An RFID-Integrated Attendance System with Photo Verification for Classroom Efficiency

A Special Problem Proposal
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Abstract

The UP System started deployment of RFID/NFC-enabled UP ID in 2019. 5 years later, we have yet to see a system that fully utilizes the technology embedded in the UP ID. In particular, we see a great potential in using it as an access key for tracking the attendance of students in their classes. Professors currently either use the traditional pen and paper or a spreadsheet in their laptops to check for attendance. The mentioned practices are prone to forgery and takes precious time away from the class period.

Our paper proposes a fully digital attendance tracking system that can be used by professors to record the attendance of their students in real time. The system uses UP ID and facial recognition for a two-layer validation process ensuring accuracy of the records. Facial recognition uses a pretrained Facenet model that surpasses human beings in multiple facial recognition tests for accuracy. The proposed system allows the students to check in by tapping their ID to the RFID/NFC reader, and aligning their face in the camera. The current prototype takes only about 2-3 seconds per student to complete the whole validation and recording process, with more room for optimizations down the line.

Keywords: UP System, RFID, attendance, machine learning, facial recognition, Facenet model.

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Chapter 1

Introduction

1.1 Overview

Attendance plays an important role in improving the academic performance of students. There is evidence that students with lower attendance often have lower grades (Ancheta, Daniel, & Ahmad, 2021). Therefore, attendance is usually enforced and recorded at most higher education institutions. However, the systems in place for recording attendance are typically manual and time-consuming.

The traditional pen and paper attendance system has existed since the invention of paper itself. It is used for time keeping by manually writing or checking the 'present' status in a paper log book. Manually writing names takes an average of 17 seconds per student (Shoewu, Makanjuola, & Olatinwo, 2014), and for class size of 30 students that leads to approximately 8 minutes of class time wasted. While it is recognized that such system is time-consuming and wastes resources, it persisted because of it's familiarity. Going to class means bringing pen and paper for most students and teachers alike, so using the same material for recording attendance seemed the most practical.

In recent years, as laptops and portable computers became more accessible, some faculty of UP started transitioning to digital spreadsheets provided by services like Microsoft Excel. While it seemed to have moved the traditional pen and paper towards digitalization, another problem arises as this required manually roll calling students to say 'present'. It had the same problem of being a manual process. It is easily disrupted by a noisy class. Some time that was supposed to be utilized for immediate teaching was used for roll call.

Both systems mentioned are prone to errors and unnecessarily increases administrative burden for the faculty. Reduction in teaching time means frequently moving the lesson discussions by the faculty, with some topics being rushed or skip entirely by the end of semester. This reduces overall the quality of education students received and may negatively impact their readiness for subsequent courses they may take.

Therefore, we propose a fully automatic, digital attendance system that addresses these concerns. We utilize the already distributed UP ID and pretrained face recognition models that ensures an easy, accurate, attendance keeping. It aims to ease the burden of faculty and students from manual methods of attendace system, allowing them to focus on class discussions instead.

1.2 Problem Statement

The current methods of taking attendance today such as the manual call roll, biometrics, and online or remote attendance provides challenges in terms of efficiency, security, and authenticity. Manual roll calls are time consuming, according to (Mahato & Suman, 2013, p. 5875), it consumes an average of 5 to 15 minutes in order to complete an attendance using manual roll call attendance. It also provides a burden to some of the teachers through the disruptive behaviors of the students which lower the efficiency of manual roll call ("How Teachers Can Meet the Challenges," 2015). Biometrics attendance systems like fingerprint and facial scanning provide efficiency in taking an attendance but it is more costly and widely not accessible. The online or remote attendance system is only advisable in virtual class and not in face to face class as it is prone to attendance fraud.

Failure to resolve efficiency and a secured attendance system may lead to inaccurate attendance records and high risks of attendance fraud. These gaps may also affect the integrity in terms of attendance of the university. To fill those gaps, the solution should be the integration of RFID and facial recognition technology but there are uncertainties which are the efficient ways to integrate the real-time face capture while managing the privacy concerns and also finding an optimal way to gather sensitive information which are the student's biometric and their RFID serial number.

Given the gaps of the current attendance system method, there is a need to design an attendance system with the integration of RFID and facial recognition technology which are:

1. Efficiently captures the real-time data using the RFID and facial recognition technology.

2. Ensure and maintain security and privacy of the student's sensitive data such as their facial biometrics and unique serial number of their RFID.

3. Ensure compatibility with the university infrastructure which is the availability of RFID and the hardware for facial scanning.

4. Determine the effectiveness of the combination of the RFID and facial technology in the attendance system.

1.3 Research Objectives

1.3.1 General Objective

This project aims to develop a web application that effectively uses the current UP RFID and face recognition for attendance checking and recording in the University of the Philippines Visayas. Additionally, it also aims to assess the performance of the application in terms of accuracy and efficiency.

1.3.2 Specific Objectives

1. To develop a full stack web application that uses an RFID scanner and facial recognition models such as Facenet for an accurate and efficient tracking of student attendance.

2. To enhance application security by implementing the CIA triad.

3. To analyze the application's performance based on metrics such as accuracy, efficiency and security.

1.4 Scope and Limitations of the Research

The focus of this project is to create an attendance system that uses RFID together with facial technology. This project will take real time attendance by scanning the student's RFID and verify the student's identity using facial technology. The

project will also focus on the User Experience part where students can take their attendance as quickly as possible by aligning their faces while they scan their RFIDs. In that way it will enhance the overall efficiency and accuracy of taking attendance in the university.

This project will not involve the training of face recognition models, as there are high-performance, pretrained models readily available. The focus will be on utilizing these existing face recognition models for the development of an effective attendance tracking system. This project will only limit face to face classes, it will not cover the virtual or online classes, it will also not cover the other forms of biometric authentication such as fingerprint and eyes (iris scanning) because of its expensive hardware and the privacy concerns of the students.

1.5 Significance of the Research

Facial recognition has been in use mobile applications for validation of identity and the performance has significantly improved over the years. This allowed us to explore the possibility of using it in attendance tracking of students in UP Visayas as there are currently no system like it in place. We also intend for this project to be open-source. Some of the people that will benefit from our developed app are:

- Students - will benefit from the increased class time. This allow better retention of topics and lesson discussions. This complements the goal of recording attendance itself, which is to increase the quality of education the students receive.

- Faculty - will also benefit from the increased class time. An automated system will allow them to focus entirely on delivering the topics that need to be covered. It will lessen the possibility of skipping modules or topics needed by students to learn before taking their subsequent courses.

- UP System - Since the UP RFID are used across all constituent units of the UP System, our project can be used by any faculty under the UP System. They may also choose to create their own version as long as they also make it open source, as stipulated in GNU GPLv3 license.

- Society benefits - this project is significant in our society. The project is scalable and when it is improve more in the future, there is a high possibility that it can be applicable not only to tertiary, higher or in any education

but also it will be applicable to large organizations or corporations as it can improve taking attendance plus it can reduce the fraud in taking attendance because one of the gaps to be filled by this project is the integrity, the combination of RFID and the real-time face capture can help the organizations to have integrity in terms attendance.

We also hope that this project will bring focus on the growing accessibility of facial recognition technologies and inspire the community to explore on how it can be incorporated their own projects.

Chapter 2

Review of Related Literature

2.1 Importance of Attendance Tracking

Attendance has become increasingly important in every organization, institution, and workplace to ensure accountability, productivity, and engagement. For example, in schools, it ensures that students are present, participating, and fulfilling their responsibilities. Taking students' attendance is important for monitoring their performance in class. Good attendance is usually linked to good class performance, and vice versa (Zhi, Ibrahim, & Aris, 2014).

2.1.1 Traditional Attendance Methods

The traditional method of taking attendance is through a manual roll call. According to Uniyal (2022), using manual attendance is cost-effective, simple to use, and remains functional during power interruptions. However, despite these advantages, manual attendance has several flaws such as time consuming like for the roll call method, according to (Mahato & Suman, 2013, p. 5875). An average of 5 - 15 minutes is wasted for manual roll calls which is a lot of time that will be consumed during class or work time. Another one is that there is no integrity when the ledger sheets are the method of taking attendance as there is a possibility to fake another student's attendance through forging another student's name and signature plus it is also easy for the student to replace and erase someone already there.

2.1.2 Biometric-Based Attendance Systems

The Biometrics - fingerprint filled some of the gaps in manual attendance. According to (Walia & Jain, 2016), replacing the traditional way of taking an attendance to biometric fingerprint is a must as it fills the gaps in taking the manual attendance such as the roll call and paper based. The unique fingerprint of each person is a great idea to include in the field of attendance management. Even though a biometrics fingerprint attendance system is an ideal way to have validity, reliability, etc., there are still possible problems that may occur if we totally applied this way alone itself. According to (Truein, 2024), there is a possibility to have an issue in terms of the target's biometric recognition when the part of their finger they use to register to identify their fingerprint is wounded or injured as the current sensors are not capable to detect deeply within the wound plus dirty and dusty fingerprint may give the sensor a difficulty to analyze the person's fingerprints' biometrics. Deployment also might be expensive as mostly the biometric fingerprint attendance system relies on hardware and peripherals, in addition to that, since biometric fingerprint will be the attendance system, meaning it must be available to each of the rooms where attendance is needed plus it is not ideal to remote settings.

According to (Truein, 2024), there is another one that is more reliable and has a higher accuracy than the fingerprint biometric attendance system and that is facial recognition. According to (Yang & Han, 2020), with the use of real time video processing, it can result in a high accuracy for about 82% which is higher compared to other attendance systems. It can also reduce the truancy rates in school as the facial recognition system can easily identify who gets in and out in real time, preventing the students from cutting classes or even skipping classes.

2.2 Chapter Summary

Should include a table of related studies comparing them based on several criteria.

Highlight research gaps and the research problem.

Chapter 3

Research Methodology

This chapter lists and discusses the specific steps and activities that will be performed to accomplish the project. The discussion covers the activities from pre-proposal to Final SP Writing.

3.1 Research Activities

This project aimed to create an automated attendance system with the help of RFID together with facial recognition technology. This attendance system will replace and reduce the usage of manual attendance such as the written and oral and enhance its lacking optimized features such as security, reliability, authenticity, and integrity using the student's RFID and facial biometric.

The proposed system is expected to function by tapping the RFID of the students with real time facial capture through face recognition technology. The identity of the students will be verified through the unique serial number of their RFID that will match from the system database while the face recognition will serve as the two-factor authentication. The face recognition is expected to work by capturing the students face then will be matched also through the system database. The attendance will only be valid once both student's unique serial number in their RFID and their face has been verified.

To make the system functional, several data from the students need to be collected. Those are the student's name, student number, student's unique serial number of their RFID, and their facial biometrics. Those data will be gathered either online or face to face. Students are encouraged to download any of the RFID

card readers to know their RFID's serial number but in case they are incapable of doing that. Face to face to face will be an option where we can provide a physical RFID card reader. The facial recognition data will be gathered through capturing their image or video to be more accurate.

The hardware components will be using in this system are: RFID scanner: Which will be used to read the RFID given to the students. This will also be responsible for taking the students unique serial number on their RFID ensuring the integrity of the students. USB connector: This will be used to connect the RFID scanner and the Camera Module to the Laptop or Raspberry Pi. Laptop / Raspberry Pi: This will serve as the main processing unit. The laptop or raspberry pi will be used for running the required algorithm to make the face recognition and read the RFID correctly. Overall, the laptop / raspberry pi will be in charge of handling the data. Camera Module: In charge of capturing the student's facial image while scanning the RFID to the RFID scanner. Software Python facial recognition

3.2 Software Development Tools

Our current protoype include these frameworks and tools that are heavily used in the industry for rapid development and deployment of web applications. All of the tools used are open source. These include but are not limited to:

- Django - The web framework for perfectionists with deadlines. Django, which serves as the backend server, allows us to interface with the database server to do queries in the Python using Django's Object Relational Mapping tool(ORM). We can easily integrate popular pretrained facial recognition models as they are typically written in Python.

- deepface Python library - Provides the face verification tool and anti-spoofing capabilities. It wraps the popular face recognition models into an easy to use library. These include but is not limited to: Facenet, VGG-Face and OpenFace.

- Django Ninja - Creates the REST API on top of our Django backend to allow the frontend to consume the backend content.

- NuxtJS - The frontend JavaScript framework used to build our web interface. Includes all the tools for routing, quering, and security. By default, it renders

our web interface in Server Side Rendering(SSR) mode. Most of the work happens in the server and no authentication tokens are stored in the client browser. This increases security since authentication tokens are only added in the server side per request.

Chapter 4

Preliminary Results/System Prototype

4.1 System Architecture

Using the tools mentioned in Section 3.2, our system can be visualized as shown in Figure 4.1:

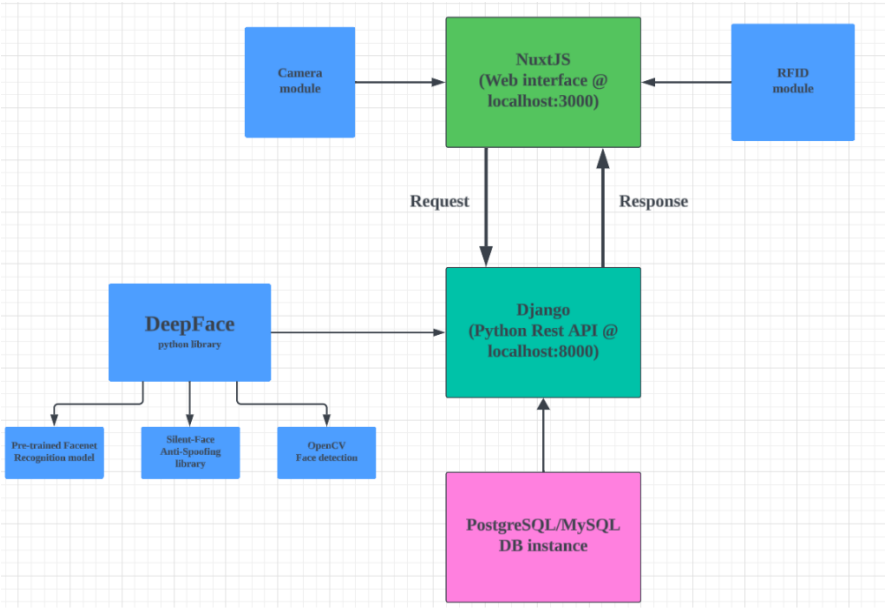

Figure 4.1: System Architecture

4.2 Django Backend

4.2.1 Models

Django Model class maps to SQL tables. For example, a Student table will have the following columns which maps to Student Model class' attributes like in Figure 4.2:

```python
class Student(models.Model):
    student_id = models.IntegerField(primary_key=True)
    first_name = models.CharField(max_length=100, default='')
    last_name = models.CharField(max_length=100, default='')
    email = models.EmailField(null=True)
    face_data = models.TextField(null=True)

    Codeium: Refactor | Explain | Generate Docstring | ×
    def full_name(self):
        return f'{self.first_name} {self.last_name}'
    Codeium: Refactor | Explain | Generate Docstring | ×
    def __str__(self):
        return self.full_name()
```

Figure 4.2: Student model

SQL equivalent would be:

```
CREATE TABLE Student (
student_id INTEGER PRIMARY KEY,
first_name VARCHAR(100) NOT NULL DEFAULT '',
last_name VARCHAR(100) NOT NULL DEFAULT '',
email VARCHAR(254),
face_data TEXT,
CONSTRAINT unique_email UNIQUE (email)
);
```

4.2.2 REST API by Django Ninja

Figure 4.3 is the automatic OpenAPI compliant documentation provided by Django Ninja. It contains all endpoints we can use to query data from the database. All endpoints are protected using HTTP Bearer token authentication.

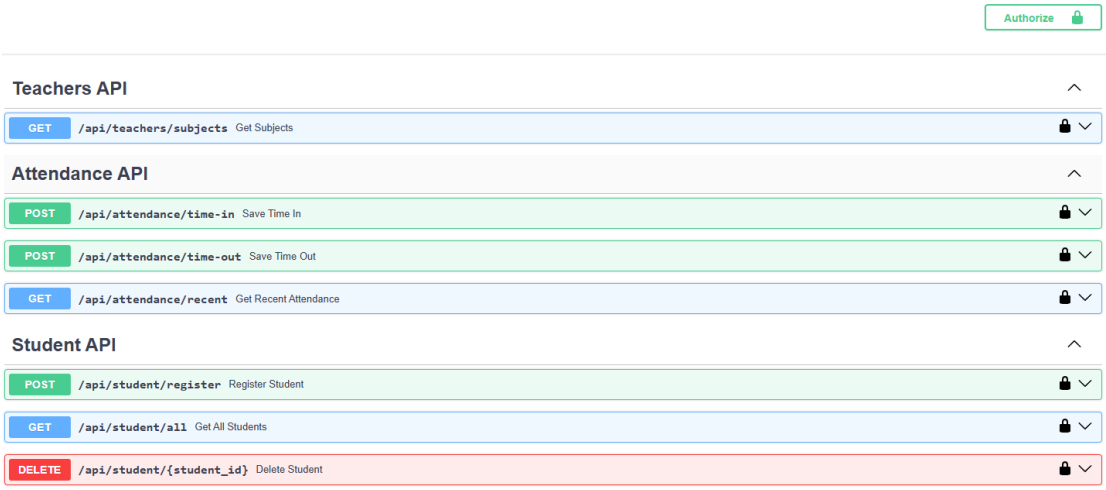

Figure 4.3: API Documentation

4.2.3 Admin panel by Django

Figure 4.4 is the Django administration page only accessible to a superuser account. This is where most of the backend maintanance work happens. It contains all the data inside the database allow full control over them. It also contains every authentication tokens used by each teacher account.

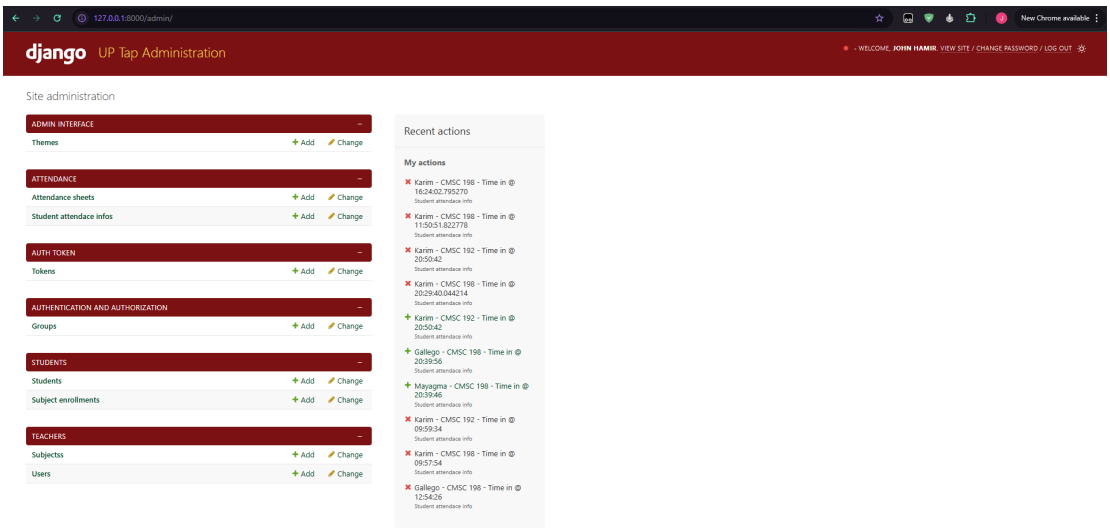

Figure 4.4: Django Administration

4.3 Nuxt Frontend

With the backend handling most of the heavy work, the frontend only needs to capture images from the camera and sending them to the backend to verify student identity. The localhost:3000/dashboard/time-in-out page handles the time in and time out process. The RFID input is automatically highlighted upon opening

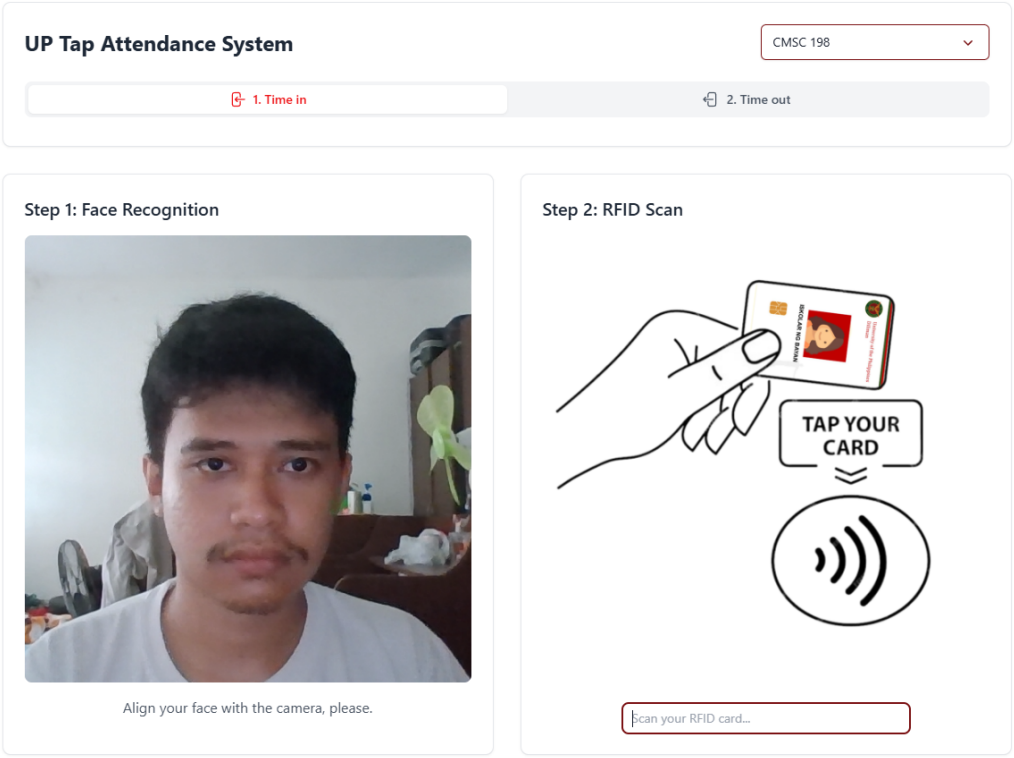

Figure 4.5: Time in and Time out Page

the page so it will be immediately ready to take in input from the RFID scanner. When the proper number length is inputted, it will immediately start to verify the identity. It will then notify the student for the time in/time out time and status. It will also notify for any errors like spoof image or no face detected. From our testing, the response time is currently at most 2.3 seconds, most of the delay comes from the fake delay we used to allow the student to read the notification after verification.

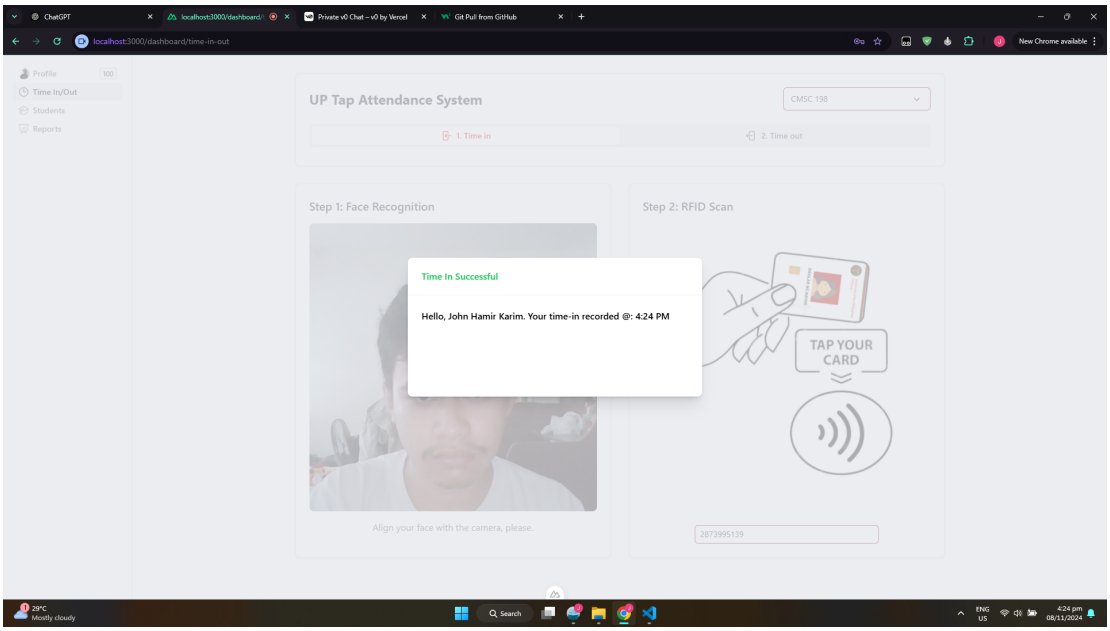

Figure 4.6: Successful Time In

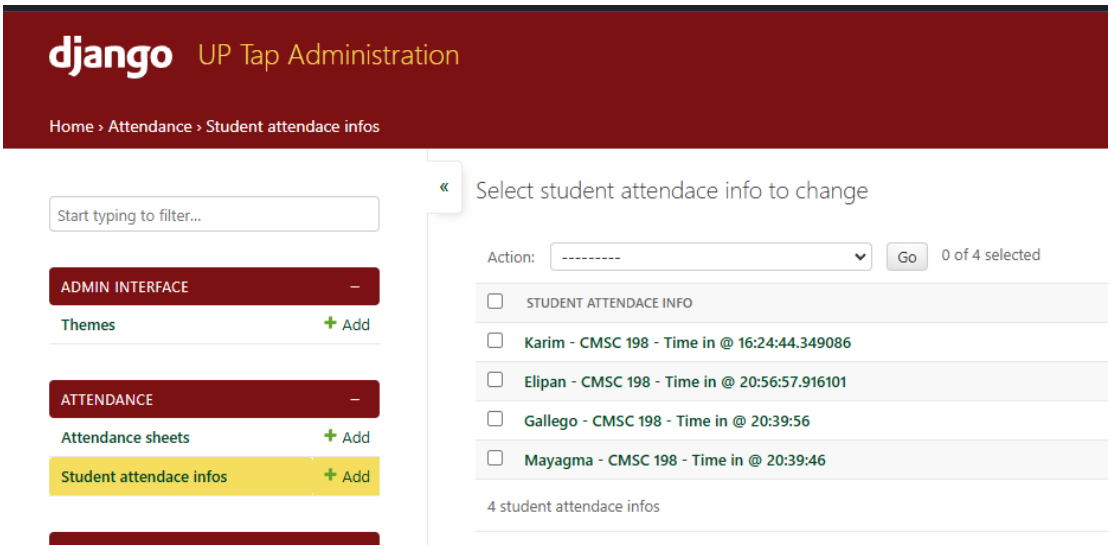

Figure 4.7: Django saving the attendance time instance in 24-hr format

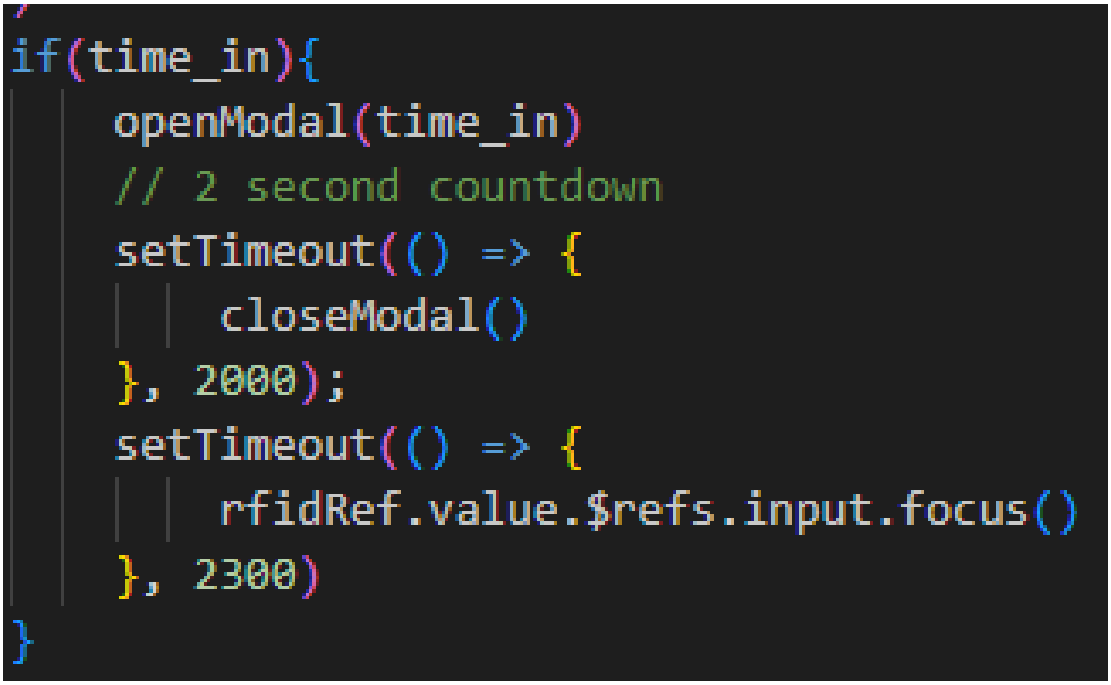

Figure 4.8: Fake Delay

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Appendix A

Appendix Title

Appendix B

Resource Persons

Mr. Firstname1 Lastname1
Role1
Affiliation1
emailaddr1@domain.com

Ms. Firstname2 Lastname2
Role2
Affiliation2
emailaddr2@domain.net

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