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Abstract

In this age of rapidly evolving technologies and trends, performing routine tasks like Attendance Recording should no longer follow the manual or semi-manual tiresome methods. Taking students' attendance records in the classroom during a lecture period is now a common practice in the University systems especially in most private institutions in Nigeria; a case study employed is Babcock University, Ilisan Remo, Ogun State, Nigeria. This helps to account for where a student is per time, increases student's learning focus and helps the institution to make the right decision for instance whether to allow a student to take the final exam or not. Attendance marking using conventional methods such as calling students' names one by one or having them to write it could be quite tedious and time wasting. It becomes more difficult to manage when the class size is large. Another challenge includes the possibility of capturing a proxy attendance such as students writing for their absent colleagues. This study proposes to solve this problem using a biometric information processing known as the facial recognition system. Its application is easier with working range larger than others such as fingerprint, iris scanning and signature. Many algorithms and techniques have been developed to improve facial recognition performance, but the proposed model employs Cascade Classifier which breaks the problem of detecting faces into multiple stages. For each stage, the algorithm performs a very rough and quick test, and if this current stage passes, it does a slightly more detailed test. It eventually detects a face if all stages are passed. The implementation tools include Python, HTML, MySQL, PyCharm, XAMP server as the local host server and a web browser to register and display results. As a result, this development makes attendance monitoring simple, efficient, and time saving.

Keywords: *Attendance, Monitoring, Biometric, Facial Recognition, Cascade Classifier.*

1. INTRODUCTION

The involvement of information technology (IT) in major sectors such as the educational sector has brought a never-ending evolution into the space. A significant aspect of any educational system is the proficient use of educational tools to deliver services, proper maintenance of student, lecturer, and staff data, and successfully integrating IT solutions to assure competence, ease of operation, and efficiency within said system are all important aspects of any educational system [1]. Attendance Recording or Monitoring is crucial to most organizations. More importantly in the academic environment, students class attendance and participation in lectures could only be tracked or documented via taking attendance using means chosen by the instructor. The most common is still manual. The Teacher or Instructor calls the names of the participating students before, during or at the end of the lecture manually or asks them to sign an attendance sheet which he subjects to further processing and reporting. The purpose of this is that the Teacher or the School or even the parents could be interested in such records at the end of the semester. The parents might want to know how punctual their wards are in terms of class activities. Class attendance should be beneficial for learning irrespective of the specific teaching methods and strategies [2]. In spite of the importance of class attendance, students do miss classes for various reasons [3]. Some of the noticeable reasons according to [4] on the part of the

students include the following: "Attendance is not taken or does not influence my grade", "The teacher doesn't notice or care whether I am there" etc. Relatively recent research reported that poor academic performance was found significantly correlated with irregular class attendance [5]. Some possible cases could be that some students stay in the hostel doing other things different from class activities or get out of school to engage in something else. This does not add value to the educational system. Hence, this necessitates the good reason to keep records and monitor students' attendance. In this age of rapidly evolving technologies, performing routine tasks like Attendance Monitoring should no longer follow the manual or semi-manual tiresome and time-consuming methods. Taking students' attendance records in the classroom during a lecture period is now a common practice in the University systems especially in most private institutions in Nigeria. This helps to account for where a student is per time, increases student's learning focus and helps the institution to make the right decision as per whether such student should be allowed to take the final exam or not. Attendance marking using conventional methods such as calling students' names one by one or having them to write their names down could be quite energy-zapping and time wasting. This, of course, poses a serious challenge to everyone, for instance, managing a large class becomes more difficult. Another challenge includes the possibility of capturing a proxy attendance such as students writing for their absent colleagues. Generally, the maintenance and evaluation of attendance records is critical in every organization review. This study proposes to solve this problem using a biometric information processing known as the facial recognition system.

A Facial recognition system is a technology capable of matching a human face from a digital image or video frame against a database of faces, typically employed to authenticate users through ID verification services, working by pinpointing and measuring facial features from a given image. Face recognition is a well-known biometric technology that uses facial traits and face picture recognition to identify the associated individual**.** Its application is easier with working range larger than others such as fingerprint, iris scanning and signature. Many algorithms and techniques have been developed to improve facial recognition performance, but the proposed model employs Cascade Classifier which breaks the problem of detecting faces into multiple stages. For each stage, the algorithm performs a very rough and quick test, and if this current stage passes, it does a slightly more detailed test. It eventually detects a face if all stages are passed. The implementation tools include Python, HTML, MySQL, PyCharm, XAMP server as the local host server and a web browser to register and display results. The goal of this study is to develop a dependable and transparent system that is free of personal biases and interests, in order to eliminate the manual method of taking attendance in the University.

2. PROBLEM STATEMENT

Attendance monitoring remains a crucial activity in most major sectors especially the educational institutions. Capturing Student attendance is strenuous and time consuming especially in schools/classes where there are large number of students and the attendance is being taken at the beginning, middle or end of classes with row call of names or an attendance sheet being passed around the classroom for students to sign on their respective matriculations number and name to indicate their presence in the class. Another challenge includes the possibility of capturing a proxy attendance such as students writing for their absent colleagues. Also, the maintaining and updating of the attendance records is quite burdensome, making records very difficult to maintain. The records are also prone to losses. Moreover, managing paper-based attendance records comes with other drawbacks; mistakes during data input, losing some sections of the records and the like. This study aims to design a student attendance monitoring system using facial recognition technique that authenticates the identity of individuals who are registered on the system's database, mark their presence, and save it for future use.

3. LITERATURE REVIEW

Face recognition software was first developed in the 1960s.Woody Bledsoe, Helen Chan Wolf, and Charles Bisson collaborated on developing a computer that could recognize human faces and because the coordinates of the facial characteristics in an image had to be defined by a person before they could be utilized by the computer for recognition. Their early face recognition project was called "man-machine" [6],[7]. A person had to locate the coordinates of face characteristics such pupil centers, inner and outside corner of eyes, and the windows' peak in the hairline on a graphics tablet. Twenty distances were calculated using the coordinates, including the breadth of the mouth and eyes. A human could process about 40 pictures an hour in this manner and so build a database of the computed distances. A computer would then automatically compare the distances for each photograph, calculate the difference between the distances and return the closed records as a possible match [7]. Face detection technology (which came around 1997) that outperformed most other facial detection systems called the "Bochum system" was commercially available as ZN-Face to airport and other busy area operators. The software was "robust" enough to make identifications from less-than-perfect face views. It can also often see through such impediments to identification as mustaches, beards, changed hairstyles and glasses even sunglasses [8]. The Viola–Jones object identification framework for faces made real-time face detection in video footage possible in 2001 [9]. To create Ada Boost, the first real-time frontal-view face detector, Paul Viola and Michael Jones merged their face detection method with the Haar-like feature approach to object recognition in digital pictures [10]. In less than a decade ago, the Viola-Jones method had been implemented on portable devices and embedded systems employing tiny low-power detectors. *Over and above, the Viola–Jones algorithm has helped in broadening the practical application of face recognition systems and at the same time been used to support new features in user interfaces and teleconferencing [11]. In recent time, it was reported that Clearview AI's facial recognition database is available to government agencies to be used exclusively as a technology to assist in the course of law enforcement investigations or national security [12].*

3.1 Review of Related Works

The section discusses some closely related works that this study could reference. It is worthy of note that Biometrics are generally more secure than using typical passwords and PINs [13].

1) Design of a Face Recognition System [14].

Face recognition systems as a part of facial image processing applications use biometric information of humans and are easily applicable instead of fingerprint, iris, signature etc. This is preferred in metropolitan life for crime prevention, video surveillance, person verification, and similar security activities. This study acknowledged that facial recognition system is a common image processing problem in real world applications with complex effects of illumination, occlusion, and imaging condition on live images. It combines face detection and recognition techniques in image analysis. A detection application is used to find the position of the faces in each image. Recognition algorithm is used to classify given images with known structured properties, which are used commonly in most computer vision applications. Knowledge-Based face detection methods are used to find, locate, and extract faces in acquired images. Neural networks are used for face recognition. Facial components on face candidates appear with implementation of Log filter. The log filter shows good performance on extracting facial components under different illumination conditions. Classification is also flexible and correct when extracted face image is small oriented, closed eye, and small smiled. Proposed algorithm is capable of detect multiple faces, and performance of system has acceptable good results. Here, a face can only be identified correctly if your information is in the gallery. These galleries create privacy concerns when they are assembled, used, or shared without your knowledge or consent.

2). Class Attendance Management System Using Face Recognition [15]:

In the study, the images of students were stored in the database by taking a real time video and then splitting the video in frames of 30 seconds. The LBPH (Local Binary Pattern Histogram) algorithm was employed. The captured images are compared against the stored images to mark attendance. The First of the four Phases involved is the Image capturing Phase such that the lecturer captures the images of students to be stored in the database. This is done with the use of the Droid Cam application which links the system running on a laptop to a phone. The Second uses the Haar Cascade algorithm is applied to capture the individual features of the students; it basically gives us the most relevant parts needed for detection and crops other parts. Once this is completed, the faces are stored in the database. The Third Phase is Image Matching Phase; it is where captured images are compared against the stored images using LBPH. If this is successful the name would appear. The Fourth and last Phase is the Attendance Marking Phase where the attendance is populated. Worthy of notes is that there is no provision for unrecognized faces. This will lead to a problem as unrecognized will be deleted and marked absent in the attendance database. If any student goes unrecognized then the image should be stored in a secondary database and the admin should be alerted.

4. MATERIALS AND METHODS

The iterative development model was adopted in this study. The Haar cascade classifier technique which breaks the problem of detecting faces into multiple stages was employed. For each stage, the algorithm performs a very rough and quick test, and if this current stage passes, it does a slightly more detailed test. It eventually detects a face if all stages are passed. Worthy of mention is the linear support vector machine (SVM) classifier algorithm which creates a line or hyper plane which separates the data into classes and the histogram of oriented gradients a feature descriptor used in computer vision and image processing for object detection.

4.1 Face Detection Using Haar Cascade Classifier

Haar-cascade is an object detection algorithm used to identify faces in an image or a real time video. The algorithm uses edge or line detection features. Cascade is a machine learning based approach where a lot of positive and negative images are used to train the classifier. Positive images are the images the classifier is expected to recognize while negative images are the images that the classifier to is not expected to recognize.

4.2 Support Vector Machine

Support Vector Machine is a supervised learning method used for classification. Support Vector Machines are another good technique for classifying educational data. The idea is to find data points ("support vectors") which define the widest linear margin between two classes. Non-linear class boundaries can be handled by two tricks: first, the data can be mapped to a higher dimension, where the boundary is linear, and second, we can define a soft margin, which allows some misclassification.

4.3 Histogram of Oriented Gradient

This is a feature descriptor used in computer vision and image processing for the purpose of object detection. The technique counts occurrences of gradient orientation in localized portions of an image. This method is like that of edge orientation histograms, scale-invariant feature transform descriptors, and shape contexts, but differs in that it is computed on a dense grid of uniformly spaced cells and uses overlapping local contrast normalization for improved accuracy. The essential thought behind the histogram of oriented gradients descriptor is that local object appearance and shape within an image can be described by the distribution of intensity gradients or edge directions. The image is divided into small, connected regions called cells, and for the pixels within each cell, a histogram of gradient directions is compiled. The descriptor is the concatenation of these histograms.

4.4 The Proposed System Main Phases

This section deals majorly with the proposed techniques, methodologies, and concepts relevant to facial recognition and image processing. The design includes four sequential phases.

1. Image capturing
2. Image detection
3. Image matching
4. Attendance marking

1. Image Capturing: In this phase, the image of the student is captured in real time in the classroom by means of a laptop making use of its webcam. It is then stored in the database alongside the student's profile details.

2. Image Detection Phase: In this phase, while the image is being captured, the Haar Cascade algorithm is applied to the image simultaneously to get individual faces of the students and obtain distinct features of the face. It makes use of the line and edge features. The Haar Cascade basically works by capturing the parts of the face needed the most for detection (i.e., ROI - Region of Interest) and processing and cropping out the other regions of the face that do not play a role in the image matching and processing.

3. Image Matching Phase: In this phase of the student attendance system using facial recognition, the image captured is compared with the images stored in the database. This is done by making use of the HOG method (Histogram of gradient). Each image in the data sets has a calculated histogram value. The histogram value from the captured image is cross checked with that of histogram values from the data set. Once there is a match, the name of the student then appears under the frame of the image.

4. Attendance Marking: In this phase, after the student face has been captured the machine then marks the student attendance in real-time and stores it on the database. This authenticates the validity of the student. This is the last phase of the attendance monitoring system.

4.5 Data Collection

What is represented here are the collection of names, definitions and attributes about data elements that are being used or captured in the database. The following Table 1 represents a snapshot of the data dictionary:

Table 1: Data Dictionary View

studentportal

admin

Column	Type	Null	Default	Links to	Comments	Media type
admin_id *(Primary)*	int(6)	No				
username	varchar(30)	No				
password	varchar(30)	No				

Indexes

Keyname	Type	Unique	Packed	Column	Cardinality	Collation	Null	Comment
PRIMARY	BTREE	Yes	No	admin_id	0	A	No	

student

Column	Type	Null	Default	Links to	Comments	Media type
student_id *(Primary)*	int(6)	No				
studentfname	varchar(30)	No				
studentlname	varchar(30)	No				
studentImage	blob	No				

Indexes

Keyname	Type	Unique	Packed	Column	Cardinality	Collation	Null	Comment
PRIMARY	BTREE	Yes	No	student_id	2	A	No	

4.6 Use Case Diagram

The following use case diagram illustrates possible interactions between the user and the interface. This includes actions to be taken by the actors (users and admin). Here, the user actor is the student and the admin actor is the Teacher/Lecturer. In the following Figure 1, the system has primary actors as lecturer and student, who are the users of the system. The secondary actor of the system is the timer which assists the system to achieve the primary actors' goals.

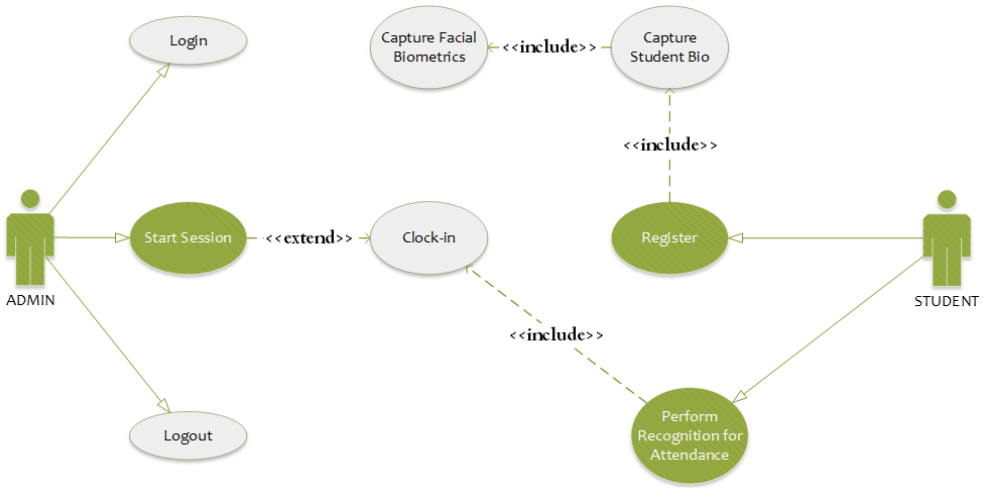

Figure 1: Facial Recognition Attendance system use case diagram

4.7 Context Model of The System

This system model shows an external view of the system and its surroundings. This model represents the system's boundaries and its surroundings. These limits might be created to address both technical and non-technical issues. After determining the boundaries, the analysis would strive to define the context simulated and the system's dependence on its surroundings. The following Figure 2 represents Student Attendance System Context Model:

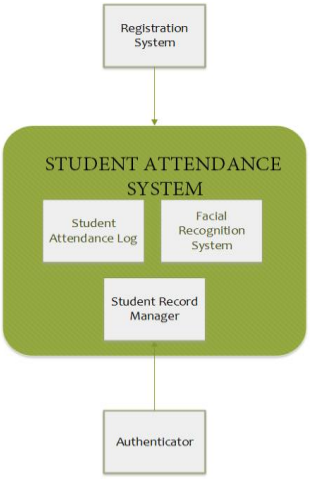

Figure 2: Student Attendance System Context Model

4.8 Process Flow of The Proposed System

The Process Model is used in combination with the Context Model to define human and automated processes. This diagram depicts the activities that make up a system process and the control flow between them. A full circle indicates the start of a process; a solid filled-in circle indicates the finish. Rectangles with rounded corners symbolize activities, or distinct sub-processes. Objects may be used to represent distinct systems supporting various processes. The following Figure 3 represents the attendance system process model:

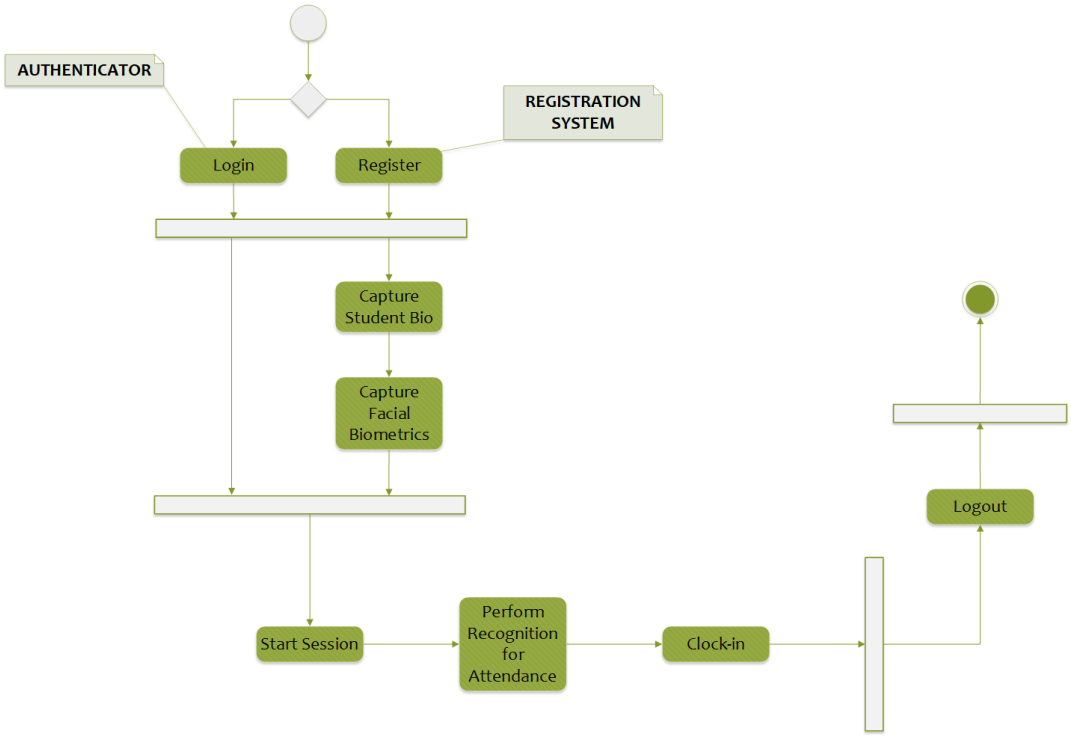

Figure 3: Attendance System Process Flow

4.9 Entity Relations Model of The System

This section discusses the objects and their relationships that comprise the system's components and functionality. These objects may be seen as entities, which can be used to represent a class connection between objects in an Object-Oriented Environment or to represent a database. The entity relation chosen serves as a model for the database structure. SAS (Student Attendance System) is the name of the database designed for this system. This application's database is comprised of three tables, which are explained below. The following Figure 4 also illustrates the Student Attendance System Entity Relations Model.

1. **Admin Table:** This table stores admin login credentials.
2. **Student Table:** This table stores the student's bio information which is used as reference for recognition.
3. **Attendance Table:** This table stores the attendance of students generated on this platform.

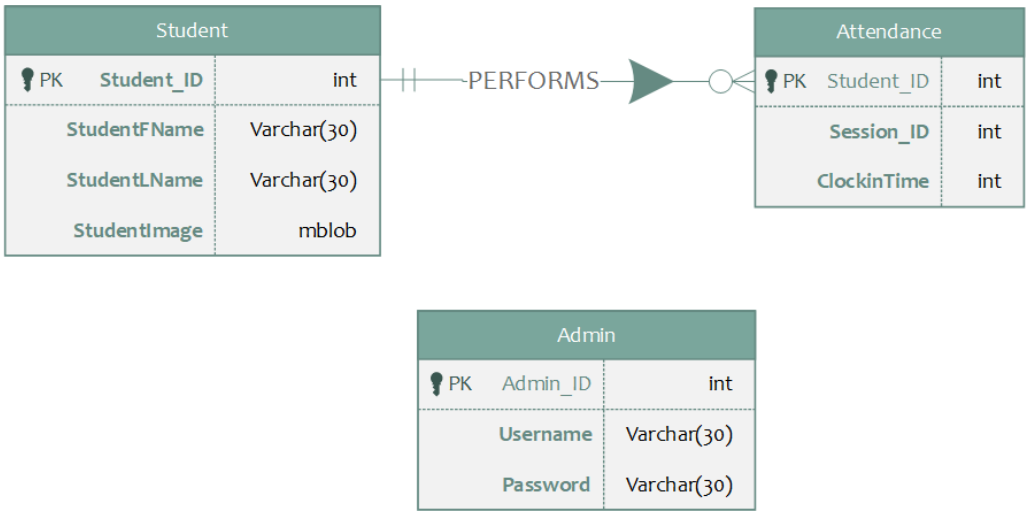

Figure 4: Student Attendance System Entity Relations Model

4.10 Development Phases

The development of the proposed system was quite a learning experience, as each phase came with its own unique challenges which were listed as followed:

1. Phase1: The system is developed in koras and facial information is stored on a csv file. The system can recognize faces, however, it has yet to integrate to a web interface for students to register on the platform.
2. Phase 2: The web interface is developed and integrated with the database system enabling admin to login to the facial recognition portal, and students to register on the platform, however, yet to integrate the web platform with the facial recognition system developed in python language.
3. Phase 3: The web application is integrated with python application to provide a complete web student attendance system using facial recognition.

5. RESULTS AND OUTPUTS

This section focuses on the aspect of user interactions that generate outputs because of user interaction and the analysis of the result to ascertain how well the developed application satisfied design objective and the problem statements earlier defined.

5.1 Login Page

As shown in Figure 5, this page provides the administrator of this platform an interface to login to the main page for student attendance. There is a link here to register a student on the platform.

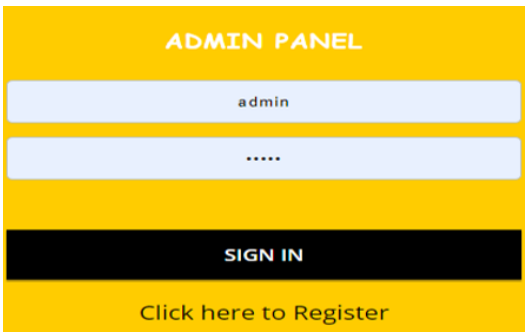

Figure 5: Login Page

5.2 Register Page

As shown in Figure 6, this page provides the students the interface to register their information on the platform using their personal information and facial image. The facial image is used as a reference for recognition during class attendance.

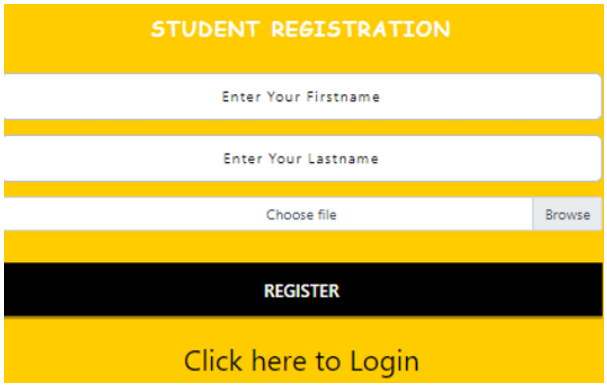

Figure 6: Student Registration Page

5.3 Main Attendance Capturing Page

As shown in Figure 7, this page is used by the administrator to initiate a class session where students can have their facial image captured to register or document their attendance. From here, a table containing the list of recognized students as well as their clock-in time is populated. The face recognition is achieved via the system's webcam. After capture, the file is sent to the python application where the facial features are extracted and stored in a variable. Then python application loads all facial images stored on the student table from the database and stores the image features of all images in an array. The image features of the student from webcam is compared to all images, and if there exist an image with above 90% match, the system inputs the student's information on the table and clock-in time (as a student present in class).

Figure 7: Admin Main Attendance Capturing Page

Furthermore, the following Figure 8 depicts a student clocking out of the system at 9:32pm. The system displays the student's credentials, status and time spent.

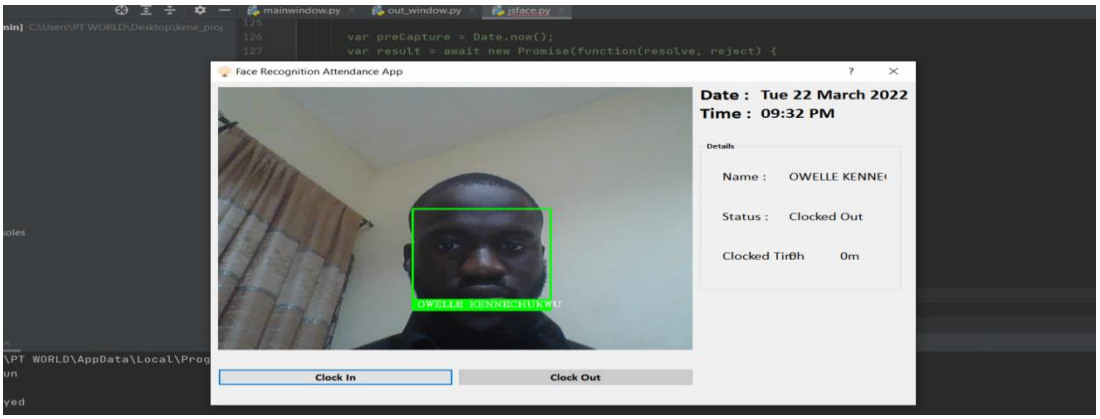

Figure 8: Facial recognition system capturing participant

5.4 Test Case Scenario

This study focuses on developing a web-based student attendance monitoring system using facial recognition. The developed application requires the python facial recognition application running at the background, and the Xamp web server running also at the background to host the Server-side application for processing student information for registration and access to the database.
The following Table 2 lists the test adopted to ascertain the effectiveness of the developed system.

Table 2: Attendance System Correctness Evaluation

Trial	No of Faces Registered	No of Faces Tested	No of Faces Detected
Test 1	3	3	2
Test 2	3	3	2
Test 3	3	3	1
Test 4	3	3	3

Test Scenario 1: Here, three new students are registered to the platform, the admin logins for recognition and the system are able to identify all three students accurately.

Test scenario 2: In this scenario, the registered students were tested under low ambient lighting conditions, and it was observed that the green bounding box around a recognized face took longer to appear on the screen. The green bounding box indicates a face has been detected in the camera view.

Test Scenario 3: Given the less than perfect results in scenario 2, the system is tested in less ambient lighting than that employed for scenario 2.

Test Scenario 4: Upon observation on the effects of low ambient lighting on the efficiency of facial recognition process, this scenario was tested in an environment with fairly high ambient light and as can be observed in the result above in Table 1, the system performs better.

6. CONCLUSION AND RECOMMENDATION

The attendance monitoring system using facial recognition was developed to recommend a better way of taking and monitoring student attendance within the University system, especially in private schools like Babcock University, Nigeria where taking records of student's participation in class is crucial to parents and the school at large. With the results demonstrating that the system can efficiently aggregate student attendance, eliminating the problem of the present manually filling attendance sheet, preventing proxy attendance that is possible with manual methods, this design should be very advantageous especially where population is large. This monitoring system would minimize tension among employers, employees, staff and students and reduce the amount of time it takes to compile attendance records. This development is recommended to private and public sectors who wish to measure punctuality and see how it could improve their businesses. Educational institutions should find this system useful in their daily activities.

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