ClassPic: Automated Attendance Checking Web Application using Facial Recognition

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Abstract

Attendance checking is an essential part of classroom management, but it can be time-consuming and tedious. Thus, many technologies were developed in order to automate this task. These technologies are often expensive because they require machinery to operate. This paper presents a more economical and efficient method of automating attendance checking by utilizing facial recognition. A web application was developed where the teacher can upload class pictures and the attendance is automatically recorded in a spreadsheet based on the faces recognized. Results show that in a class size of 10 students, the application can detect 100% correctly as long as the faces of the students are clearly visible.

I. Introduction

A. Background of the study

All academic institutions have certain policies on class attendance. The importance of attendance in class participation is evident. A student cannot be involved in school work if he or she does not come to school. Thus, attendance checking is an essential aspect of classroom management, it makes sure that students maximize their potential for learning by attending every single class (Laws, 2013); but the process of attendance checking can be tedious and time-consuming. It can also be a source of inaccuracy and cheating. The status quo of most educational institutions in attendance checking is through paper and pen, either by giving a quiz or passing around sheets of paper for students to sign which can also be lost, cheated, or stolen.

Automating attendance checking can increase the efficiency of the class. Instead of manually checking the attendance especially for large classes, the teacher can allocate the saved time into fulfilling other class agenda. It can also generate a more reliable and accurate attendance sheet compared to the traditional method of attendance checking. Existing technologies that automates attendance checking include Geolocation tracking, Radio Frequency Identification (RFID), and Quick Response (QR) code, which mostly require expensive gadgetry and are prone to cheating.

Facial recognition is a technique used to detect faces of individuals whose images are stored in a database. It uses algorithms to pick out specific, distinctive details about a person's face. These details are then converted into mathematical representation and then compared to other faces in the database ("Facial Recognition",2018)**.** Today, facial recognition technologies are widely used for various sectors like security, healthcare and marketing.

In this day and age, there are companies and schools that have a multitude of students consisting of hundreds to thousands or more. To handle this large group of people more efficiently without sacrificing the accuracy, a more appropriate system that is more economical,

practical, and precise, and which utilizes facial recognition and mobile application based technology must be developed.

B. Statement of the problem

Handling the attendance of a large number of students can pose serious problems on accuracy and efficiency. The manual process of attendance checking proves to be tedious and has the possibility of being cheated, lost or stolen. Thus, there is a need to develop a system that automates attendance checking that is more economical, efficient and accurate.

C. Significance of the study

The findings of this study may benefit certain groups and the benefits that they may able to gain are as follows:

Teachers. The findings of the study can be used to have a more efficient and accurate way of checking the attendance of a class by just having to take a single snapshot of a class.

Students. The findings of the study can be used to track the students' absences hoping that it will lessen a student's absenteeism.

School Administrators. The findings of the study can be a cheaper alternative to other expensive automated attendance checking systems that will help save more funds for the school.

Future Researchers. The findings of the study may be used as a good source of data in conducting new researchers regarding the automation of attendance checking.

D. Objectives of the study

The general objective of the study is to implement a web application that utilizes facial recognition which will be used to automate attendance checking. It specifically aims to:

1. Create a web application for teachers to easily manage the attendance of a class;

2. Generate a spreadsheet that contains the attendance record using the web application; and

3. Assess the overall performance of the developed application.

E. Scope and Limitations

The study focused on the development of a web application that utilizes facial recognition for automating attendance checking. Only the efficiency and the accuracy was evaluated. Due to Enhanced Community Quarantine that mandated physical distancing for the foreseeable future, the web application was evaluated through testing it on a household of only ten people.

II. Review of Related Literature

Technologies utilized for attendance checking that are expensive and vulnerable

A. RFID

Radio-Frequency Identification (RFID) is the use of radio waves to read and capture information stored on a tag attached to an object. The tag does not need contact for information to be read, it can even be read from several feet away. In a report, a faculty claimed that in their university that enrolled the RFID system, he raised some glaring flaws that came with the system. It was costly especially for the installation of the card readers in all teaching rooms across the entire campus, there were disparities between the number of students that were registered in every class than those attending making the lecturer disempowered to make sure that proper attendance checking was observed, there were also reports of students that appeared to attend class but actually didn't since all they had to do was tap their RFID tag in the reader that was installed at every doorway of the lecture hall and leave afterwards (The Guardian, 2018). This shows that in totality, a lot of factors such as cost must definitely be considered because this will be passed on to the students who will have higher tuition fees for an ineffective and inconsistent attendance checking system.

B. Geolocation

Geolocation is the process or technique of identifying the geographical location of a person or device by means of digital information processed using the Internet. Geolocation also utilizes server-based data collection that is from every device's IP address through a Wi-Fi or Ethernet connection. IP addresses are stored in databases where physical locations are associated with those IPs, which is mapped through collection of data over time. There have been some advancements to utilize this technology for attendance checking an example of which is Jibble, wherein a staff or student can claim to be at a certain place, all they have to do is activate the Geolocation power-up then install the application on their phone then clock in or out with their

location (Jibble, 2017) .This system is more portable but it can have some flaws such as there is no assurance that the student or staff is the one holding their personal device and it can be just given to a colleague or friend that will clock in and out for them.

C. QR Code

QR or Quick Response code is a machine-readable code that is a trademark for a type of matrix barcode first designed in 1994 for the automotive industry in Japan. A barcode is a machine-readable optical label that contains information about the item to which it is attached; it is typically used for storing URLs or other information for reading by the camera on a smartphone (Lyne, 2011). In a study examining the system for attendance checking, the researchers proposed a system that is based on a QR code, which is displayed on a class screen then students must scan during or at the beginning of each lecture to confirm their attendance (Almasalha, 2014). This method is once again assuming that all students have a personal device and that they come to class on time. The study did not account for students who came tardy and there was no real time application integrated into the system, just a list of students who attended the class.

D. **Attendance checking technology using Facial Recognition that are inconvenient**

CCTV (closed-circuit television) is a TV system in which signals are not publicly distributed but are monitored, primarily for surveillance and security purposes. CCTV relies on strategic placement of cameras, and observation of the camera's input on monitors somewhere (Rouse, n.d). CCTV is commonly used for a variety of purposes, including traffic monitoring, building and grounds security, and obtaining a visual record of activities in certain areas. In a study done by a group of Tokyo Techies Student Research Project, they were able to create an attendance checker using OpenFace. They utilized a machine learning approach to build a classification model to identify a person’s name from the unique facial features of an individual subject. The problem using this system is that CCTVs need to be installed in every classroom which is very expensive and also inconvenient.

Another method that was explored was facial recognition but only for Personal Computer (PC) platforms, In a study conducted in India, a team of researchers explored the possibility of using an automatic attendance system using image processing. First, a video clip of the entire classroom is taken which is stored into a database then converted into frames and images. This is where face detection techniques such as the Adaboost algorithm are used to detect the faces in frames/images and then features are extracted from the faces detected using Histogram of Oriented Gradients (HOG) and Local Binary Pattern (LBP) algorithms. After storing the faces of the students in the database, the detected faces are then compared with the faces stored in the database using Support Vector Machine (SVM) classifier. Attendance gets marked after matching the recognized face (Amedi, 2015). This however uses a computer as its platform, although it is not a specialized equipment, it does not have the portability of a phone which makes it difficult to implement in every lecture hall in a university.

E. Automated Attendance Checking Web Application using Facial Recognition

Web applications utilize web browsers to perform certain functions that are dependent on Internet access (Gibb, 2016). A report claimed (CNN Philippines, 2019) that Filipinos spend an average of 10:02 hours a day on the internet and there are 76 million internet users in the Philippines which can give us an idea that teachers or the school administration must have a device that has internet access readily available for the proposed attendance checker program. By being a web application, it can be utilized by any device that is connected to the internet which makes it way cheaper compared to systems requiring extensive computer equipment or complex machinery. Since this proposed paradigm is a web application tool, phones can even be utilized making it even more convenient since it is smaller, lighter and easier to bring around. Compared to the RFID, CCTV, or the current existing Facial Recognition Attendance system which is only available for PC and is usually installed or fixated in a certain place. Another factor for consideration is the security and accuracy of the recorded data since it is hard to confirm if the user is the actual person in the attendance. For example in Geolocation technologies, students may simply ask a friend to check in for them by asking that their device be carried with them. In Facial Recognition attendance systems, a student cannot cheat to obtain an attendance, because

the student needs to be physically present in order to be marked present. These factors were taken into consideration and a cheaper, more secure, more efficient way of attendance checking must arise.

III. Methodology

A. Image Acquisition

Due to the COVID-19 pandemic, the web application was tested not in a classroom setting but in a household of 10 people.

The class pictures were shot using the 12MP Main Camera of Samsung S9+ while the student selfies were shot using the 8MP Front Camera of Samsung S9+. In testing the accuracy of the program, the students were asked to arrange themselves randomly and also by their height. The class pictures were shot in different distances such as 3 meters away and the farthest distance possible in the house which was 13 meters and in an angle that can clearly capture all the faces of the students.

B. Architecture of the Application

Figure 1 presents the architecture of the application. It consists of four major components which are the Users, User Interface, Application Server and Kairos API.

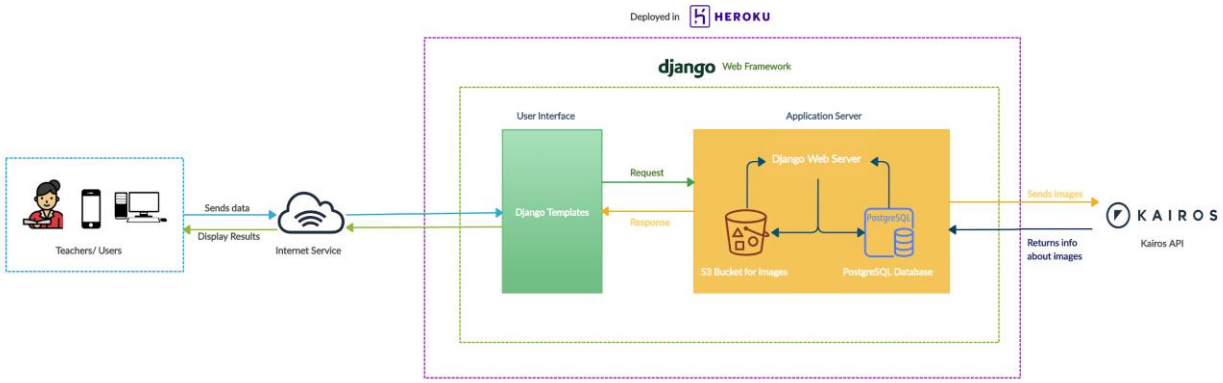

Figure 1: Architecture of the Application

1. Users

The application has only one type of user which is the teacher. The teacher has access to the following functionalities:

a. Class Management: the user may add, edit, or delete a subject;
b. Student Management: the user may add, edit or delete a student belonging to a subject;
c. Attendance Management: the user may view and delete the attendance record;
d. Take ClassPic: the user may check the attendance of students by uploading a class picture ;
e. Export Attendance: the user may export the attendance record of a subject in a .csv file.

2. User-Interface

The User Interface (UI) of the web application serves as the portal for the user to interact with the web application. This is where the user can manage their subjects, students, and attendances. This was developed using Django Templates which uses HTML and CSS. In order to improve the appearance of the UI, Bootstrap4 was also integrated.

3. Application Server

The Application Server houses all the data needed for the web application. This server is responsible for data storage and executing the different processes related to the management of subjects, students and attendances. This is also where the process related to facial recognition is located, which is done through an API call from the application server to Kairos API. Lastly, this is where the process for creating a .csv file based on the attendances is also located. The application server is a Django Web Server which has a PostgreSQL database to store the models of the subject, students and attendances and an Amazon S3 bucket in order to securely store the images that were used for this web application.

4. Kairos API

Kairos API is a Facial Recognition API where a user submits images into the API, and its deep learning algorithms analyze the faces found, then the API returns a bunch of useful data about them. The data returned can be used to search, match and compare faces, or measure characteristics such as age, and gender. Kairos API was the chosen Facial Recognition API because of its ease of use, accuracy, security and ethics. Its accuracy scores at 99.63% on the popular LFW(Labeled Faces in the Wild) database. LFW database is a public benchmark for face verification. It has a high level of security because of the High level encryption and tokenization of sensitive data. Lastly, it values ethics because it does not allow government agencies to use its API (“Kairos API”).

C. Generation of Face Templates

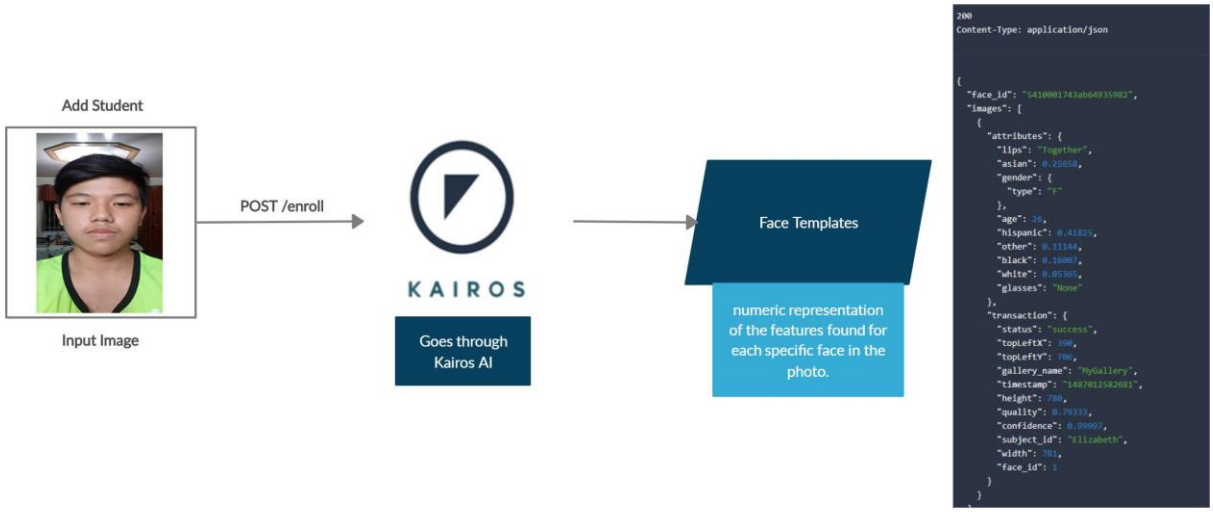

Figure 2: Overview of Generation of Face Templates

Using the web application, when a student is added it needs to upload a selfie or a self-portrait. This image alongside the information of the student is sent to the Kairos API /enroll path where the image goes through Kairos AI in order to generate a face template which contains the information extracted based on the face uploaded such as age, gender and race. This face template is then saved to a Kairos API gallery which contains the other face templates of other students belonging to a subject.

D. Attendance Checking and Recording

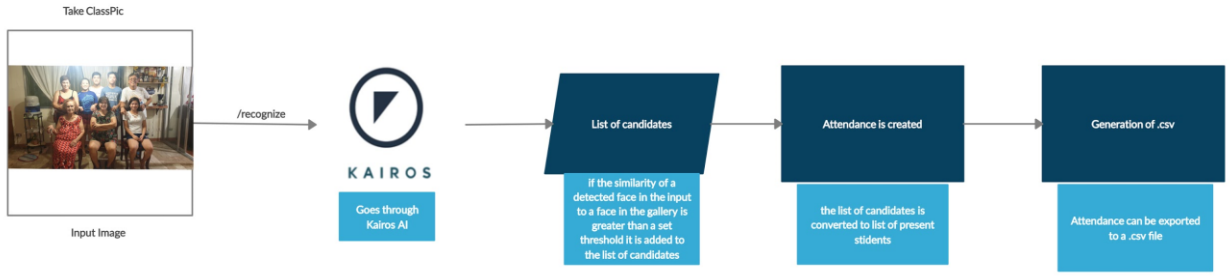

Figure 3: Overview of Attendance Checking and Recording

In order to take a ClassPic or Attendance, the user needs to upload an image containing the picture of the class. The image is sent to Kairos API /recognize where each face in the image is detected and matched against the face templates saved to a Kairos API gallery. If a face in the uploaded image is greater than a set threshold, it is added to the list of potential candidates and then Kairos API returns the list of potential candidates and how closely they match ("Kairos API"). The threshold set was 0.75 which is the minimum threshold and also the default for Business Acceptable applications according to Kairos API. The list of potential candidates is then sent to the Attendance entity where the list of potential candidates are converted to the list of present students on the time the ClassPic was taken.

IV. Results and Discussion

A. Web Application

A web application has been developed that automates attendance checking with the use of facial recognition. The User Interface for the web application developed is shown below.

1. Login Page

This page is the landing page of the web application. It shows the login form and the link to the registration. It uses Django's built-in authentication system in order to verify the credentials given. A session is generated for every successful login. The session framework lets you store and retrieve arbitrary data on a per-site-visitor basis. It stores data on the server side and abstracts the sending and receiving of cookies. Cookies contain a session ID – not the data itself ("Django Documentation").

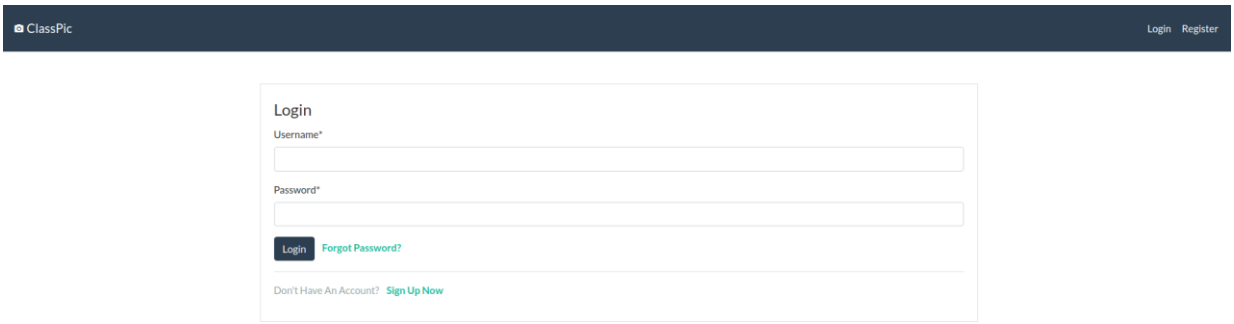

Figure 4: Login Page

2. Registration Page

This page is for the users who want access to the web application. It generates credentials for the user to use in the login page. It also uses Django's built-in authentication system which generates a User object for every successful registration. In Django, passwords use the PBKDF2 algorithm with a SHA256 hash, a password stretching mechanism recommended by National Institute of Standards and Technology (NIST) which means it is secure and requires amounts of computing time to break ("Django Documentation").

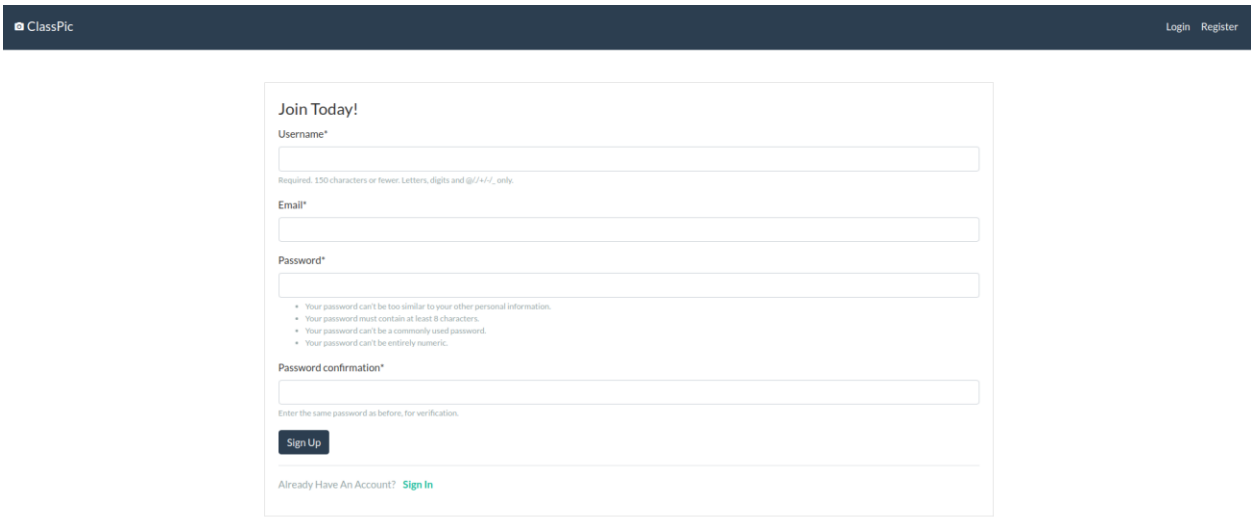

Figure 5: Registration Page

3. Profile Page

This page enables the user to change their username and email.

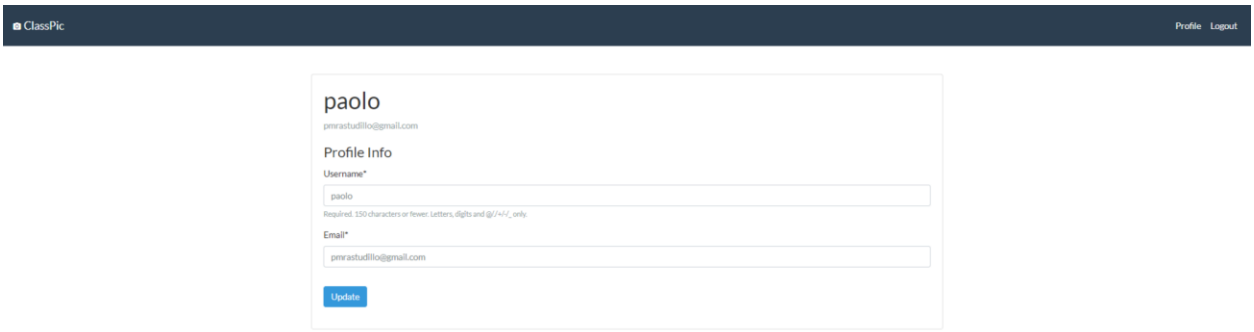

Figure 6: Profile Page

4. Forgot Password Page

This page allows users to reset their password by providing the correct user email. The Web application sends an email with a link containing the form that allows users to change their password.

Figure 7: Forgot Password Page

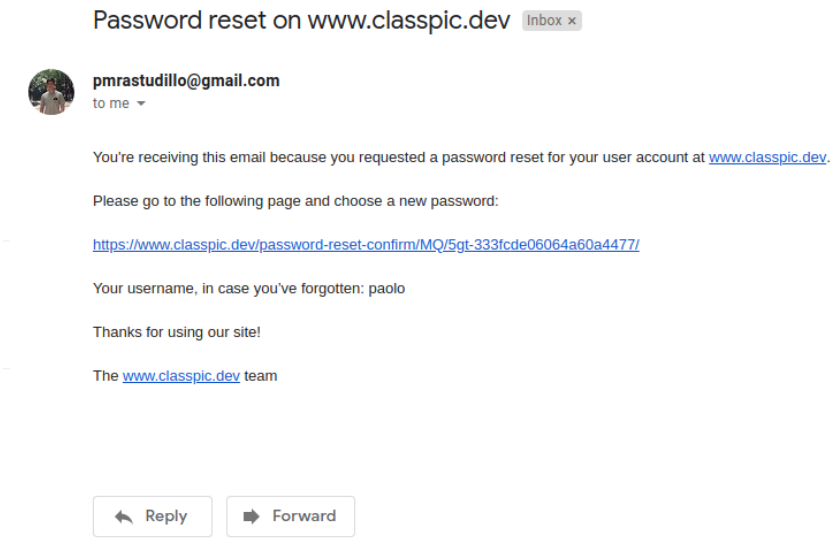

Figure 8: Forgot Password Email

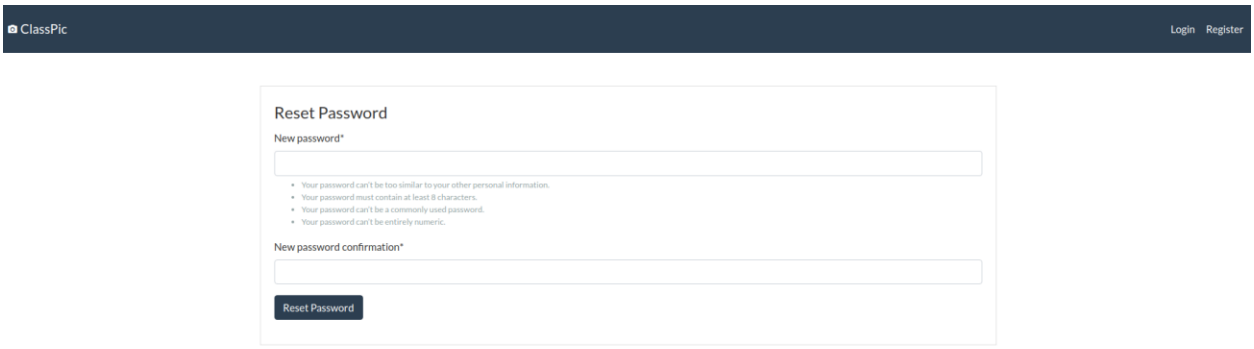

Figure 9: Change Password Form

5. Dashboard Page

This page is where the user is taken after a succesful login. It shows all the created subjects by the user and a button that enables the user to create another subject. Each subject is displayed with their title, description, schedule, location and the number of students in the subject.

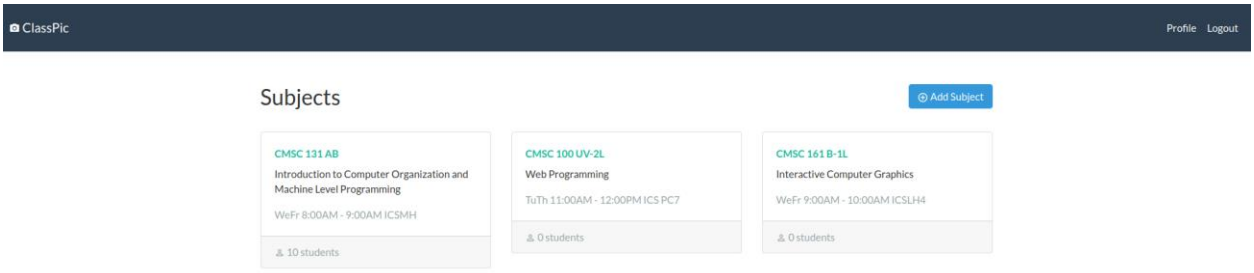

Figure 10: Dashboard Page

6. Subject Detail Page

This page appears when the title of the subject is clicked in the dashboard. It shows information about a subject. This page enables the user to create an attendance, view the attendance of the subject and add a student to the subject. This page also shows the class list which is a list to show the students belonging to a subject. It also enables the user to edit or delete a student by clicking the buttons near a student's name.

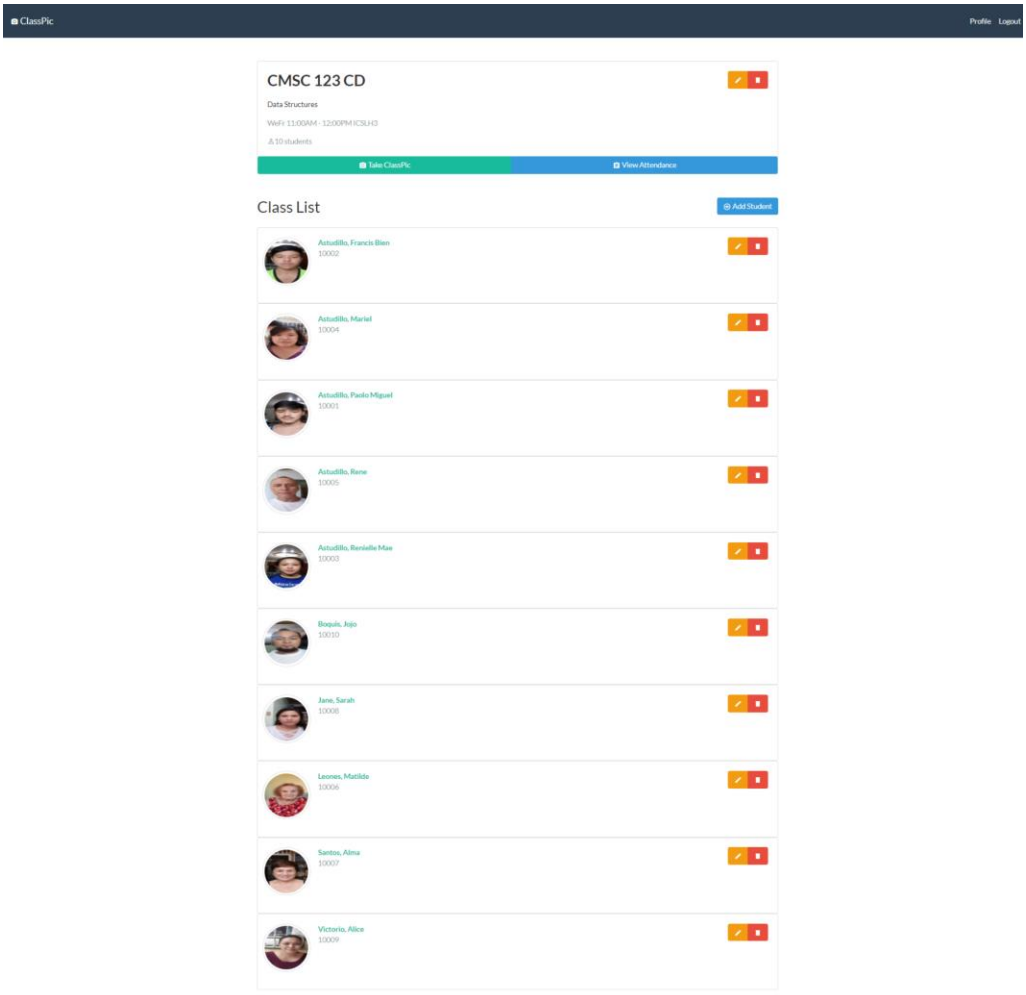

Figure 11: Subject Detail Page

7. Take ClassPic/ Create Attendance Page

This page enables the user to create an attendance by taking a class picture. It can take up to two class pictures. It shows the guidelines in order to increase the accuracy of the facial recognition.

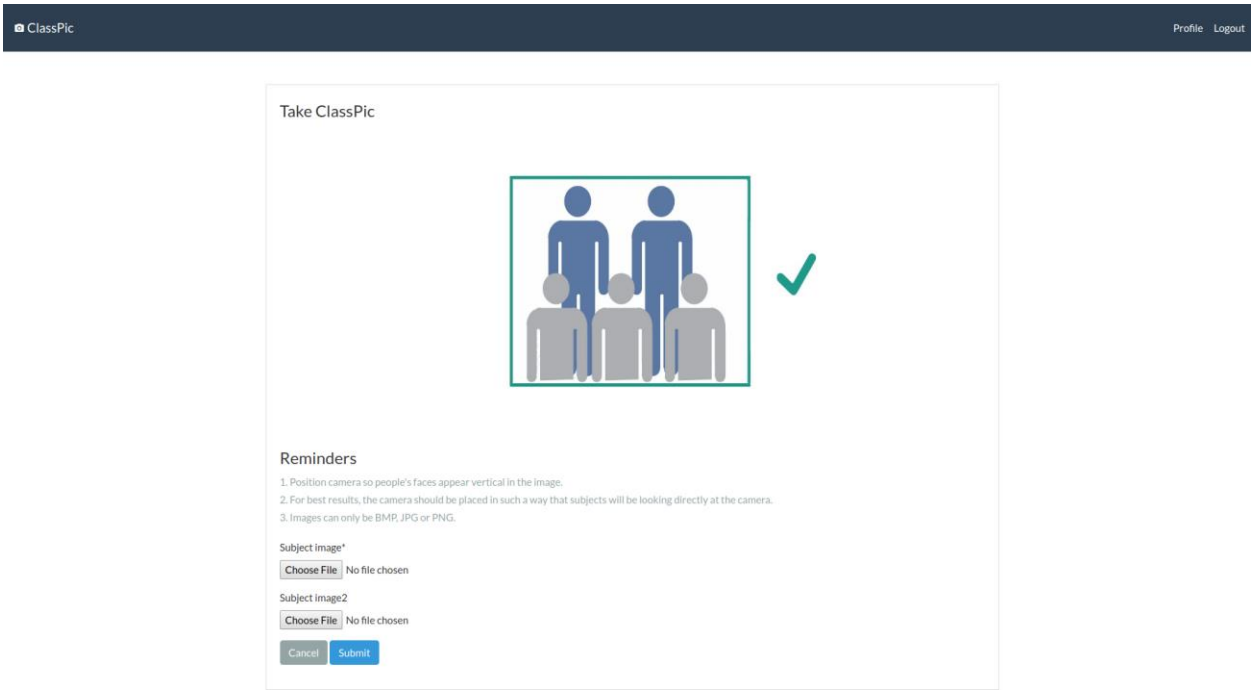

Figure 12: Take ClassPic/ Create Attendance Page

8. Attendance List Page

After an attendance is taken, it redirects to this page. It shows all of the attendances taken with the corresponding date and time . It also allows the user to delete an attendance. This page enables the user to convert all of the attendances into a .csv file by using the “export to csv” button.

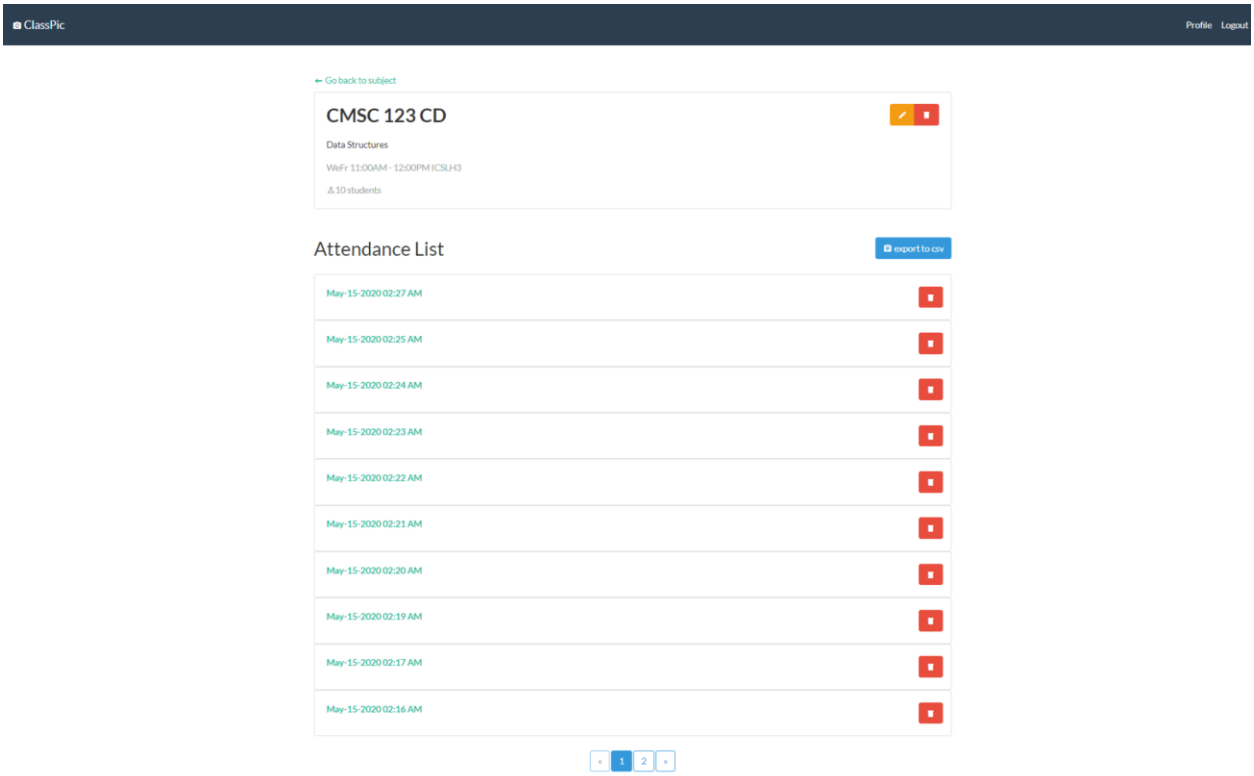

Figure 13: Attendance List Page

9. Attendance Detail Page

This page shows all of the class pictures taken which can be viewed when discrepancies are encountered, the list of present and absent students, and the number of present students over the number of all students in a subject.

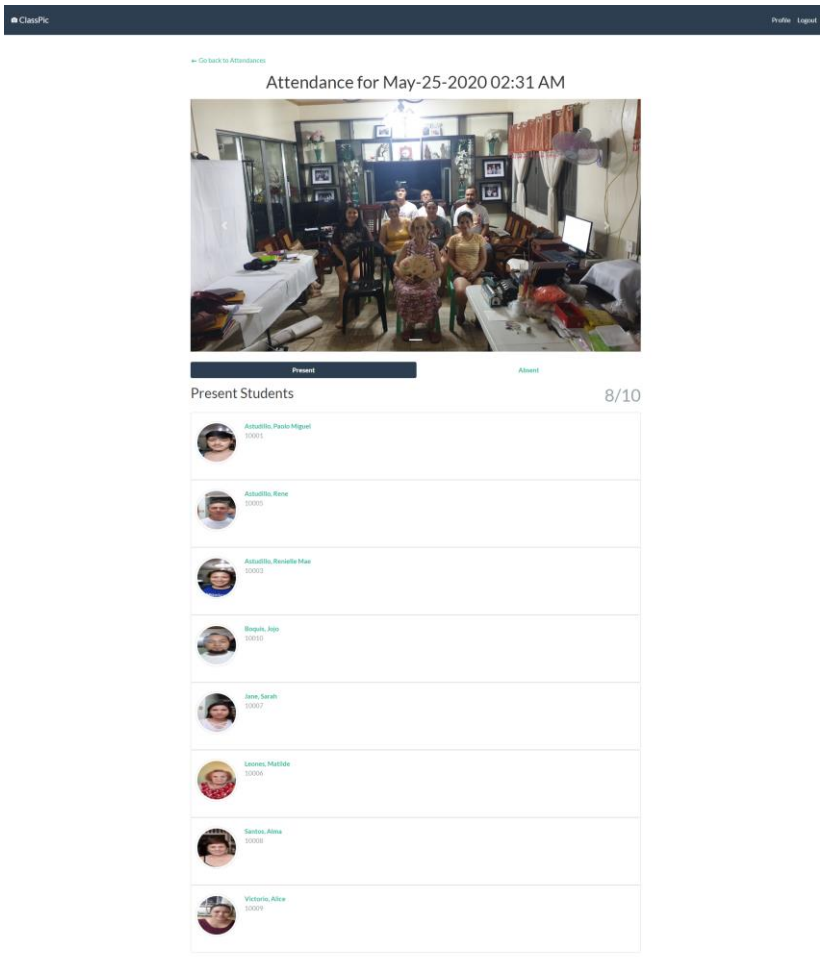

Figure 14: Attendance Detail Page

B. Attendance Checking

The web application was given different scenarios to test the accuracy of the automated attendance checking. Figure 16 shows some of the male students with new haircuts and even new trim of facial hairs compared to their appearance in Figure 15. It shows that facial hair or even change in hairstyle does not affect the accuracy of the automated attendance checking. They also show that wearing eyeglasses does not affect the accuracy of the automated attendance checking as can be observed by the man with the eyeglasses in Figure 15 which he removed in Figure 16. Figure 16 shows that even when there is a "sit-in" or unenrolled student, it does not detect that person and takes the attendance according to the class list. The web application can also take up to two images and combine those into a single attendance entity which can be useful in large classes that are too large to fit in a single picture which can be observed in Figure 17.

Figure 15: No. of students=10, Automated Count=10

Figure 16: No. of students=10 + 1 Sit-in , Automated Count=10

(a) Left side of the room: No. of students=6

(b) Right side of the room: No. of students=4+1 sit-in

Figure 17: No. of students=10 + 1 Sit-in , Automated Count=10

Figure 18: No. of students=10 , Automated Count=6

Randomized and according to height seating arrangements were tested. Table 1 shows the performance of the system in a randomized seating arrangement. Meanwhile, Table 2 shows the performance of the system in an according to height seating arrangement. In both tables, the second column refers to the correct count of the students, the third column refers to the automated count generated by the web application and the fourth column refers to the Accuracy of the system which declares the correctness of the Automated Count compared to the correct number of students. The low accuracy in Image 4 which can be seen in Figure 18 is caused by some students' faces not visible because it was blocked by the student in front of them which are taller than them. There is 100% accuracy in some images even though they are in a randomized seating arrangement because as seen in Figure 17, their faces are clearly visible. In according to height seating arrangement, we can observe that the accuracy of the web application greatly improved because this kind of seating arrangement increases the possibility of having class pictures with more visible faces. In both seating arrangements, there were no false positives recorded which means that there is no absent student recorded as present. Therefore, the web application will have 100% accuracy regardless of seating arrangement as long as the faces are

clearly visible. It is highly recommended that the participants are seated according to height as it increases the chance of having their faces clearly visible for the class picture.

Table 1: System Performance in Randomized Seating Arrangement

Test Image	No of students	Automated Count	Accuracy
Image 1	10	10	100%
Image 2	10	10	100%
Image 3	10	8	80%
Image 4	10	6	60%
Image 5	8	8	100%
AVERAGE			88%

Table 2: System Performance in an According to Height Seating Arrangement

Test Image	No of students	Automated Count	Accuracy
Image 6	10 + 1 Sit-in	10	100%
Image 7	10	10	100%
Image 8	10	9	90
Image 9	8	8	100%
Image 10	8	8	100%
AVERAGE			98%

C. Performance Issues

Due to time request limitations caused by Heroku a request which is greater than 30 seconds throws back a request timeout error. The web application requires an image upload when a class picture is taken which means if a user has slow internet connection the website will throw back a request timeout error and the taking of attendance cannot be executed. This error can also be encountered when attempting to upload two images in a take attendance form. This error can be caused by slow upload speed and due to the fact that Kairos API /recognize can only cater one image per request.

V. Conclusions and Recommendations

Attendance checking is an essential aspect of classroom management, it helps students maximize their potential for learning by attending every single class however attendance checking can be tedious, time-consuming and can be a source of discrepancies. Thus efforts to automate attendance checking are developed. These efforts are often expensive, because they require certain machinery. Thus, a web application was developed to make attendance checking more efficient, reliable and cost-effective. The web application will have 100% accuracy regardless of seating arrangement as long as the faces are clearly visible. It is highly recommended that the participants are seated according to height as it increases the chance of having their faces clearly visible for the class picture. Future works can include using another API or developing a new facial recognition algorithm to improve accuracy of the attendance checking, fixed phone camera mounted on the top that can take images on a set time in order to take out the hassle of taking the time to take the pictures of the class and can even detect late students. Future works can also include a feature that makes the registration of students in a certain subject easier by just making the students fill out a form instead of making the teacher input the students one by one and also integration to existing class management portals such as Google Classroom and Edmodo.

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