RFID Based Security Control Access System Using Raspberry Pi

Clarence Francis, Student, Fr.C.R.I.T, Vashi, India, clarancefrancis24@gmail.com

Jemima Thavakumar, Student, Fr.C.R.I.T, Vashi, India, jemimajtk99@gmail.com

Jini Elizaba Biju, Student, Fr.C.R.I.T, Vashi, India, jinubiju123@gmail.com

Noel Rao, Student, Fr.C.R.I.T, Vashi, India, noeljksn@gmail.com

Vaishnav Manoj, Student, Fr.C.R.I.T, Vashi, India, vvm602@gmail.com

Pushpa US, Asst. Professor, Fr.C.R.I.T, Vashi, India, pushpaus@fcrit.ac.in

Abstract - The term 'security' has become an utmost priority for human beings. Every upgradation in this security based technologies promises to be much better than its base prototype by providing unique features and stern security. RFID based security solutions proves to be a pre-eminent technology in the field of security due to its uncomplicated and simple working that provides resilient security which is far more better than the conventionally approached manual and tokens based security system. These conventional security systems proves to be in efficient with providing little or no safety whereas the RFID technology employs cryptography and radio-waves based communication to provide maximum protection. So, this system is efficient and reduces cost by automating processes and improving utilisation of assets and quality. The scalability of this system to real time requirement is done in our Project. The main reason people install at their business premises is to keep their property and valuable safe.This technology of RFID automates the data collection and displays in the dashboard created. This dashboard keeps on getting updated as in when the student's enter and exit. This technique vastly minimizes the human effort and errors in attendance tracking.

Keywords — cloud storage, dashboard, IoT, real-time application, RFID, security and access control

I. INTRODUCTION AND MOTIVATION

A. Background

In today's time its an utmost priority for people to keep their valuables safe so to address that priority we have come up with a solution in our project by interfacing RFID and Raspberry Pi Attendance system needs to implement at many places, university for students and in the other areas such as industries for login – logout times for employees. RFID based attendance system used in school, college, university and company. Main use of RFID project is to take automatically attendance of school students or employees. New technologies supported to have good technique and minimize human errors. Therefore, it is specially to use efficient and modern systems, waste of time and energy could be averted.

B. Problem Overview

The main reason people install at their business premises is to keep their property and valuable safe. So in this project, we are developing one such security system using RFID. This technology of RFID automates the data collection and vastly minimizes the human effort and errors. It also removes potential safety concerns that come with the manual security measures/solutions. Here in this project this interfaced technology will be installed at the door entrance so that whenever any student enters the premises(lab to be more precise) the respective authorities will be notified of the same and also apart from several other parameters can also be monitored using the cloud technology and the Wi-Fi module.

C. Problem Statement and Proposed Solution

Considering the security threat for robbery and manual way of taking attendance a solution was proposed to get accurate results in this field. After conducting an elaborate literature survey and studying about existing methods and technologies, a decision of making a Security Access System using RFID was formulated. The implication of this system is that this system is cheaper to maintain and more efficient in comparison to the manually operated type systems. The electronic circuit was built with all its peripherals, Python code was also written for the Raspberry Pi to function and at the end it was implemented.

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D. Primary Objectives of the Project

1. To study about the emerging new technologies such as RFID and NFC which can help us to make a more secured system.
2. To develop a working model of a Security Access Control System using RFID Technology.
3. To make a real-time database using Cloud Storage which helps in storing the data of the students entered and exited.

II. LITERATURE REVIEW

A. Related work

In [1], Umar Farooq et al. (2014) describes the design of RFID based security system for the use in the student hostels. This prototype combines the RFID technology and bio-metrics along with the 8051 Micro-controller to accomplish the task. When the RFID reader which is installed at the entrance of hostel detects a number on the Identity Card, the system captures the user image and scans the database for a match. If both the card and the captured image belong to a registered user, access is granted; otherwise the system turns on the alarm. Also, it makes an emergency call to the security van through the GSM modem, which is installed for better security. In this way, the suspicious persons can be caught. From this paper, we get to know about the use of RFID technology to automate various processes ranging from industrial sector to home control. Here, the security system is comprised of three modules which are Entrance monitoring, Exit monitoring and Mess monitoring. These modules communicate to the computer system through main controller. After the information from these modules is processed by the computer, the control commands are issued to the modules for granting or denying access to the user.

In [2], Peter Adole et al. (2016) designed a prototype which is cheaper to maintain and more efficient when compared with a manually operated key lock system. This system can be useful in providing security for homes, organizations and automobile terminals to increase the level of security. Here, RFID is integrated with GSM Technology with the help of 8051 Micro-controller. The electronic circuit was implemented, the codes for Micro- controller were written in assembly language, debugged and compiled using the KEIL Micro vision 4 integrated development environment. We can see that the resultant Hex files were programmed into the memories of the Micro-controllers with the aid of a universal programmer. Hardware simulation was carried out using the Proteus Virtual System Modelling (VSM) version 8.0.

In [3], D. Santhi Priya et al. (2016) deals with face detection for an attendance recorder system for the purpose of maintaining attendance details of the students using Raspberry Pi. The faces of the students are pre-stored in class databases. Raspberry pi camera captures the student face and compares it to the database image. If the image gets matched, it means that the student attendance registers with time. The absentees faces will be send to the authorized mail id. This method is secure enough, reliable and available for installing the system in the classroom. It can be constructed using a camera and computer. There is a need to use some techniques that can recognized the faces in veil to improve the system performance.

In [4], Pradeep Kumar et al. (2017) made use of Biometric Authentication. Now days, Bio-metrics is used in many real time applications. However, recognizing fingerprints in Linux based embedded computers (Raspberry Pi) is still a very complex problem. This entire work is done on the Linux based embedded computer called Raspberry Pi, in which database creation,fingerprint reader access, authentication, recognition and fine tuning has to be done to improve the accuracy of the system and developing the system for real time higher end application development using cloud created are done.

In [5], N.Vaitheeka et al. (2018) made use of RFID and IoT (Internet of Things). Both of them were combined due to which attendance can be taken automatically and there is no need to do it by lecturer's manually. Here, the Cloud is used as the storage to enhance the performance as shown in Figure 1. After detecting the RFID of student identity card, the data is stored. So that's why, they have used Wi-Fi adapter to connect to the Cloud. So by using the adapter, the data is transferred from the reader to the Cloud. Using IOT and Cloud, the relevant data can be accessed from anywhere and anytime which will provide the users better ability and flexibility. From Figure1, we can see that the real-time updation of the entry and exit of the students are updated.

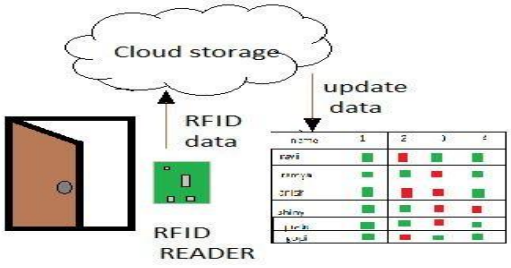

Figure 1: Cloud storage Architecture [5]

In [6], Orji EZ (2018) designed an automatic RFID-based access control system using Arduino.This system combines RFID technology and Arduino to perform the required task.When the RFID reader installed at the entrance detects an RFID tag, the system captures the user unique identifier (UID) and compares it with the stored UID for a match. If the user UID captured match with any of the stored UID, access is granted; otherwise access is denied. The results clearly show that the system is cheap, effective, and a reliable means of granting or denying access in a secured environment.

In [7], Joseph Dedy Irawan, Emmalia Adriantantri and Akh Farid (2018) made use of RFID utilization in education.

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Here, Student attendance monitoring system is made by using Internet of Things (IOT) and Cloud technology. It will produce a real time attendance monitoring system that can be accessed by various parties, such as lecturer, campus administration and parents. With this monitoring system if there are students who are not present can be immediately discovered and can be taken immediate action and the learning process can run smoothly.

B. Implementation Platform

1. Jupyter Notebook

Jupyter Notebook is a very powerful platform to showcase data science projects interactively and without any mess. It is a notebook where you customize the code cells with headings, output windows and cells. Jupyter is an open-source and free software. Jupyter supports many programming languages within it like Python, R Studio, and others.

2. Python Programming Language

Python is the most preferred programming language used. Python is a high-level programming language which supports object-oriented approach to solve complex tasks. Python's design philosophy emphasizes code readability with its notable use of significant indentation. Python is dynamically-typed and garbage-collected.

The features of Python are as follows:

- **Simple to write and grasp** - Because of its user-friendly syntax, Python is comparatively easier than its other programming counterparts even for beginners.
- **Multifaceted** - Python supports object-oriented programming, structured programming and Functional programming which gives versatility to the code.
- **Open Source Community support** - As Python is an open source software, it has a great developer community support. This ensures that major bugs, if any, are never left unresolved by the Python Community [8].

3. Raspbian Operating System

An operating system is the set of basic programs and utilities that make your Raspberry Pi run. However, Raspbian provides more than a pure OS: it comes with over 35,000 packages, pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi.We downloaded the Raspbian OS in the laptop initially and using the etcher software we burnt the OS onto a 16 GB SD Card. That SD Card was inserted on the Raspberry Pi and later on it's installations were carried out [9].

4. Docklight Software

Docklight software for the testing,analysis and simulation tool for serial communication protocols.It allows you to monitor the serial communication between two serial devices or test the serial communication of a single device so here we have used this software to test the serial communication of the RFID Reader module on the laptop [10].

III. IMPLEMENTATION PROCESS

A. Requirements

The requirements for the practical software implementation include Python version 3, Anaconda as the Python IDE (for Jupyter Notebook) and Raspbian OS 64 bit.

B. Block Diagram of the System

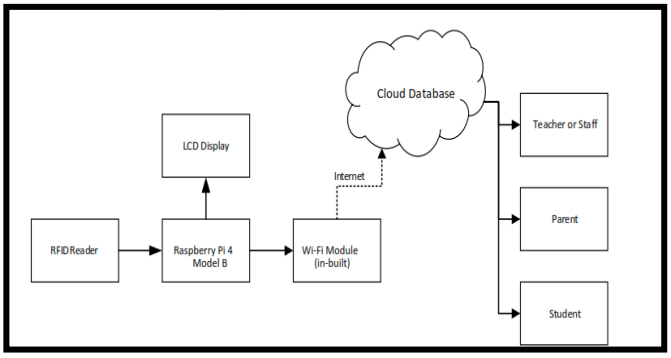

Figure 2: Simplified Block diagram of the Proposed System

As shown in Figure 2, it represents the primary objective of the project. The main components used in our Project are Raspberry Pi, RFID Reader, LCD Display and the RFID Tags. When the RFID reader will be installed at the door each individual person will be given RFID tag which contains a unique RFID password. In such a situation, whenever a person will enter from the door, containing the password which is present in the memory of Raspberry Pi would be allowed to enter and subsequently the information about the person's absence or presence could be accessed by the authorities and parents using the cloud technology and wifi module.

C. Flow Chart

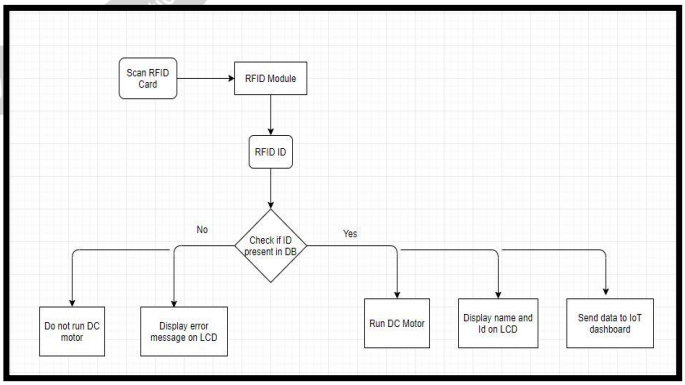

Figure 3: Flowchart of the Project

D. Process Flow

The implementation process can be divided and performed in three phases as follows:

- Setting up the Raspbian OS
- Using the Docklight software for Serial Communication
- Execution of Source Code
- Setting up of Dashboard

E. Hardware Implementation

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HDMI which stands for High Definition Multimedia is an interface or port for transmitting high definition digital video and audio data between devices. The RAM Size of the Raspberry Pi is 1GB whereas the Flash Memory Installed Size is 256 MB. Raspberry Pi also have 2xMicro-HDMI ports. The RFID Reader can operate on Low Power. It has a reading distance of about 10 cm, which mainly depends on the Tag and it varies from Tag to Tag. As shown in Figure 4 and 5, we have connected a few HDMI and USB Cables to the Raspberry Pi. We have also interfaced the RFID Reader Module with the Raspberry Pi. Thus, we make use of the HDMI Cable to view the output on the Television or Computer Screen.

Figure 4: Connection of Raspberry Pi 4 to HDMI and USB Cables

Figure 5: Interfacing of RFID Reader Module to the Raspberry Pi

F. Software Implementation

The password on the tag is displayed on the Raspbian (Viewed on Television) when the card was tapped on the RFID reader.The password was already stored in the tag. For each different tag, unique password is allocated. Thus, one cannot enter the Premises without having a proper RFID Tag as shown in Figure 6.

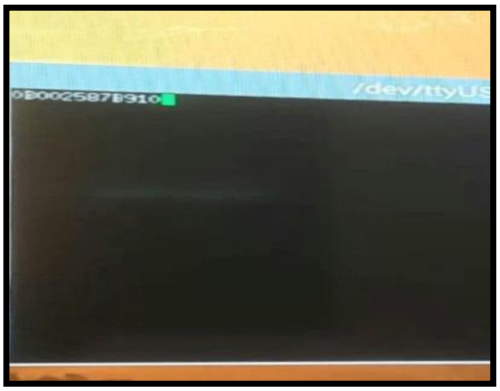

Figure 6: Communication between Raspberry Pi and RFID Reader Module

Docklight software acts as the testing,analysis and simulation tool for serial communication protocols. The Password of the Tag that is displayed in the Docklight Software when the RFID Reader Module was connected to the laptop using a DB9 to USB cable through Serial Communication as shown in Figure 7.

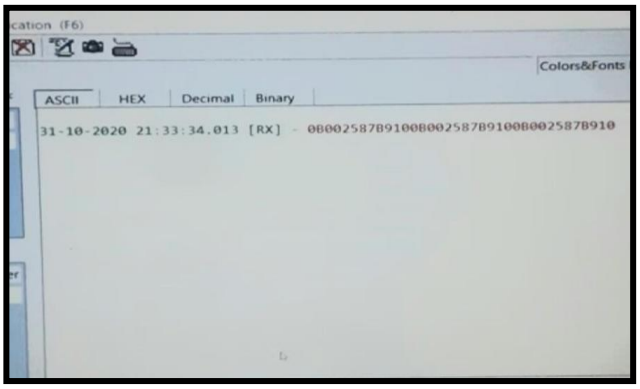

Figure 7: Serial Communication of RFID Module using Docklight Software

In this part of the program it shows the mechanism of checking the incoming Id that has been scanned against the reader and with the ID which is already present in the data base as shown in Figure 8. If the ID matches it will display the name and will mark that person present and vice versa. Thus, using a while loop, we get the required outputs.

```
# import sys
# import pydevd;pydevd.settrace("192.168.0.102", port=5678)
total_no_students = len(data['database'])

while True:
    id_found = False
    lcd_string("Please scan your", 0x80)
    lcd_string("card", 0xC0)
    count = count + 1
    out_data = dict()
    scanned_id = get_rfid_id()

    for i in range(len(data['database'])):
        for name, id in data['database'][i].items():
            name = data['database'][i]['Name']
            id = data['database'][i]['ID']
            if scanned_id == id:
                id_found = True
                out_data["S.No"] = str(count)
                out_data["Name"] = name
                out_data["ID"] = id
                out_data['DateTime'] = datetime.datetime.now().isoformat()
```

Figure 8: Part of Source code which shows the while loop and for loop

In Figure 9, it is shown the part of the code that works behind the Id's don't match and will not grant access to this particular person. Thus, the authorized person can only be allowed to enter a restricted premise using the relevant Id.

```
                out_data['DateTime'] = datetime.datetime.now().isoformat()
                iot_data = json.dumps(out_data)
                client.publish(topic, iot_data, 0)
                print("Data sent")
                lcd_string(str(name), 0x80)
                lcd_string("Marked Present", 0xC0)
                start_motor()
                time.sleep(3)
                break

    if not id_found:
        out_data["S.No"] = str(count)
        out_data["Name"] = "Unknown"
        out_data["ID"] = scanned_id
        out_data['DateTime'] = datetime.datetime.now().isoformat()
        iot_data = json.dumps(out_data)
        client.publish(topic, iot_data, 0)
        print("Data sent")
        lcd_string("Not Registered", 0x80)
```

Figure 9: Part of Source code which shows the continuation of the while loop

In Figure 10, it shows the database where the name of the students along with their Id is stored in the Raspberry Pi

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which can be accessed by the official authorities. Using similar syntax, many names can be stored, as Raspberry Pi has a lot of storage capacity.

```
{
"database": [
    {
        "Name": "James Smith",
        "ID": "4B00449579E"
    },
    {
        "Name": "Michael Smith",
        "ID": "270017A0B62"
    },
    {
        "Name": "Robert Smith",
        "ID": "270017A0128"
    }
]
```

Figure 10: Part of Source code which shows the information stored in the Database

The part of the code in Figure 11 is for controlling the movement of the motor in order to allow entry for the valid students and simultaneously not allow entry for the invalid students.

```
setup_motor()
lcd_init()

lcd_string("Starting", 0x80)
lcd_string("Motor", 0xC0)
time.sleep(2)
start_motor()
lcd_string("Stopping", 0x80)
lcd_string("Motor", 0xC0)
time.sleep(2)

lcd_display(0x01, False)
GPIO.cleanup()
"""
```

Figure 11: Part of Source code which shows the setting up of motor

IV. RESULTS & DISCUSSION

As shown in Figure 12, when the circuit will be powered ON the Raspberry Pi will initially display a message "Swipe the card" on the LCD display. When the RFID card is swiped against the RFID reader, it will detect the ID card and it sends the unique card number to the Raspberry Pi via the Serial Terminal. With suitable programming we compare the received card number with the data that is actually stored in the Cloud Storage. As a result, the door is opened for the pre-defined command, otherwise the door will not open.

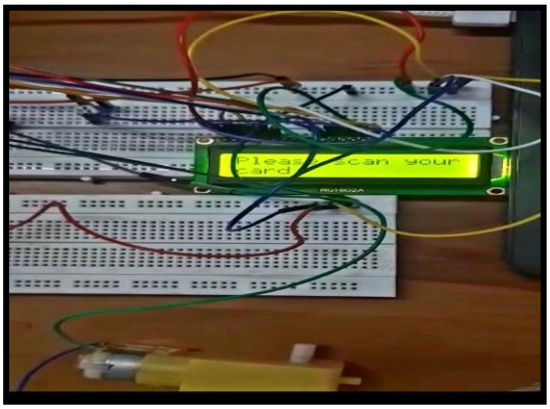

Figure 12: LCD showing message "Please scan your Card"

ThingsBoard is an open-source IoT platform that enables rapid development, management, and scaling of IoT projects. Our goal is to provide the out-of-the-box IoT cloud or on-premises solution that will enable server-side infrastructure for your IoT applications [11].

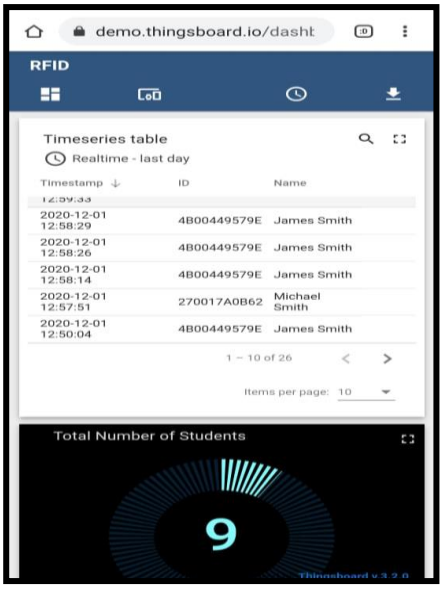

Figure 13:ThingsBoard shows the real-time data of students showing the entry and exit time

In Figure 13, the Dashboard displays the real-time data updation of the students with their names and the alloted Id Number and also the time they have entered and exited.

V. FUTURE SCOPE

In future, the intention is to apply the advanced version of the RFID technology that is the NFC technology which is contact-less technology with improved range for RFID password detection keeping the current Covid situation in mind, it also provides improved operational efficiency and enhanced security. This system also presents a dynamic and forward thinking mindset.

VI. CONCLUSION

An RFID based Attendance based System has been developed in such a way in which it can fulfil the needs of the user or an organization for a particular surveillance area. Hence, we have accomplished the task by making use of Raspberry Pi, RFID Reader, LCD Display and the RFID Tags. When the RFID card is swiped against the RFID reader, it will detect the ID card and it sends the unique card number to the Raspberry Pi. The cryptography ability between the RFID Reader module and the tag enables utmost security as the unique ID inscribed in each tag cannot be easily misappropriated. In this way, any suspicious human movements can be monitored. This project can also be called as a context-aware updation system that basically aims to deliver/update the status or information about some parameters in the dashboard that will be designed for the respective authorities to view. The evaluation results have indicated that the proposed system is useful, easy to install and use,efficient, has better ability and flexibility.

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