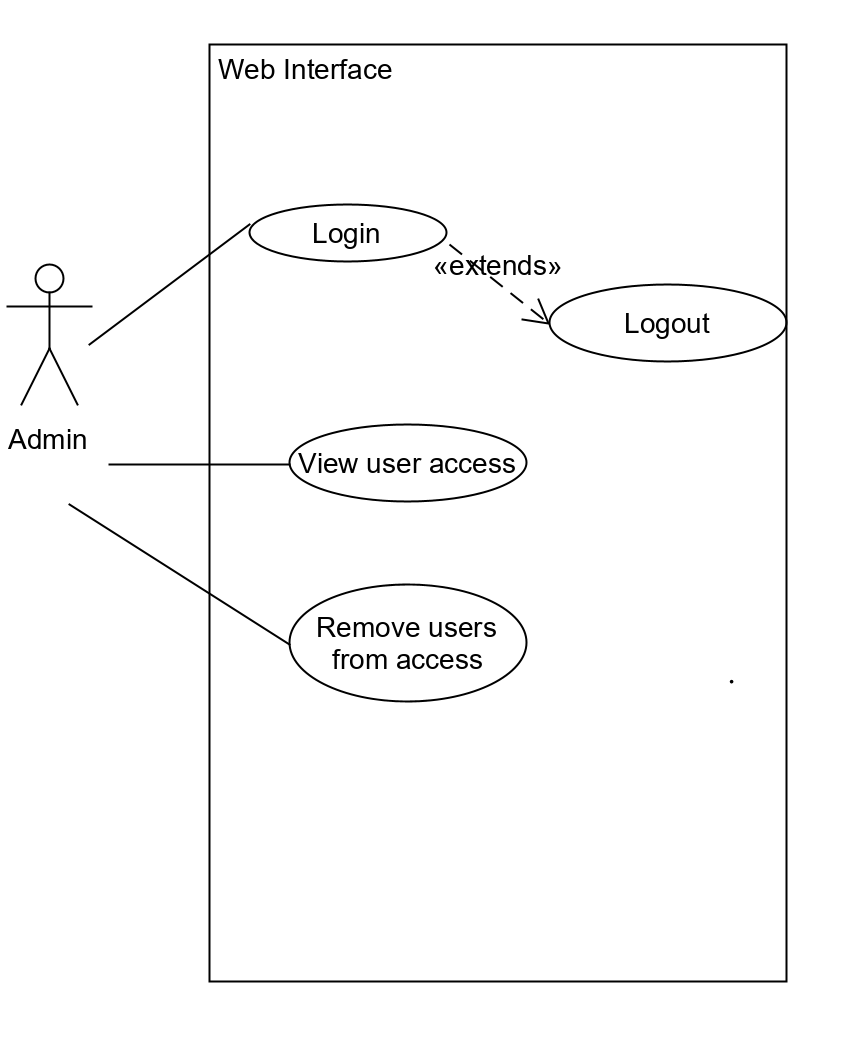


Figure 2: UML Case: Web Interface

### **3.3.2 Case Description**

Table

|  |  |
| --- | --- |
| Case | Description |
| Use Case | Log in |
| Objective | Allow admin to log in to the interface |
| Precondition | Admin can access the system |
| Main Flow | 1. Admin can access the web interface 2. Admin enters a passcode to access 3. Admin clicks login option 4. Admin has access to the system |
| Alternative Flow | 1. If Admin gets passcode wrong, display error message and allow to try again. 2. 3 attempts of incorrect passcode will prompt the user to recover passcode. |
| Post Condition | Admin can access system and use it. |

Table

|  |  |
| --- | --- |
| Case | Description |
| Use Case | Remove users |
| Objective | To deny user access to the door. |
| Precondition | Users can’t access the NFC/RFID powered door. |
| Main Flow | 1. Admin can view who has access to the door 2. Admin views list of users 3. Admin clicks on the option to remove. |
| Alternative Flow | 1. A pop up asking if you are sure you want to remove |
| Post Condition | Removed user can’t access door. |

Table

|  |  |
| --- | --- |
| Case | Description |
| Use Case | View user access |
| Objective | To view who has access |
| Precondition | Admin to view user activity |
| Main Flow | 1. Admin clicks view tab, to view the activity of users. 2. Can see most recent, the user who accesses room. |
| Alternative Flow | 1. Can click a specific user to check his/her activity. |
| Post Condition | View activity of users. |

### **3.3.3 Sequence**

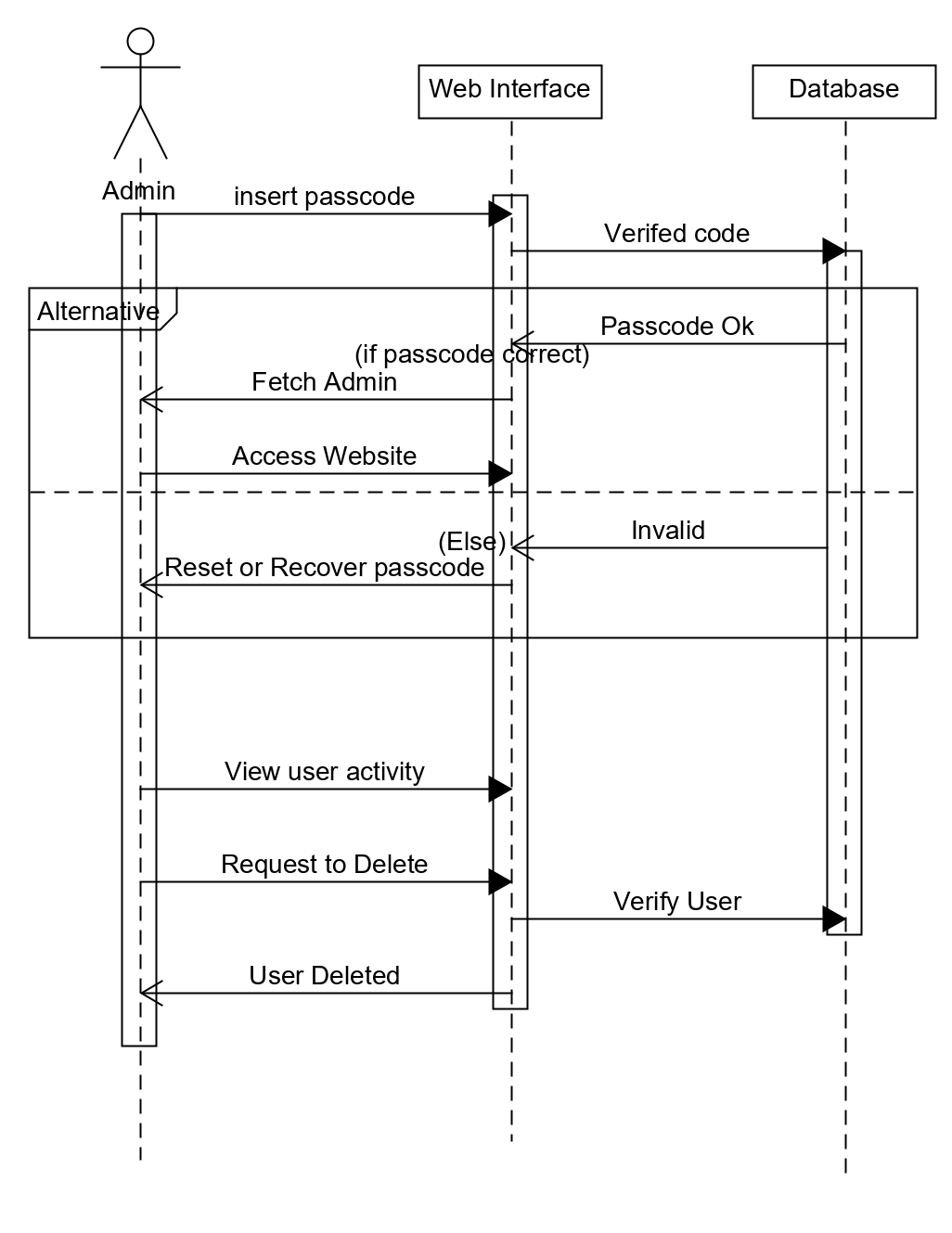


Figure 3: Sequence of Admin relationship with the website

### **3.3.4 State Machine**

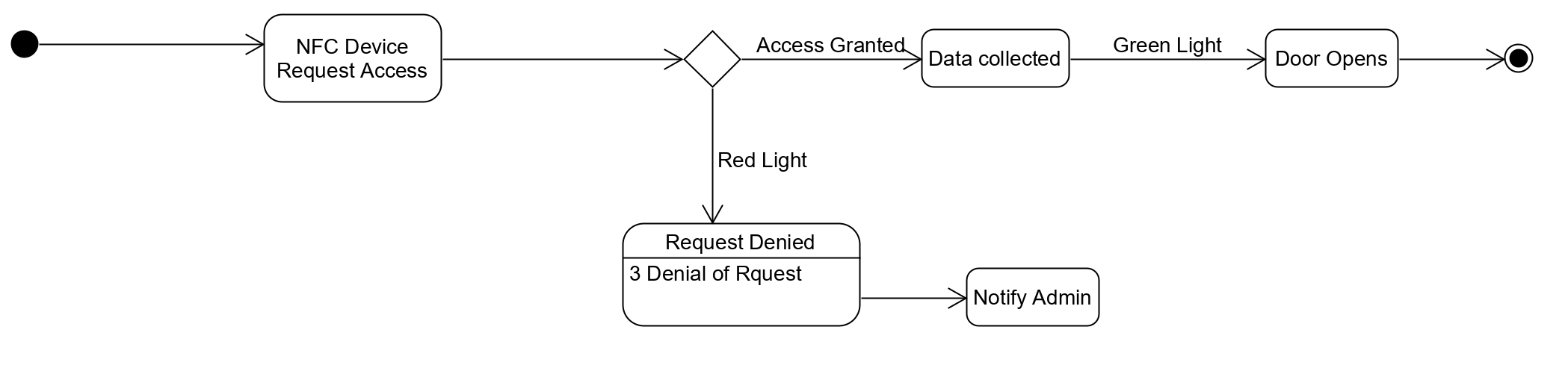


Figure 3: state machine relationship between the user and smart lock

As the figure outlines, the diagram shows the different states that are possible with the smart lock. If a user tries to access the room, there are two possible outcomes. First, a possible outcome is the user has access, second is a denial of access and 3 failed attempts results in the notifying the admin. The first outcome allows for the data collection of the user. This will display the activity log of the user to the admin when the admin accesses the web interface.

### **3.4 Storyboard**



Figure 4: Login page

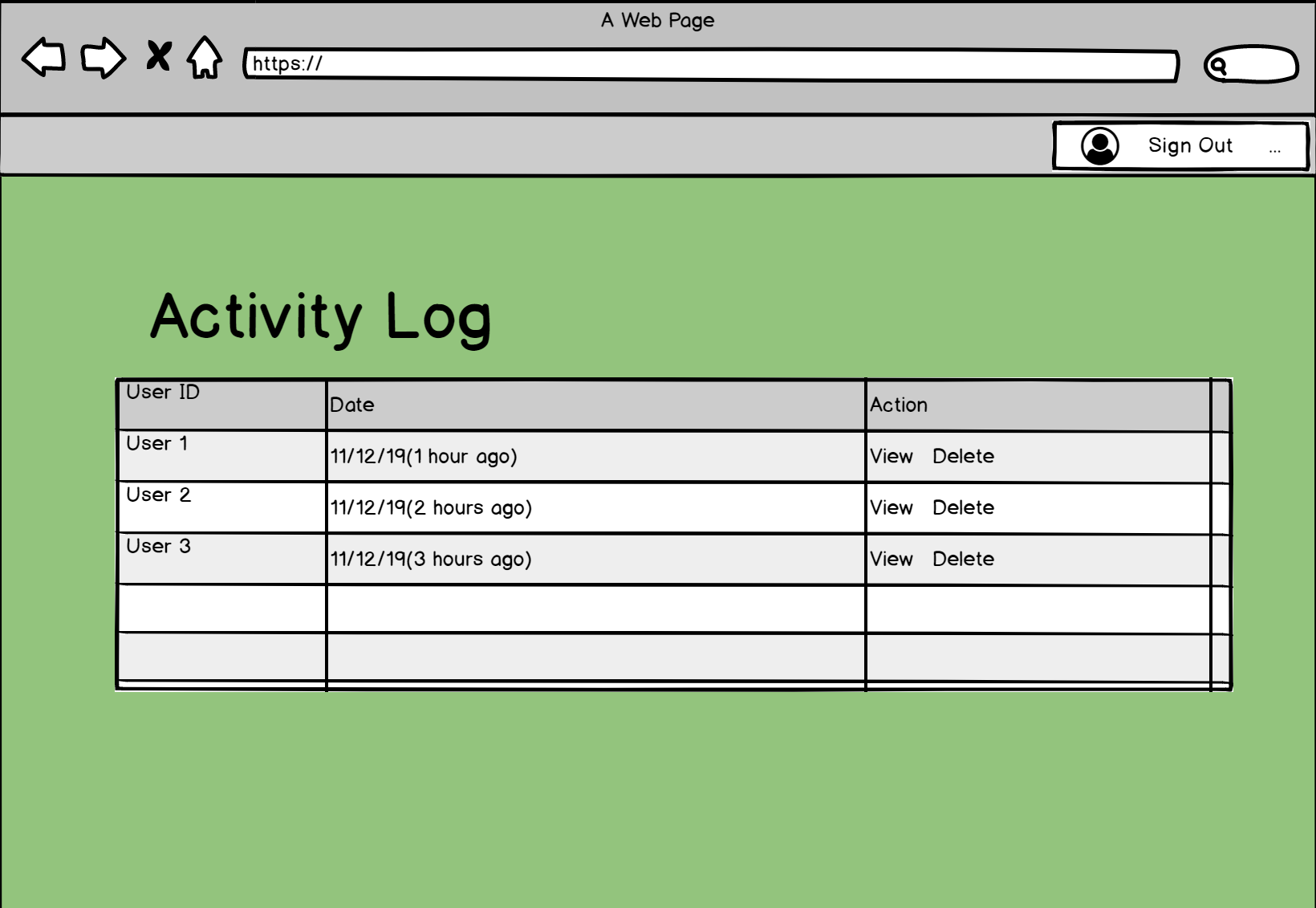


Figure 4- Home page

## 3.4 Conclusion

This chapter focuses on the design aspect of the project. Chapter 2 was the literature review which went more in-depth with previous projects and more detail what must be involved. Chapter 3 outlines the functional and non-functional requirement needed for the project to function. Since chapter 3 focused on design, chapter 3 established a UML diagram like use case diagram and use case description. These describe a function of the system and the outcome of the options selected. Lastly, the storyboard demonstrates the look of the web interface, this enables us to have an idea of how visually the project will look like before starting the development. The research and design are completed, the hardware and software have been established, the information made for both chapter 2 and 3 will lead to chapter 4.

# Implementation

## 4 Introduction

The implementation is an extension of chapter 3. This chapter will focus on and show the steps it will take to implement the project and how the artefacts will look like. This will be a detailed step on how the artefact will be developed along with the problems/ limitations faced along the process. The project is about opening a door using an RFID reader and NFC tag. This will require the implementation of Raspberry Pi and MySQL database as well as an interface for the admin to interact with.

## 4.1 setting up Raspberry PI/Installing Raspbian

The Raspberry pi is a minicomputer that allows users to learn code and complete electronic projects. The raspberry pi that Is being used is model 3, it contains one HDMI port, four usb ports, ethernet port, an audio port, a micro SD card slot and a micro usb port for the power. The sd card requires the Raspbian for the raspberry pi to work. For this project I downloaded the latest version of Raspbian for the Raspberry Pi. This file will be unzipped that will be written to the SD card. Once in the SD Card the raspberry is ready to start and access. However raspberry pi wont work unless it has the keyboard, mouse, SD card and monitor slotted in the raspberry pi.



Figure 5- Raspberry pi set up

## 4.1 Web server

For this project, it requires me to have a web server that allows the admin to register a user then displays data of the users that have access to the room. In order to achieve this goal a database must be installed into raspberry pi to fulfil the requirement.

pi@raspberrypi: ~$ sudo apt-get install mariab-server

pi@raspberrypi: ~$ sudo apt-get install apache2

pi@raspberrypi: ~$ sudo apt install php-mysql

The following code was used to install MySQL which is the first step to installing phpMyAdmin, for easier access and input of the database.

### **4.1.1 Bitvise**

Bitvise is a software used for SSH, with this program I was able to run the terminal for the raspberry pi on my laptop. This was done by enabling SSH on the pi and then using the command ifconfig to locate the IP Address and input it on the Bitvise program to access terminal via the laptop. Comparing this with putty is that when you log into the server you also have access a side by side of the server’s folder and folder of the PC in use.

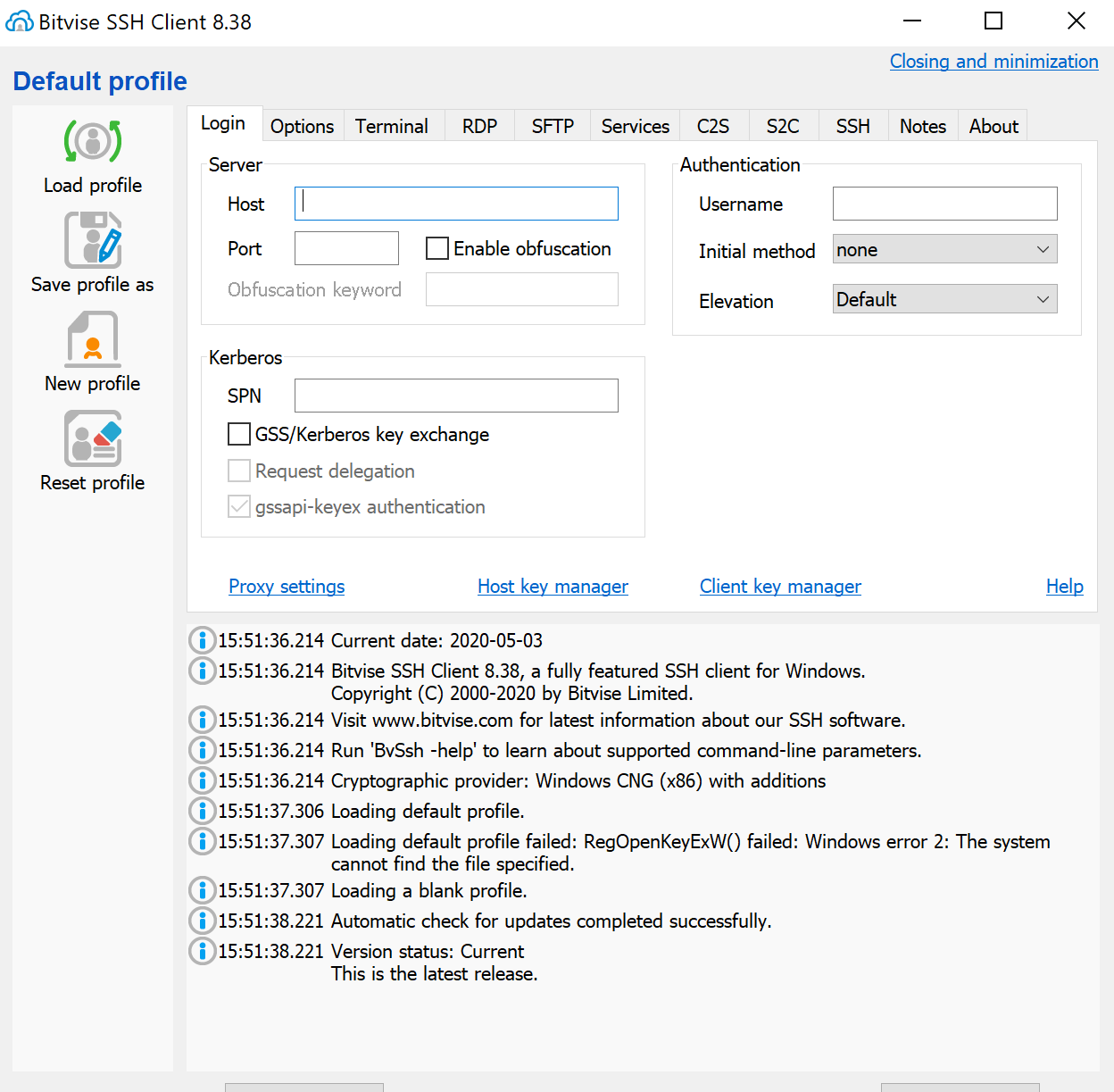


Figure 6:Bitvise

### **4.1.2 phpmyadmin**

pi@raspberrypi: ~$ sudo apt-get install phpMyAdmin

pi@raspberrypi: ~$ GRANT ALL PRIVILEGES ON \*.\* TO piproject@'localhost' IDENTIFIED BY 'projectpi' WITH GRANT OPTION;

This code will help install phpMyAdmin while configuring you will be asked to give it a root password. After doing so you will use the ip address/phpMyAdmin to access it. You will be required to put the user and password to gain access of the database. After installing phpMyAdmin configuration of apache must be done for phpymyadmin to operate. This is done by altering the apache configurations.

Using command “**nano /etc/apache2/apache2.conf**”, navigating through the file and add “**Include /etc/phpmyadmin/apache.conf**” and then restart apache.“**/etc/init.d/apache2 restart**”

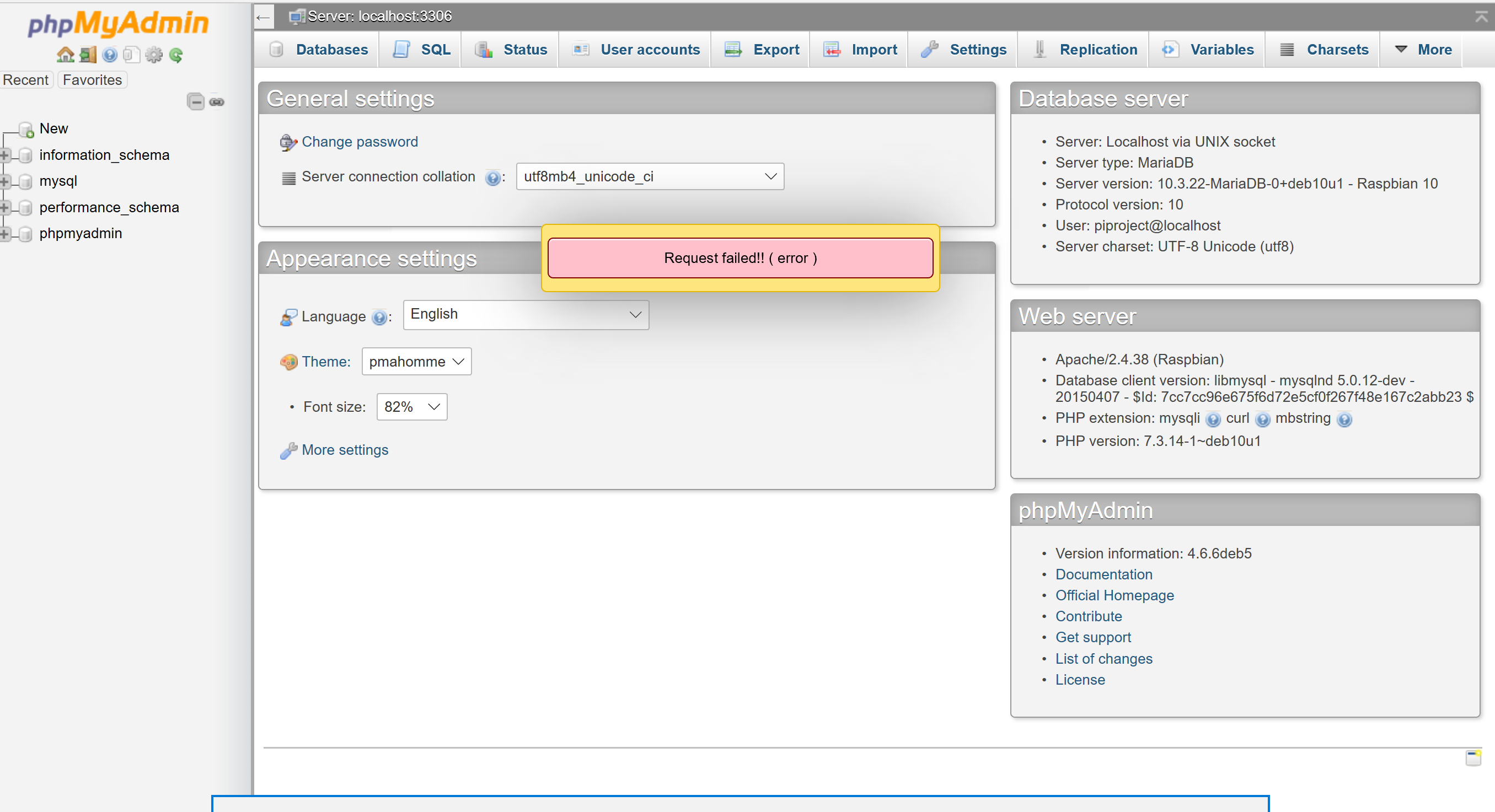


Figure 7: php my admin

### **4.1.3 Setting up RFID**

In the RFID reader there is 8 connections and will need to be wired to the raspberry pi GPIO pins directly. This requires you to connect to 7 of the GPI pins directly to reader.

* **SDA** connects to **Pin 24**.
* **SCK** connects to **Pin 23**.
* **MOSI** connects to **Pin 19**.
* **MISO** connects to **Pin 21**.
* **GND** connects to **Pin 6**.
* **RST** connects to **Pin 22**.
* **3.3v** connects to **Pin 1**.

(Gus, 2017)



(Gus, 2017)Figure 8:GPIO

The RFID being in use is RC552 and before we can utilize the RFID on the raspberry pi the SPI interface is enabled so the reader can be fully connected with the raspberry pi to allow read and writing. The file spi\_bcm2835 should be present to confirm the SPI is enabled.

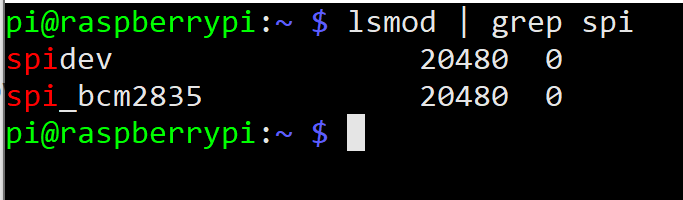


Figure 9-SPI

sudo apt-get update

sudo apt-get upgrade

sudo apt-get install python3-dev python3-pip

sudo pip3 install spidev

sudo pip3 install mfrc522

The spidev code being installed will assist with interactions with the PI and RFID and the MFRC522 handles the heavy lifting of RFID communication with the pi. Once the needed tools were downloaded, writing code the implementation of RFID reader was possible. Using Python to write and read with the RFID RC522.

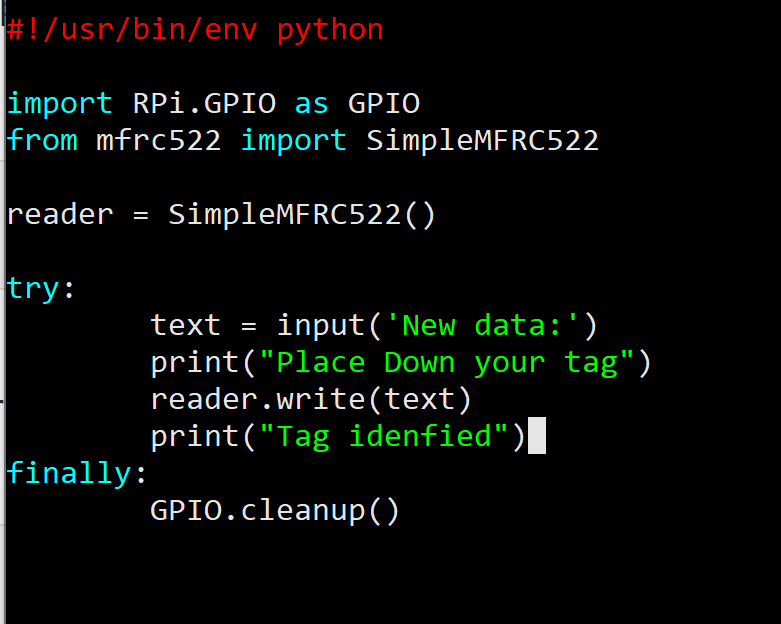


Figure 10-Writing RFID Code

### **4.1.4 Web Interface**

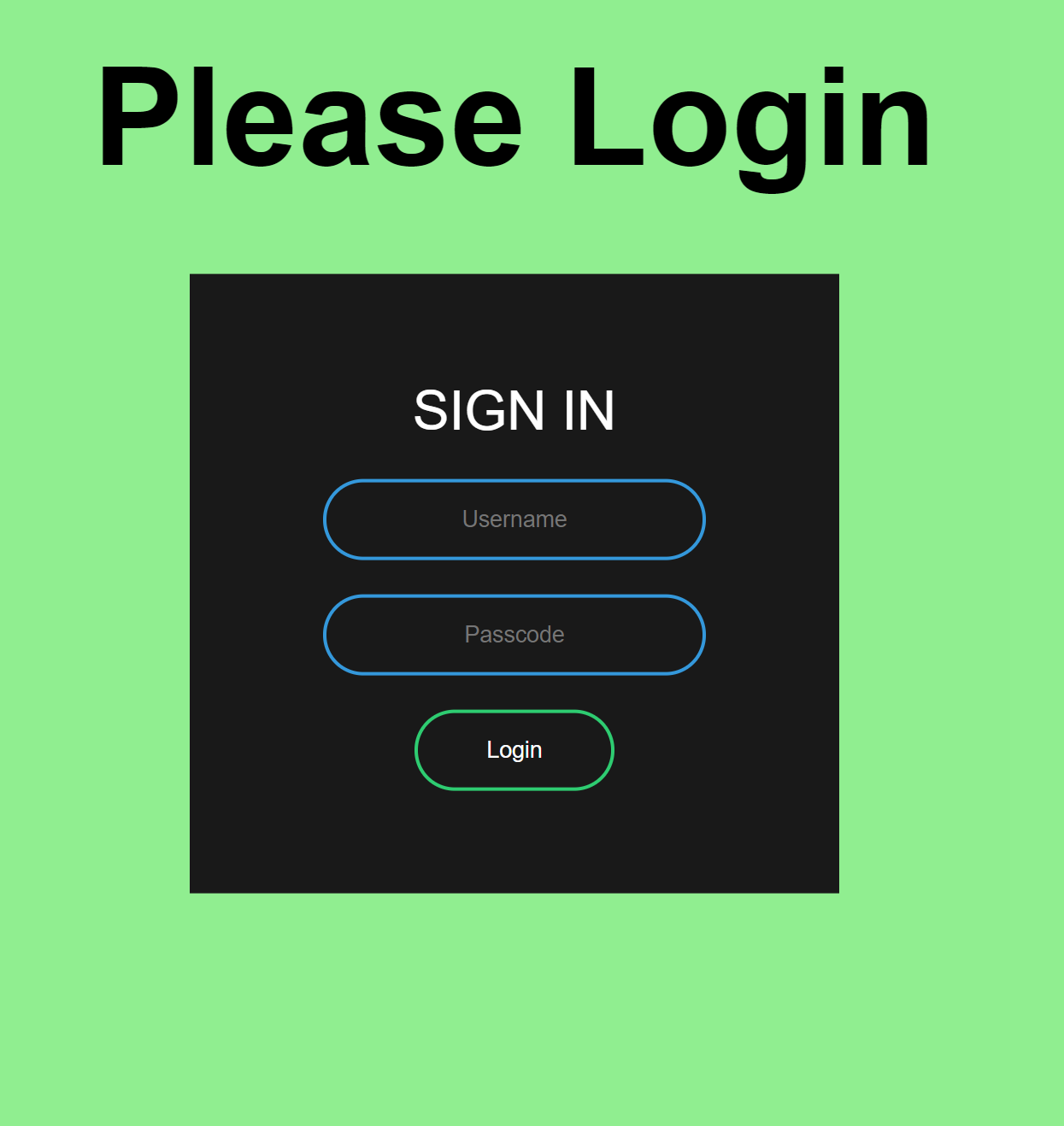


Figure 11: Implemented login page

As seen in figure 10 the login page has been implemented, somewhat resembling the initial design. Using php, html and bootstrap from w3schools, the student had to implement the code of the connection of a database to fetch and display the data in the database into the website.

$s = "select \* from loginform where username = '$name' && password = '$pass'";

Code to allow the fetching of data into the text field.

C

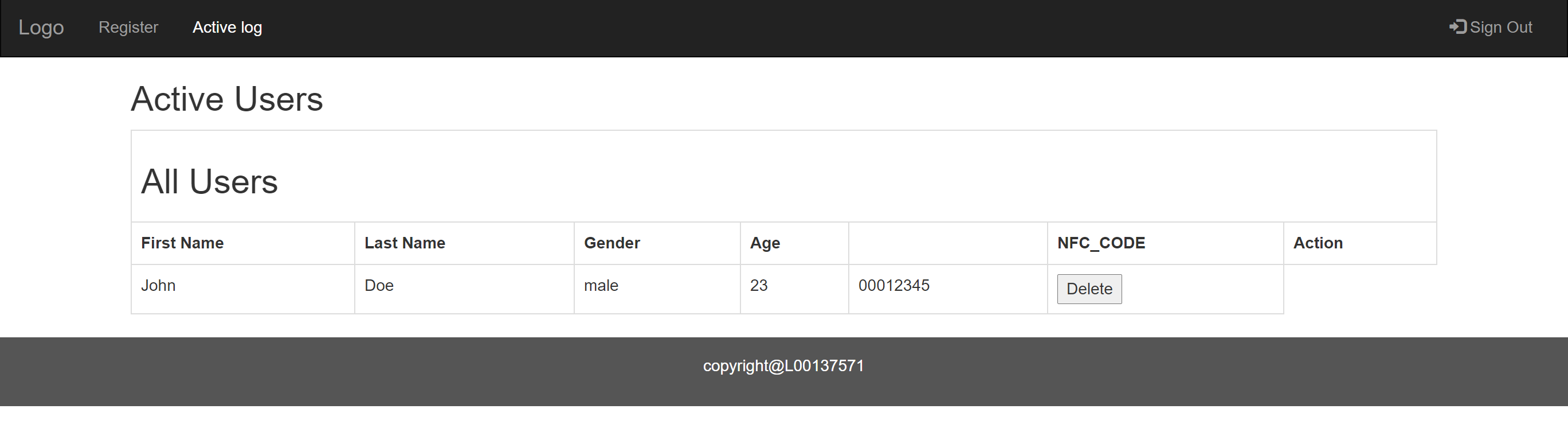


Figure 12: Implemented Home page

When admin logins using the required username and password, the webpage will be redirected to the home page. This will display every users that currently has access to the room. Also, two other tabs like active log that shows the real time data of a user having access and a register page to register the user.

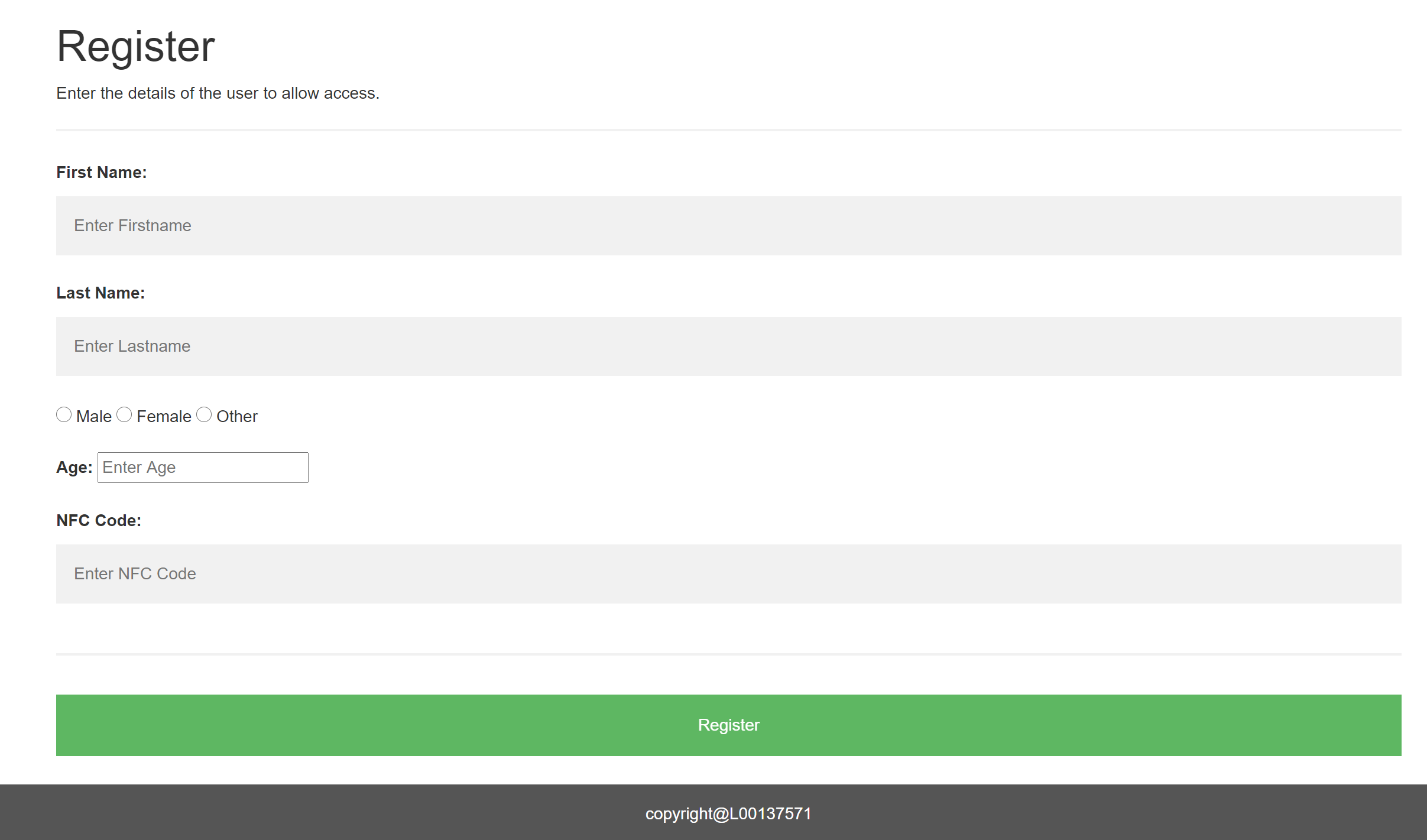


Figure 13: Register Page

register pages purpose is for the admin to create a user and input the NFC card code that the user will use to access the room. The purpose of this action is to track the users that have access and allow them to gain it.

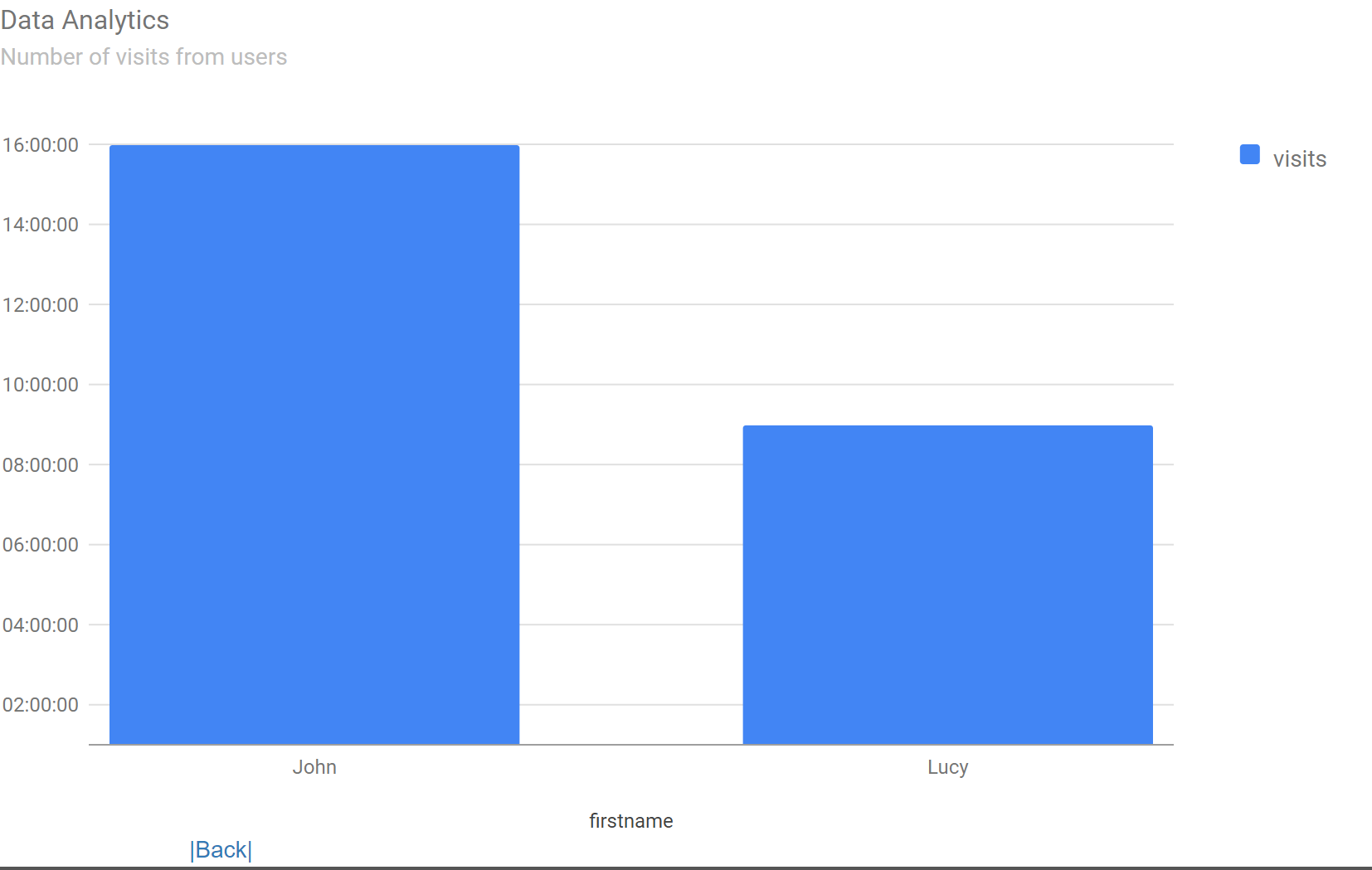


Figure : Data analytics page

This is the Data analytics page, this will be able to be accessed via the home page to view all users visiting activity, its purpose is to show the admin the amount of times a user entered the room.

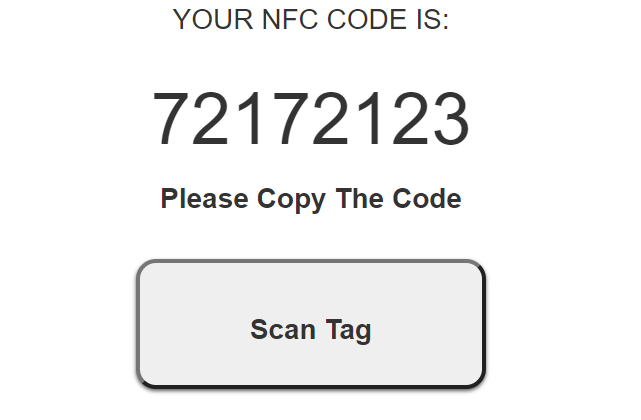


Figure : NFC Code Generator

Before the admin can Register a user to allow access, admin must scan the tag to acquire the unique NFC Code for that will be used to be stored in the database. This will keep track of users’ specific code in the home page.

## 4.2 Installing python package

1. python -m venv env

\*\*\*\*\*Where env is the name of the environment or folder where it is created. Takes a minute or 2 to create the virtual environment

1. (a) source env/bin/activate.

\*\*\*\*\*To activate the Python virtual environment on Linux or mac

            (b) env\Scripts\activate.bat.

\*\*\*\*\*\*To activate for Windows

(env) will appear indictating you are on an environment.

1. deactivate.

\*\*\*\*\*\*\*To end the virtual environment after installation of module or using and go back to where you switched from.

-----—INSTALLING AND USING PACKAGES IN PYTHON----------------

1. pip install requests

\*\*\*\*Where [requests] is the name of the package. You must have activated the environment first according to the previous topic...To upgrade pip itself if you wish, use the command:  [python -m pip install --upgrade pip]

. Now, tge package 'requests' having been installed, we can go on to make use of it in our Application because that is the beauty of installing a package so that we don't have to reinvent the wheels.

For example, myrequest\_package.py file follows:

import requests

r = requests.get('<http://google.ie>')

print (r.content)

1. pip freeze
2. pip freeze > requirements.txt

\*\*\*\* nós 2 and 3 helps you to share environments because each environment is specific. That is why it is called virtual environment \*\*\*\*\*

# 5 Test

## 5.1 Introduction

Chapter 4 is the test stage and builds on what chapter 3 started on.

This chapter will focus on the types of testing that can be done for this project. For example, exploring Blackbox and Whitebox testing and what type of testing is best suited for this project and why.

# 5.2 Testing

Testing involves the evaluation of the functionality of a software application with the intent to seek if the developed software meets the requirements. The purpose of testing is essentially finding defects associated with the software, to make sure the product is defect-free for a better-quality product. There are ways in which testing can be done, either manually, which is testing by hand or automatically, testing by tools. The approach in how you test the product is either Black box or White box testing.(Rajumar, 2015)

## 5.2.1 Black Box Testing

Black box testing focuses on expected output and the input while not knowing the internal aspect of the application and how it's being processed. The tester focuses his/her attention on the output generated in response to execution condition and input as suppose to the internal mechanism. This approach is similar in the way end-users interact, by using GUI and not code. The interaction involves giving the application input and wait for the output to get back to the user. Black box is one approach that can be very beneficial for the testing of this project. (V. Singh, 2019)

With black box testing, as previously mentioned testers don’t worry about the internal workings of the application. This results in easier creation of test case. Another benefit from black box is being able to identify GUI paths and the lack of effort that’s required for inputs when compared to writing code for unit tests. (Singh, 2019)

There were other methods like white box that were looked at when it came to the testing of this project.

## 5.2.2 White Box Testing

White Box focuses on testing internal structures or working applications. This type of testing is recommended to teams that know code, more specifically developers. With the knowledge of the code by the developer, it enables them to make changes in source code easily. The understanding of code enables for exercising code paths. The white box purpose allows for better security and the improvement of performance and reliability.(V. Singh, 2019)

One main advantage of white box testing would be the application analysis. This enables developers to evaluate the sections of the code, in every area. They can determine the relationship between the code and how it's linked.(V. Singh, 2019)

## 5.2.3 Testing Justification

The type of testing the project will use would be white box testing, one main reason would be security. The project is the improvement of home automation using NFC/RFID. Like previously mentioned, the white box allows for better security and performance.(V. Singh, 2019)

It is also suited for small scale operation while black box is more focused on larger-scale operations. Black box is a test based while white is software-based. Automation is easier for white box while black box is harder to process. Also, time consumption is less compared to black box. The features and advantages better suit the project when compared to the black box. (Singh, 2019)

## 5.3 RFID TEST

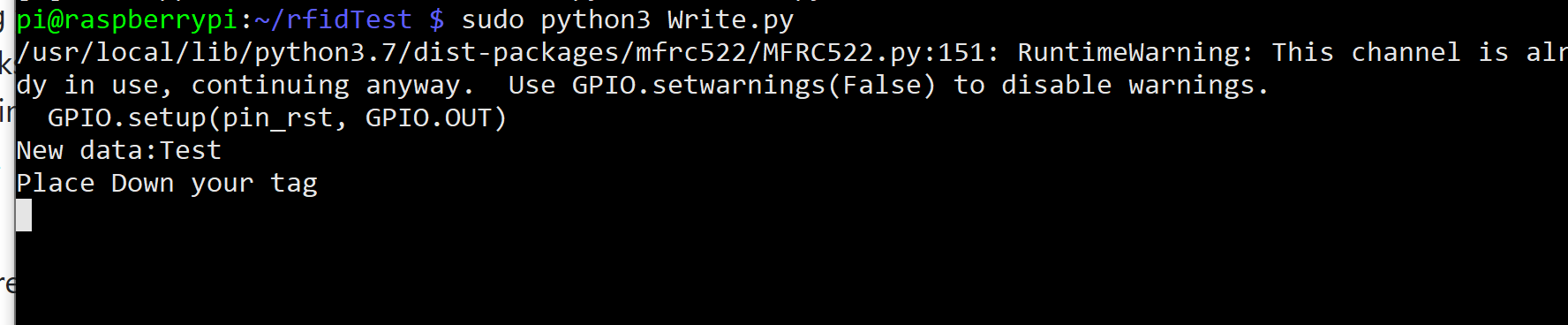


Figure 17- RFID TEST

Once the tag is placed on RFID reader, a text should be prompted, however it didn’t output the texted, indicating that the RFID reader isn’t reading the tag.

Table

|  |  |  |
| --- | --- | --- |
| **Test** | **Expected Test** | **Results** |
| RFID Reads tag | When placing the tag RFID will prompt a message saying “written” | detected the tag. |

## 5.4 Validation Testing

### **5.4.1 Login Page**

Table

|  |  |  |
| --- | --- | --- |
| **Test** | **Expected Results** | **Results** |
| Entering a Username but no Password | It will prompt you to fill in a password | It asked the user to fill in the blank field with the correct password. |
| Entering Password but not username | It will ask you to fill in the blank field with the correct username. | It asked the user to fill the blank field with the correct username. |
| Both fields are empty | It will ask to fill in the fields | It asked to fill in the fields |
| Entered the invalid Username or Password | It will refresh the page until you get correct | It refreshes the page and prompts a message. |
| Entered valid username and password. | It will take the user to the home page. | Page was directed to the home page. |

### **5.4.2 Home Page**

Table

|  |  |  |
| --- | --- | --- |
| **Test** | **Expected Results** | **Results** |
| Database of users are accurate | The database table should show the users that are stored in the database | It displayed all the users in the database. |
| Delete users | Remove access to users from access the room by delete the user from database | Admin was able to delete the user from database. |

### **5.4.3 Register Page**

|  |  |  |
| --- | --- | --- |
| **Test** | **Expected Results** | **Results** |
| Information is added to the database. | Admin successfully added the information and it was sent to database. | The inputted data was sent into the database and was displayed in the homepage. |

Table 8

### **5.4.4 Data Analytics Page**

Table

|  |  |  |
| --- | --- | --- |
| **Test** | **Expected Results** | **Results** |
| Information from the database is collected for the data analytics. | Number of visits is displayed in a bar chart. | Users number of visits are displayed in a bar chart. |

### **5.4.5 NFC Code Page**

Table

|  |  |  |
| --- | --- | --- |
| **Test** | **Expected Results** | **Results** |
| Test to see if NFC code is generated. | A unique 8-digit Code will be generated on arrival/click on button of the page. | A unique 8-digit code is generated and to be copied too in the register page to create user access. |

## 5.5 Requirement Testing

### **5.5.1 functional requirement**

Table

|  |  |
| --- | --- |
| **Test** | **Results** |
| RFID Reader Must detect NFC key | Yes |
| Reader should collect data into database | No |
| Admin should be able to view and delete users who have access to the room | Yes |
| Admin should get text message when user uses 3 attempt access | No |
| Web Server is only accessed by admin with the right code | Yes |

### **5.5.2 non-functional requirement**

Table

|  |  |
| --- | --- |
| **Test** | **Results** |
| Web interface visually appealing | Yes |
| Data analytics graph for specific user | Yes |

# 5.3 Conclusion

In conclusion, the type of testing that is available is manual and automation. Two testing approaches are white and black box testing. White box testing more suited the project because of its many advantages like security and performance. Chapter 4 focuses on the advantages of both types of testing and compared the two to best figure out which would be more suited for the project. The test results showed that most of the functional and non-functional requirements for the project did work as well as all features to the website.

# 6 Summary of Analysis

### **6.1.2 Development**

The development of this project consisted of setting up the raspberry pi and connecting the RFID reader with raspberry pi. The challenging part was working with new hardware. The second part was figuring out how to install the needed software like mysql, phpymyadmin for the web server and an SSH to allow access of the terminal through another pc. The next stage was to set up the RFID Reader, so it can Read and Write the NFC tag, If the test goes as planned then it would be possible to write code that will be incorporated with the database. This allows the user to take in the tag next to the reader so the unique id can be stored into the database for the admin to view or delete in the web interface.

Project overall was a challenge, many of the aims and objectives were meet, however the main project such as using python to implement the RFID reader didn’t corporate, in theory if the project was fully completed with every feature implemented, it would have answered the research question of improving home security using RFID/NFC .

### **6.1.3 Expected Outcome**

The expected results for this project was to enable the admin to view users who have access to the admins room. The web interface had several purposes:

* + View and delete users who have access to the room.
  + Register a user to allow access.
  + View users Data analytics to determine their behaviour.

Using phyton to code, the user with a registered NFC tag will be able to access the room. For this to work, the admin must register the user first before allowing access. This will be done by identifying the NFC tag which can be identified by the RFID reader. The users’ data will be stored in a database, their all the information like, number of visits, who the user is will be displayed in the web interface.

If the author were to do this project again, he would take the time to have all spare parts for my hardware and make sure these hardware’s aren’t prone to breakage. Also take my time with the coding process of the project to reduce mistakes

### **6.1.3 Results**

80% of the aims and objectives outlined in the research paper was satisfied. The only aim that was seen has an issue was the RFID reader. Even though the hardware wasn’t up achieved the overall idea and web interface was achieved, which I believe is much more important than the hardware, as it shows exactly what the project would have looked like if the hardware had worked. The admin was able to login and logout using the correct credentials and was able to view and delete user access has well as view the database of the user activity.

## 6.2 limitation of Research

This project was the first introduction to new technologies and languages that I had not really studied, such as python. The lack of knowledge made the process of solving issues and problems occurred in the project longer, which as a result extended the time it took to solve.

Another limitation would be the overheating, one issue that occurred during the project was the raspberry pi overheating. For the smart lock to work it would require the raspberry pi to be active, which overtime can result in overheating even with the fan. Originally the first raspberry pi bought overheated and having to replace it.

My original reader wasn’t working so I got a replacement, a USB reader. The RFID reader was able to detect the NFC tag, however I was using a USB RFID, so it was difficult to find any tutorials or examples of code that can be used to implement phyton code with the RFID reader to test reading and writing. The usual readers that many used was the original version.

## 6.3 Recommendations for Future development

There are a lot of potential for this project to move forward. This project was designed with the thought of improving security and adding into the IoT ecosystem. This project could be further implemented by using real life examples of how it works, demonstrating using a door opening because of the tag communicating to the RFID reader. Another way this project could be further developed would be the adding of behavioural user patterns to determine when a user will usually enter the room based on the data analysis used. This project intention is to replace traditional methods of locking and opening a door at home. Adding three step verification for all doors in the house would improve the security in a home. Instead of just using a tag, having the option to also use fingerprint and passcode would work. I would have also investigated having more spare parts for the hardware in case of damage when doing the project.

## 6.4 Conclusion

This project has enhanced the authors programming skills as well has project management skills. Initially writing the dissertation, the author set out aims and objectives that would be completed by the end of the project. The author was faced with a lot of obstacles, such as:

* + Not being able to run my raspberry pi at home, because of lack of WIFI, so the only solution was doing it at the college computers
  + The phpMyAdmin would not work and I had to initially manually create the database and tables for my project.
  + My raspberry pi broke and had to great a replacement.
  + USB RFID reader code I not implemented to read and write a NFC tag due to lack of code examples using USB RFID readers to detect read and write NFC tags

Most of these obstacles were overcame, however one main limit, that was highlighted in the limitation section was the hardware issues. Overall implementation was the most difficult aspect of the process for the author but has greatly improved his skills has a programmer and writer, in relation to writing the thesis. A lot was learned such has getting familiar to python and navigating through new pieces of hardware like the raspberry pi, as well as improve the web development skills of the author.

# Appendix A

## Installing mysql

pi@raspberrypi: ~$ sudo apt-get install mariab-server

pi@raspberrypi: ~$ sudo apt-get install apache2

pi@raspberrypi: ~$ sudo apt install php-mysql

## installing phpMyAdmin

pi@raspberrypi: ~$ sudo apt-get install phpMyAdmin

pi@raspberrypi: ~$ GRANT ALL PRIVILEGES ON \*.\* TO piproject@'localhost' IDENTIFIED BY 'projectpi' WITH GRANT OPTION;

nano /etc/apache2/apache2.conf

Include /etc/phpmyadmin/apache.conf

/etc/init.d/apache2 restart

## Setting up Raspbian for RFID

sudo apt-get update

sudo apt-get upgrade

sudo apt-get install python3-dev python3-pip

sudo pip3 install spidev

sudo pip3 install mfrc522

## Writing RFID Reader

#!/usr/bin/env python

import RPi.GPIO as GPIO

from mfrc522 import SimpleMFRC522

reader = SimpleMFRC522()

try:

text = input('New data:')

print("Place down your tag")

reader.write(text)

print("Tag detected")

finally:

GPIO.cleanup()

Sudo python3 Write.py

## Reading with RFID

#!/usr/bin/env python

import RPi.GPIO as GPIO

from mfrc522 import SimpleMFRC522

reader = SimpleMFRC522()

try:

id, text = reader.read()

print(id)

print(text)

finally:

GPIO.cleanup()

Sudo python3 Read.py

## Lock2.py

#!/usr/bin/env python3

import sys

import MySQLdb

from threading import Thread

import threading

import time

import RPi.GPIO as GPIO

import json

from random import randint

from evdev import InputDevice

from select import select

GPIO.setmode(GPIO.BCM)

GPIO.setwarnings(False)

GPIO.setup(13,GPIO.OUT)

try:

    # python 2

    import Tkinter as tk

    import ttk

except ImportError:

    # python 3

    import tkinter as tk

    from tkinter import ttk

class Fullscreen\_Window:

    global dbHost

    global dbName

    global dbUser

    global dbPass

    dbHost = 'localhost'

    dbName = 'DB\_NAME'

    dbUser = 'USER'

    dbPass = 'PASSWORD'

    def \_\_init\_\_(self):

        self.tk = tk.Tk()

        self.tk.title("Three-Factor Authentication Security Door Lock")

        self.frame = tk.Frame(self.tk)

        self.frame.grid()

        self.tk.columnconfigure(0, weight=1)

        self.tk.attributes('-zoomed', True)

        self.tk.attributes('-fullscreen', True)

        self.state = True

        self.tk.bind("<F11>", self.toggle\_fullscreen)

        self.tk.bind("<Escape>", self.end\_fullscreen)

        self.tk.config(cursor="none")

        self.show\_idle()

        t = Thread(target=self.listen\_rfid)

        t.daemon = True

        t.start()

    def show\_idle(self):

        self.welcomeLabel = ttk.Label(self.tk, text="Please Present\nYour Token")

        self.welcomeLabel.config(font='size, 20', justify='center', anchor='center')

        self.welcomeLabel.grid(sticky=tk.W+tk.E, pady=210)

    def pin\_entry\_forget(self):

        self.validUser.grid\_forget()

        self.photoLabel.grid\_forget()

        self.enterPINlabel.grid\_forget()

        count = 0

        while (count < 12):

            self.btn[count].grid\_forget()

            count += 1

    def returnToIdle\_fromPINentry(self):

        self.pin\_entry\_forget()

        self.show\_idle()

    def returnToIdle\_fromPINentered(self):

        self.PINresultLabel.grid\_forget()

        self.show\_idle()

    def returnToIdle\_fromAccessGranted(self):

        GPIO.output(13,GPIO.LOW)

        self.SMSresultLabel.grid\_forget()

        self.show\_idle()

    def returnToIdle\_fromSMSentry(self):

        self.PINresultLabel.grid\_forget()

        self.smsDigitsLabel.grid\_forget()

        count = 0

        while (count < 12):

            self.btn[count].grid\_forget()

            count += 1

        self.show\_idle()

    def returnToIdle\_fromSMSentered(self):

        self.SMSresultLabel.grid\_forget()

        self.show\_idle()

    def toggle\_fullscreen(self, event=None):

        self.state = not self.state  # Just toggling the boolean

        self.tk.attributes("-fullscreen", self.state)

        return "break"

    def end\_fullscreen(self, event=None):

        self.state = False

        self.tk.attributes("-fullscreen", False)

        return "break"

    def listen\_rfid(self):

        global pin

        global accessLogId

        keys = "X^1234567890XXXXqwertzuiopXXXXasdfghjklXXXXXyxcvbnmXXXXXXXXXXXXXXXXXXXXXXX"

        dev = InputDevice('/dev/input/event0')

        rfid\_presented = ""

        while True:

            r,w,x = select([dev], [], [])

            for event in dev.read():

                if event.type==1 and event.value==1:

                        if event.code==28:

                            dbConnection = MySQLdb.connect(host=dbHost, user=dbUser, passwd=dbPass, db=dbName)

                            cur = dbConnection.cursor(MySQLdb.cursors.DictCursor)

                            cur.execute("SELECT \* FROM access\_list WHERE rfid\_code = '%s'" % (rfid\_presented))

                            if cur.rowcount != 1:

                                self.welcomeLabel.config(text="ACCESS DENIED")

                                # Log access attempt

                                cur.execute("INSERT INTO access\_log SET rfid\_presented = '%s', rfid\_presented\_datetime = NOW(), rfid\_granted = 0" % (rfid\_presented))

                                dbConnection.commit()

                                time.sleep(3)

                                self.welcomeLabel.grid\_forget()

                                self.show\_idle()

                            else:

                                user\_info = cur.fetchone()

                                userPin = user\_info['pin']

                                self.welcomeLabel.grid\_forget()

                                self.validUser = ttk.Label(self.tk, text="Welcome\n %s!" % (user\_info['name']), font='size, 15', justify='center', anchor='center')

                                self.validUser.grid(columnspan=3, sticky=tk.W+tk.E)

                                self.image = tk.PhotoImage(file=user\_info['image'] + ".gif")

                                self.photoLabel = ttk.Label(self.tk, image=self.image)

                                self.photoLabel.grid(columnspan=3)

                                self.enterPINlabel = ttk.Label(self.tk, text="Please enter your PIN:", font='size, 18', justify='center', anchor='center')

                                self.enterPINlabel.grid(columnspan=3, sticky=tk.W+tk.E)

                                pin = ''

                                keypad = [

                                    '1', '2', '3',

                                    '4', '5', '6',

                                    '7', '8', '9',

                                    '\*', '0', '#',

                                ]

                                # create and position all buttons with a for-loop

                                # r, c used for row, column grid values

                                r = 4

                                c = 0

                                n = 0

                                # list(range()) needed for Python3

                                self.btn = list(range(len(keypad)))

                                for label in keypad:

                                    # partial takes care of function and argument

                                    #cmd = partial(click, label)

                                    # create the button

                                    self.btn[n] = tk.Button(self.tk, text=label, font='size, 18', width=4, height=1, command=lambda digitPressed=label:self.codeInput(digitPressed, userPin, user\_info['sms\_number']))

                                    # position the button

                                    self.btn[n].grid(row=r, column=c, ipadx=10, ipady=10)

                                    # increment button index

                                    n += 1

                                    # update row/column position

                                    c += 1

                                    if c > 2:

                                        c = 0

                                        r += 1

                                # Log access attempt

                                cur.execute("INSERT INTO access\_log SET rfid\_presented = '%s', rfid\_presented\_datetime = NOW(), rfid\_granted = 1" % (rfid\_presented))

                                dbConnection.commit()

                                accessLogId = cur.lastrowid

                                self.PINentrytimeout = threading.Timer(10, self.returnToIdle\_fromPINentry)

                                self.PINentrytimeout.start()

                                self.PINenteredtimeout = threading.Timer(5, self.returnToIdle\_fromPINentered)

                            rfid\_presented = ""

                            dbConnection.close()

                        else:

                            rfid\_presented += keys[ event.code ]

    def codeInput(self, value, userPin, mobileNumber):

        global accessLogId

        global pin

        global smsCodeEntered

        pin += value

        pinLength = len(pin)

        self.enterPINlabel.config(text="Digits Entered: %d" % pinLength)

        if pinLength == 6:

            self.PINentrytimeout.cancel()

            self.pin\_entry\_forget()

            if pin == userPin:

                pin\_granted = 1

            else:

                pin\_granted = 0

            # Log access attempt

            dbConnection = MySQLdb.connect(host=dbHost, user=dbUser, passwd=dbPass, db=dbName)

            cur = dbConnection.cursor()

            cur.execute("UPDATE access\_log SET pin\_entered = '%s', pin\_entered\_datetime = NOW(), pin\_granted = %s, mobile\_number = '%s' WHERE access\_id = %s" % (pin, pin\_granted, mobileNumber, accessLogId))

            dbConnection.commit()

            if pin == userPin:

                self.PINresultLabel = ttk.Label(self.tk, text="Thank You, Now\nPlease Enter Code\nfrom SMS\n")

                self.PINresultLabel.config(font='size, 20', justify='center', anchor='center')

                self.PINresultLabel.grid(columnspan=3, sticky=tk.W+tk.E, pady=20)

                self.smsDigitsLabel = ttk.Label(self.tk, text="Digits Entered: 0", font='size, 18', justify='center', anchor='center')

                self.smsDigitsLabel.grid(columnspan=3, sticky=tk.W+tk.E)

                smsCode = self.sendSMScode(mobileNumber)

                smsCodeEntered = ''

                keypad = [

                    '1', '2', '3',

                    '4', '5', '6',

                    '7', '8', '9',

                    '', '0', '',

                ]

                # create and position all buttons with a for-loop

                # r, c used for row, column grid values

                r = 4

                c = 0

                n = 0

                # list(range()) needed for Python3

                self.btn = list(range(len(keypad)))

                for label in keypad:

                    # partial takes care of function and argument

                    #cmd = partial(click, label)

                    # create the button

                    self.btn[n] = tk.Button(self.tk, text=label, font='size, 18', width=4, height=1, command=lambda digitPressed=label:self.smsCodeEnteredInput(digitPressed, smsCode))

                    # position the button

                    self.btn[n].grid(row=r, column=c, ipadx=10, ipady=10)

                    # increment button index

                    n += 1

                    # update row/column position

                    c += 1

                    if c > 2:

                        c = 0

                        r += 1

                self.SMSentrytimeout = threading.Timer(60, self.returnToIdle\_fromSMSentry)

                self.SMSentrytimeout.start()

            else:

                self.PINresultLabel = ttk.Label(self.tk, text="Incorrect PIN\nEntered!")

                self.PINresultLabel.config(font='size, 20', justify='center', anchor='center')

                self.PINresultLabel.grid(sticky=tk.W+tk.E, pady=210)

                self.PINenteredtimeout.start()

    def smsCodeEnteredInput(self, value, smsCode):

        global smsCodeEntered

        global accessLogId

        smsCodeEntered += value

        smsCodeEnteredLength = len(smsCodeEntered)

        self.smsDigitsLabel.config(text="Digits Entered: %d" % smsCodeEnteredLength)

        if smsCodeEnteredLength == 6:

            self.SMSentrytimeout.cancel()

            self.pin\_entry\_forget()

            if smsCodeEntered == smsCode:

                smscode\_granted = 1

            else:

                smscode\_granted = 0

            # Log access attempt

            dbConnection = MySQLdb.connect(host=dbHost, user=dbUser, passwd=dbPass, db=dbName)

            cur = dbConnection.cursor()

            cur.execute("UPDATE access\_log SET smscode\_entered = '%s', smscode\_entered\_datetime = NOW(), smscode\_granted = %s WHERE access\_id = %s" % (smsCodeEntered, smscode\_granted, accessLogId))

            dbConnection.commit()

            if smsCodeEntered == smsCode:

                self.SMSresultLabel = ttk.Label(self.tk, text="Thank You,\nAccess Granted")

                self.SMSresultLabel.config(font='size, 20', justify='center', anchor='center')

                self.SMSresultLabel.grid(columnspan=3, sticky=tk.W+tk.E, pady=210)

                self.PINresultLabel.grid\_forget()

                self.smsDigitsLabel.grid\_forget()

                GPIO.output(13,GPIO.HIGH)

                self.doorOpenTimeout = threading.Timer(10, self.returnToIdle\_fromAccessGranted)

                self.doorOpenTimeout.start()

            else:

                self.PINresultLabel.grid\_forget()

                self.smsDigitsLabel.grid\_forget()

                self.SMSresultLabel = ttk.Label(self.tk, text="Incorrect SMS\nCode Entered!")

                self.SMSresultLabel.config(font='size, 20', justify='center', anchor='center')

                self.SMSresultLabel.grid(sticky=tk.W+tk.E, pady=210)

                self.SMSenteredtimeout = threading.Timer(10, self.returnToIdle\_fromSMSentered)

                self.SMSenteredtimeout.start()

    def sendSMScode(self, mobileNumber):

        # Retreive our Twilio access credentials and "from" number

        dbConnection = MySQLdb.connect(host=dbHost, user=dbUser, passwd=dbPass, db=dbName)

        cur = dbConnection.cursor(MySQLdb.cursors.DictCursor)

        cur.execute("SELECT account\_sid, auth\_token, twilio\_sms\_number FROM twilio\_api\_credentials WHERE id = 1")

        credentials = cur.fetchone()

        account\_sid = credentials['account\_sid']

        auth\_token = credentials['auth\_token']

        twilio\_sms\_number = credentials['twilio\_sms\_number']

        dbConnection.close()

        smsCode = str(randint(100000, 999999))

        messageText = "Your access code is %s. Please enter this on the touchscreen to continue." % smsCode

        client = Client(account\_sid, auth\_token)

        message = client.messages.create(

            to=mobileNumber,

            from\_=twilio\_sms\_number,

            body=messageText)

        return smsCode

if \_\_name\_\_ == '\_\_main\_\_':

    w = Fullscreen\_Window()

    w.tk.mainloop()

(Freeman-Powell, 2020)

# Appendix B: Website

## Home page

<!DOCTYPE html>

<html lang="en">

<head>

  <title>Smart Lock GUI</title>

  <meta charset="utf-8">

  <meta name="viewport" content="width=device-width, initial-scale=1">

  <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css">

  <script src="https://ajax.googleapis.com/ajax/libs/jquery/3.4.1/jquery.min.js"></script>

  <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/js/bootstrap.min.js"></script>

  <style>

    /\* Remove the navbar's default margin-bottom and rounded borders \*/

    .navbar {

      margin-bottom: 0;

      border-radius: 0;

    }

    /\* Set height of the grid so .sidenav can be 100% (adjust as needed) \*/

    .row.content {height: 450px}

    /\* Set gray background color and 100% height \*/

    .sidenav {

      padding-top: 20px;

      background-color: #f1f1f1;

      height: 100%;

    }

    /\* Set black background color, white text and some padding \*/

    footer {

      background-color: #555;

      color: white;

      padding: 15px;

    }

    /\* On small screens, set height to 'auto' for sidenav and grid \*/

    @media screen and (max-width: 767px) {

      .sidenav {

        height: auto;

        padding: 15px;

      }

      .row.content {height:auto;}

    }

  </style>

</head>

<body>

<nav class="navbar navbar-inverse">

  <div class="container-fluid">

    <div class="navbar-header">

      <button type="button" class="navbar-toggle" data-toggle="collapse" data-target="#myNavbar">

        <span class="icon-bar"></span>

        <span class="icon-bar"></span>

        <span class="icon-bar"></span>

      </button>

      <a class="navbar-brand" href="#">Logo</a>

    </div>

    <div class="collapse navbar-collapse" id="myNavbar">

      <ul class="nav navbar-nav">

      </ul>

      <ul class="nav navbar-nav navbar-right">

        <li><a href="#"><span class="glyphicon glyphicon-log-in"></span> Sign Out</a></li>

      </ul>

    </div>

  </div>

</nav>

<?php

$connection = mysqli\_connect("localhost","piproject","youarewelcome1");

$db = mysqli\_select\_db($connection, 'piP');

if(isset($\_POST['delete']))

{

  $idDel = mysqli\_real\_escape\_string($connection, $\_POST['idDel']);

  $sql ="DELETE FROM access\_list where user\_id = $idDel";

  if(mysqli\_query($connection,$sql))

  {

      header('Location: home.php');

  }

  else{

    echo 'query error:'. mysqli\_error($connection);

  }

}

 ?>

<div class="container">

    <h2>Active Users</h2>

    <p>Users that have access</p>

    <table class="table table-bordered">

      <thead>

        <tr>

          <th>ID</th>

          <th>Name</th>

          <th>image</th>

          <th>rfid\_code<th>

          <th>pin</th>

          <th>sms\_number</th>

          <th>action</th>

        </tr>

      </thead>

      <tbody>

      <?php

      $connection = mysqli\_connect("localhost","piproject","youarewelcome1");

      $db = mysqli\_select\_db($connection, 'smart\_door');

      $query = "SELECT \* FROM `access\_list`  \n". "ORDER BY `access\_list`.`user\_id` ASC";

      $query\_run = mysqli\_query($connection, $query);

while($row = mysqli\_fetch\_array($query\_run))

{

      ?>

        <tr>

          <td><?php echo $row['user\_id']; ?></td>

          <td><?php echo $row['name']; ?></td>

          <td><?php echo $row['image']; ?></td>

          <td><?php echo $row['rfid\_code']; ?></td>

          <td><?php echo $row['pin']; ?></td>

          <td><?php echo $row['sms\_number']; ?></td>

          <td>

            <form action="home.php" method="POST">

            <input type="hidden" name="idDel" value="<?php echo $row['user\_id'];?>">

            <input type="submit" name="delete" value="Delete" class="btn- brand z-depth-0">

          </form></td>

        </tr>

    <?php

}

?>

    </table>

  </div>

</table>

  </div>

<footer class="container-fluid text-center">

  <p>copyright@L00137571</p>

</footer>

</body>

</html>

## Action.php

    <?php

session\_start();

$con = mysqli\_connect('localhost', 'root', '');

mysqli\_select\_db($con, 'demo');

$user = $\_POST['user'];

$pass = $\_POST['pass'];

$s = "select \* from login where username = '$user' && password = '$pass'limit 1";

$result = mysqli\_query($con, $s);

if(mysqli\_num\_rows($result)==1)

{

    header('location:home.php');

    exit();

}

else {

    header('location:login.php?error=1');

}

?>

## Login.php

<!DOCTYPE html>

<html>

<head>

<meta name="viewport" content="width=device-width, initial-scale=1">

<link href="login.css"rel="stylesheet" type="text/css">

</head>

<body>

    <h2>Welcome Admin </h2>

    <form action="action.php" method="POST">

      <div class="imgcontainer">

        <img src="img-avatar.jpg" alt="Avatar" class="avatar">

      </div>

      <div class="container">

        <label ><b>Username</b></label>

        <input type="text" name="user" id="user" required>

        <label><b>Password</b></label>

        <input type="password" name="pass" id="pass" required>

        <button type="submit" value="pass" id="btn">Login</button>

      </div>

      </div>

    </form>

    </body>

    </html>

## Register.php

<!DOCTYPE html>

<html lang="en" dir="ltr">

   <head>

    <meta charset="utf-8">

    <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css">

  <script src="https://ajax.googleapis.com/ajax/libs/jquery/3.4.1/jquery.min.js"></script>

  <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/js/bootstrap.min.js"></script>

    <title>Register page</title>

    <style>

\* {box-sizing: border-box}

/\* Add padding to containers \*/

.container {

  padding: 16px;

}

/\* Full-width input fields \*/

input[type=text]{

  width: 100%;

  padding: 15px;

  margin: 5px 0 22px 0;

  display: inline-block;

  border: none;

  background: #f1f1f1;

}

input[type=text]:focus{

  background-color: #ddd;

  outline: none;

}

/\* Overwrite default styles of hr \*/

hr {

  border: 1px solid #f1f1f1;

  margin-bottom: 25px;

}

/\* Set a style for the submit/register button \*/

.registerbtn {

  background-color: #4CAF50;

  color: white;

  padding: 16px 20px;

  margin: 8px 0;

  border: none;

  cursor: pointer;

  width: 100%;

  opacity: 0.9;

}

.registerbtn:hover {

  opacity:1;

}

/\* Remove the navbar's default margin-bottom and rounded borders \*/

.navbar {

      margin-bottom: 0;

      border-radius: 0;

    }

    /\* Set height of the grid so .sidenav can be 100% (adjust as needed) \*/

    .row.content {height: 450px}

    /\* Set gray background color and 100% height \*/

    .sidenav {

      padding-top: 20px;

      background-color: #f1f1f1;

      height: 100%;

    }

    /\* Set black background color, white text and some padding \*/

    footer {

      background-color: #555;

      color: white;

      padding: 15px;

    }

    /\* On small screens, set height to 'auto' for sidenav and grid \*/

    @media screen and (max-width: 767px) {

      .sidenav {

        height: auto;

        padding: 15px;

      }

      .row.content {height:auto;}

    }

</style>

  </head>

  <body><nav class="navbar navbar-inverse">

  <div class="container-fluid">

    <div class="navbar-header">

      <button type="button" class="navbar-toggle" data-toggle="collapse" data-target="#myNavbar">

        <span class="icon-bar"></span>

        <span class="icon-bar"></span>

        <span class="icon-bar"></span>

      </button>

      <a class="navbar-brand" href="home.php">Logo</a>

    </div>

    <div class="collapse navbar-collapse" id="myNavbar">

      <ul class="nav navbar-nav">

      <li><a href="register.php">Register</a></li>

        <li><a href="#">Active log</a></li>

      </ul>

      <ul class="nav navbar-nav navbar-right">

        <li><a href="login.php"><span class="glyphicon glyphicon-log-in"></span> Sign Out</a></li>

      </ul>

    </div>

  </div>

</nav>

<form action="actReg.php" method="POST">

  <div class="container">

    <h1>Register</h1>

    <p>Enter the details of the user to allow access.</p>

 <?php

     /\*   if(isset($\_GET['error'])==true)

        {

            echo '<p align="center">Data not Saved</p>';

        }

  ?>

   <?php

        if(isset($\_GET['success'])==true)

        {

            echo '<p align="center">Data Saved</p>';

        }\*/

  ?>

    <hr>

    <label  for= "firstName"><b>First Name:</b></label>

    <input type="text" placeholder="Enter Firstname" name="firstName"  required>

    <label for=lastName ><b>Last Name:</b></label>

    <input type="text" placeholder="Enter Lastname" name="lastName" required>

    <input type="radio" name="gender" value="male" required> Male

    <input type="radio" name="gender" value="female"  required> Female

    <input type="radio" name="gender" value="other"  required> Other<br><br>

    <label for ="age"><b>Age:</b></label>

    <input type="number" placeholder="Enter Age" name="age"  required><br><br>

    <label  for="nfc"><b>NFC Code:</b></label>

    <input type="text" placeholder="Enter NFC Code" name="nfc"  required>

    <hr>

    <button type="submit" class="registerbtn" name="submit"value ="submit">Register</button>

  </div>

</form>

  </body>

  <footer class="container-fluid text-center">

  <p>copyright@L00137571</p>

</footer>

</html>

## regAct.php

<?php

$servername = "localhost";

$username = "root";

$password = "";

$dbname = "demo";

// Create connection

$conn = new mysqli($servername, $username, $password, $dbname);

// Check connection

if ($conn->connect\_error) {

    die("Connection failed: " . $conn->connect\_error);

}

if(isset($\_POST['submit']))

{

 $firstname = ($\_POST['firstName']);

 $lastname = ($\_POST['lastName']);

 $gender = ($\_POST['gender']);

 $age = ($\_POST['age']);

 $nfc\_code = ($\_POST['nfc']);

$sql = "INSERT INTO users (firstname,lastname,gender,age,nfc\_code)

VALUES ('$firstname','$lastname','$gender','$age','$nfc\_code')";

if ($conn->query($sql) === TRUE)

{

    echo "New record created successfully";

    header("location:home.php");

}

else

{

    echo "Error: " . $sql . "<br>" . $conn->error;

}

$conn->close();

}

?>

## Login.css

body {font-family: Arial, Helvetica, sans-serif;}

form {border: 3px solid #f1f1f1;}

input[type=text], input[type=password] {

  width: 100%;

  padding: 12px 20px;

  margin: 8px 0;

  display: inline-block;

  border: 1px solid #ccc;

  box-sizing: border-box;

}

button {

  background-color: #4CAF50;

  color: white;

  padding: 14px 20px;

  margin: 8px 0;

  border: none;

  cursor: pointer;

  width: 100%;

}

button:hover {

  opacity: 0.8;

}

.cancelbtn {

  width: auto;

  padding: 10px 18px;

  background-color: #f44336;

}

.imgcontainer {

  text-align: center;

  margin: 24px 0 12px 0;

}

img.avatar {

  width: 40%;

  border-radius: 50%;

}

.container {

  padding: 16px;

}

span.psw {

  float: right;

  padding-top: 16px;

}

/\* Change styles for span and cancel button on extra small screens \*/

@media screen and (max-width: 300px) {

  span.psw {

     display: block;

     float: none;

  }

  .cancelbtn {

     width: 100%;

  }

}

## dataanalytics.php

<?php

$connection = mysqli\_connect("localhost","root","","demo");

$results = mysqli\_query($connection, "SELECT \* FROM users");

?>

<!DOCTYPE html>

<html lang="en">

<html>

  <head>

  <title>Smart Lock GUI</title>

    <script type="text/javascript" src="https://www.gstatic.com/charts/loader.js"></script>

    <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css">

  <script src="https://ajax.googleapis.com/ajax/libs/jquery/3.4.1/jquery.min.js"></script>

  <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/js/bootstrap.min.js"></script>

  <style>

    /\* Remove the navbar's default margin-bottom and rounded borders \*/

    .navbar {

      margin-bottom: 0;

      border-radius: 0;

    }

    /\* Set height of the grid so .sidenav can be 100% (adjust as needed) \*/

    .row.content {height: 450px}

    /\* Set gray background color and 100% height \*/

    .sidenav {

      padding-top: 20px;

      background-color: #f1f1f1;

      height: 100%;

    }

    /\* Set black background color, white text and some padding \*/

    footer {

      background-color: #555;

      color: white;

      padding: 15px;

    }

    /\* On small screens, set height to 'auto' for sidenav and grid \*/

    @media screen and (max-width: 767px) {

      .sidenav {

        height: auto;

        padding: 15px;

      }

      .row.content {height:auto;}

    }

  </style>

  </head>

  <body>

    <div id="columnchart\_material" style="width: 800px; height: 500px;"></div>

    <div class ="container">

    <a href="javascript:history.back()">|Back|</a>

    <script type="text/javascript">

      google.charts.load('current', {'packages':['bar']});

      google.charts.setOnLoadCallback(drawChart);

      function drawChart() {

        var data = google.visualization.arrayToDataTable([

          ['firstname', 'visits'],

          <?php

          if(mysqli\_num\_rows($results) > 0)

          {

              while($row = mysqli\_fetch\_array($results))

              {

                  echo "['".$row['firstname']."', ['".$row['visits']."']],";

              }

          }

          ?>

        ]);

        var options = {

          chart: {

            title: 'Data Analytics',

            subtitle: ' Number of visits from users',

          }

        };

var chart = new google.charts.Bar(document.getElementById('columnchart\_material'));

        chart.draw(data, google.charts.Bar.convertOptions(options));

      }

    </script>

    </div>

  </body>

  <footer class="container-fluid text-center">

  <p>copyright@L00137571</p>

</footer>

</html>

## ScanNFC.php

<!DOCTYPE html>

<html lang="en">

<head>

  <title>Smart Lock GUI</title>

  <meta charset="utf-8">

  <meta name="viewport" content="width=device-width, initial-scale=1">

  <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css">

  <script src="https://ajax.googleapis.com/ajax/libs/jquery/3.4.1/jquery.min.js"></script>

  <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/js/bootstrap.min.js"></script>

  <style>

    /\* Remove the navbar's default margin-bottom and rounded borders \*/

    .navbar {

      margin-bottom: 0;

      border-radius: 0;

    }

    /\* Set height of the grid so .sidenav can be 100% (adjust as needed) \*/

    .row.content {height: 450px}

    /\* Set gray background color and 100% height \*/

    .sidenav {

      padding-top: 20px;

      background-color: #f1f1f1;

      height: 100%;

    }

    /\* Set black background color, white text and some padding \*/

    footer {

      background-color: #555;

      color: white;

      padding: 15px;

    }

    /\* On small screens, set height to 'auto' for sidenav and grid \*/

    @media screen and (max-width: 767px) {

      .sidenav {

        height: auto;

        padding: 15px;

      }

      .row.content {height:auto;}

    }

    input {

    width:175px;

    height:65px;

    margin:20px auto;

    border-radius:10px;

    -webkit-border-radius:10px;

    box-shadow:0 1px 2px #5e5d5b;

    text-align: center;

    line-height: 65px;

}

  </style>

</head>

<body>

<nav class="navbar navbar-inverse">

  <div class="container-fluid">

    <div class="navbar-header">

      <button type="button" class="navbar-toggle" data-toggle="collapse" data-target="#myNavbar">

        <span class="icon-bar"></span>

        <span class="icon-bar"></span>

        <span class="icon-bar"></span>

      </button>

      <a class="navbar-brand" href="home.php">Logo</a>

    </div>

    <div class="collapse navbar-collapse" id="myNavbar">

      <ul class="nav navbar-nav">

      <li><a href="register.php">Register</a></li>

        <li><a href="activelog.php">Active log</a></li>

        <li><a href="scanNFC.php">NFC Code</a></li>-->

      </ul>

      <ul class="nav navbar-nav navbar-right">

        <li><a href="login.php"><span class="glyphicon glyphicon-log-in"></span> Sign Out</a></li>

      </ul>

    </div>

  </div>

</nav>

<?php

if(isset($\_POST['code']))

{

 echo "<div style='text-align:center'>";

    $a1 = rand(100,999);

    $a2 = rand(100,999);

    $a3 = rand(10,90);

    echo "<p >YOUR NFC CODE IS: "."<h1>$a2"."$a2"."$a3</h1></p>";

    echo "<b>Please Copy The Code<b>";

  echo  "</div>";

}

?>

<div class="container">

<form action="scanNFC.php" method="POST">

<div style="text-align:center">

<input type="submit" name="code" value="CLICK ME">

</div>

</form>

</div>

<footer class="container-fluid text-center">

  <p>copyright@L00137571</p>

</footer>

</body>

</html>

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