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(RESEARCH ARTICLE)

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A generic face detection algorithm in electronic attendance system for educational institute

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Abstract

This paper aims to develop a generic face detection and recognition system that will automate the process of collecting school attendance by recognizing students' frontal faces from classroom photographs. The reliability of the data collected is the biggest problem with the traditional attendance management systems. Many automated methods, such as biometric attendance, are being used. However, technical difficulties with scanning devices always affect the efficiency of such techniques. This paper employs principal component analysis approaches for face detection and OpenCV for face recognition to improve data quality and information accessibility for legitimate parties. The Python programming language was used for the development of the proposed system, while SQL was used for the development of the database that houses the information of users in the system. The new system was tested and shown to be not only safe but also protects students' identities by offering an anonymous attendance environment.

Keywords: (ABS) Face Detection; Attendance; Machine Learning; Database; Principal component analysis; OpenCV and Face Recognition

1. Introduction

Institutions must now keep track of individuals within the enterprise, such as employees and students, in order to maximize their efficiency. Taking attendance, on the other hand, is a critical activity in any industry in order to keep track of pupils or staff. Because attendance is such a crucial aspect of administration, it may easily become a time-consuming, monotonous chore that lends itself to inaccuracy. Students' attendance is traditionally taken manually in class using an attendance sheet provided by faculty members, which takes a long time [1].

Many schools' practices have drawbacks such as waste of paper, disruption in the classroom, and so on. The method of keeping track of students' attendance during lecture periods has proven to be difficult. Because manual computing creates errors and consumes a lot of time, determining the attendance percent becomes a big undertaking.

The accuracy of the data obtained is the biggest issue in the present and existing attendance management systems. This is because the original person's attendance may not have been recorded. A third party can take a student's attendance without the institution's knowledge, which compromises the accuracy of the data [2]. The present system's second flaw is that it takes too long. Assume a student signs his or her name on a 3-to 4-page name list in one minute. Only around 60 pupils can sign their attendance in one hour, which is inefficient and time-consuming.

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Another problem is the genuinely concerned party's ability to get such information. Most parents, for example, are particularly worried about tracking their child's real locations in order to guarantee that their youngster attends college or school lessons. Parents, on the other hand, have no access to such information under the current system. As a result, the creation of a face detection system is required in order to increase efficiency, data quality, and information accessibility for legitimate parties.

A lot of research has been done on automated or smart attendance management systems to solve the problems with manual attendance [3]; [4]; [5].

A facial detection system is a computer program that can recognize or verify a person from a digital image or a video frame captured from a video source [6]. The flow of the process in face detection systems begins with the ability to identify and distinguish frontal faces from an input device such as a camera in order to extract facial traits. In general, feature extractions are performed by gathering a large number of faces and using machine learning techniques to create a face model for face recognition. Face recognition is the process of detecting faces in a scene, extracting features from those faces, and comparing them to faces in a database.

The fact that the most closely matched matches are identified and the person's attendance is updated. The system will be fed this image as input. A database of faces will be built to allow for comparison. Students' information such as roll numbers, names, and photos for identification are maintained by enrolling them in that database.

1.1. Literature survey

The evaluation of literature is significant in this work because it provides a history of how the attendance process progressed from the conventional paper and pen attendance system to the electronic-based attendance system. Additionally, the paper provides a list of the problems encountered during evolution and the many solutions scholars provided to solve them. This provides a foundation for deciding whether to use a tool and technique to get a better outcome. The following are some of the studies examined:

A fingerprint authentication attendance management system was designed and deployed [7]. The existing traditional system is automatically replaced by this system because it takes a very long time to implement and system maintenance is difficult. The presented system incorporates human interaction into the attendance process. In this system, the Eigen face technique is used to identify the face problem of face recognition. The camera is mounted in the classroom to gather the student's face image, compare it to the saved image, and then mark the student's attendance. When a student skips class, the system notifies everyone on the contact list, including parents, through SMS. However, technological challenges with this scanning equipment include the inability to scan and extract information from specific people's fingers. Given this, it is critical to develop a new system that will provide a dependable and efficient solution to the aforementioned problem.

The goal of [8] is to automatically register attendance. The camera is placed at the front of the classroom and recognizes individual student faces, which is subsequently used to record attendance. The entire procedure is carried out automatically. The camera will take a picture of the overall class, then detect individual faces in the image, verify the attendees, and update their attendance information. The images are collected at the beginning and end of each teaching session. However, due to the high cost of camera equipment, this system is difficult to deploy. This technique is also slow, considering students must queue to enter the classroom. In light of this, a new system that provides a sustainable and optimal approach to the identified problem is required.

In the work of [9], a new system for tracking student attendance based on facial traits was developed. In this fashion, the procedure is divided into four phases. The first part involves labeling the faces, training the data, and classifying the dataset based on the labeled data. The classifier is used to identify the faces. The input visualizations are from the classroom. However, the computing cost can be enormous, and the identification speed in an embedded context is horrible. Taking this into account, a system that provides a workable, inexpensive, and prime solution is desired to ease the challenges affecting the procedures of taking attendance.

A new method in which real-time data from the classroom is used to automatically record attendance [1]. The camera's collected data is connected to the classrooms. The photos are recorded in real-time and compared to the data that has been saved. This author presented a novel system for keeping track of students' attendance. However, the developed system can only detect faces from a certain distance, and the system may not recognize faces effectively in low light, so it may provide erroneous results. In this regard, developing a new system that will mitigate the aforementioned problem will be of great importance.

Principal Component Analysis and the Eigen Face Technique were used to create the face recognition system [10]. The algorithm recognized human faces efficiently and functioned well when different facial expressions and salt and pepper sounds were included. An automated attendance updating system that relies on facial recognition technology was created. This system will also be utilized to gather photographs of different people's faces. However, this system runs a centralized database system, which can be hacked with new advancements in technology. The quest for a new system with a sophisticated database infrastructure that is invulnerable and immune to hacking is required.

A system that describes approaches used in automated attendance systems, such as the Viola and Jones algorithm for face detection and the MSE algorithm for face identification, was developed [11]. The model uses the Viola-Jones approach to convert the RGB image to a YCbCr image and is designed to detect features on the face. The MSE is computed using both the live and referenced image pixels, and the face is detected if the MSE exceeds the threshold. This approach is more efficient, faster, and provides the user with quick access. This kind of system consumes resources and can be considered expensive to implement as a result of repetitive attendance-taking procedures. Also, algorithm recognition accuracy needs to be improved when there are inadvertent changes in a person's appearance, like tonsuring, wearing a scarf, or growing a beard. Since the developed system can only detect facial changes of up to 45 degrees, which still needs improvement.

The work of [12] developed a system that utilizes facial features to identify students by collecting photographs from video. This system's main purpose is to take attendance without the need for human interaction. Faces are recognized in this system using the Viola-Jones algorithm in combination with the Fisher Face method, with an accuracy of 45 to 50 percent. However, the technology does not recognize slanted or rotated faces. It is also affected by lighting conditions. Given this, it is necessary to build a new system that delivers a dependable and efficient solution.

The paper [13] proposed a system that captures each student's face and records it in a database for their attendance. video capture Inside a classroom, the camera is set at a specified distance to take films of all of the pupils' frontal pictures. separate frames from the video: For faster identification and recognition of the student's face while creating the attendance database network, the acquired video must be transformed into frames per second (Convolution Neural Network). It may be used in bigger locations, such as a lecture hall, to detect the presence of a huge number of individuals. However, the bad illumination in the classroom can sometimes decrease system performance. Conversely, this can be mitigated by improving the video quality or employing various algorithms.

A new system that includes features such as face identification, feature extraction, feature detection, and attendance analysis to address the limitations of previous systems was proposed in the work of [14]. The use of more face features (such as form, color, LBP, wavelet, autocorrelation, and so on) would increase the system's accuracy in detecting and recognizing faces. It primarily used Eigen face, line edge map, and HOG (histogram of oriented gradients) to detect faces. Eigen Face: This approach easily extracts the necessary information from a photograph. Line Edge Map: Line matching is used to map the most noticeable features of the face. A histogram of oriented gradients: One use of this method is for object detection. Images are converted to greyscale using an integer gradient. This system, however, requires time, decreases noise, and diminishes details. Subsequently, a new system is necessary that provides sustainability and optimal solutions for the identified problem.

[15] developed a unique method for converting learning into automatic emotion recognition (AER), and this technology was applied across many modalities. In the proposed method for recognizing facial expressions, saliency maps are utilized to transmit knowledge from a source to a target network by "hiding" irrelevant data. The proposed technique is independent of the model used because the experience is only transferred through augmentation of the raw data. The assessment discovered that when the proposed model was forced to concentrate on the parts of the input that were judged to be critical sources, the new model was able to adapt to the new domain faster. Nevertheless, when using saliency maps to assess the likelihood of fixating a certain location in a viewed scene, the temporal dimension of visual attention deployment is a key issue. In addition, the human recognition accuracy of emotions was measured at 72%, which is low and requires improvement. Consequently, a new system is needed that provides improved face recognition accuracy for the identified problem.

2. Material and methods

This paper makes use of the combination of Principal Component Analysis (PCA) and OpenCV. PCA is a statistical method used for face detection to reduce the number of variables. Each picture in the training set is represented in PCA as a linear combination of weighted eigenvectors known as Eigen faces. These eigenvectors are derived from a training set's covariance matrix. While OpenCV is a library for performing image processing using computer languages, it is

mostly used to do Real-Time Face Detection with a webcam as the primary camera. The main reasons for this selection are their smooth applicability and reliability issues.

2.1. Workflow of the Proposed System

The proposed system is divided into six phases with the aid of a flow diagram shown in Figure 1. The phases are image acquisition, image preprocessing, face detection, face recognition, training datasets, and attendance generation, respectively.

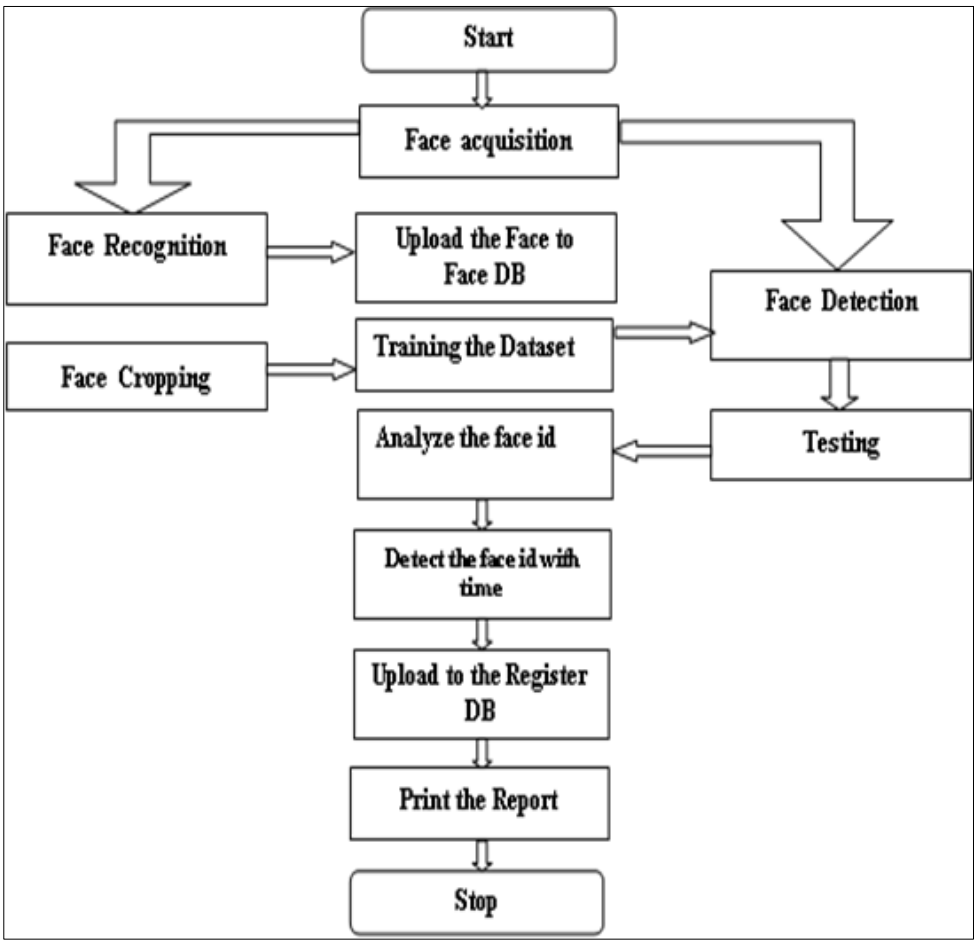

Figure 1 Workflow of the Proposed System

As seen from Figure 1, the acquired image is turned into numerical data at the stage of image acquisition.

At this stage, following the conversion, the picture is subjected to a variety of procedures. Grayscale photos are created from the gathered photographs. The image is further processed to increase the quality of the photo. The collected photos will be forwarded to the detecting module. This is the initial stage of identifying a person's face. Facial traits or the structure of the face are used to identify faces. The LPBH algorithm is utilized to recognize faces in this system. Using this algorithm, each pixel in a photo is labeled by thresholding its area and converting its result into a binary number. The photos are cropped and passed to the next job after face detection.

After the face detection phase, the next task is face recognition. The cropped photo is compared to previously saved images in the databases. The face recognition phase encompasses a set of approaches, including feature extraction and categorization. The photos captured by the webcam camera are compared to previously saved photographs to verify their authenticity in this step. Once the confirmation is successful, this system generates the student's attendance based on their facial traits or structure.

2.2. Block Diagram of Proposed System

The proposed block diagram of the proposed system is shown in Figure 2.

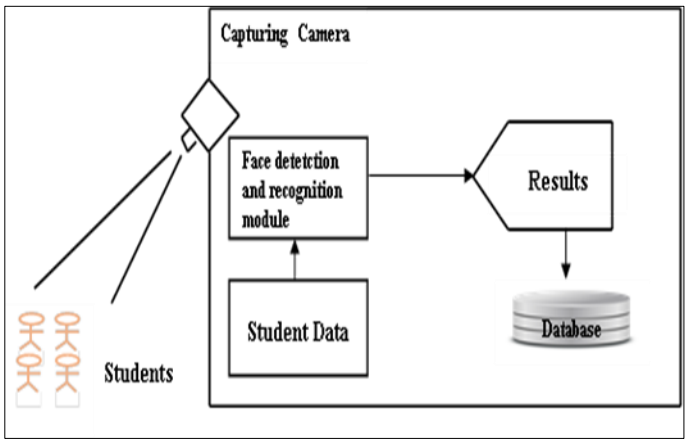

Figure 2 Block Diagram of Proposed System

As seen from Figure 2, the faces of the students are captured by a webcam camera. The acquired photos are compared to the data that has been trained. The outcome will be saved in the database, and the attendance status will be updated as soon as possible.

2.3. General Algorithm and Flowchart of the System

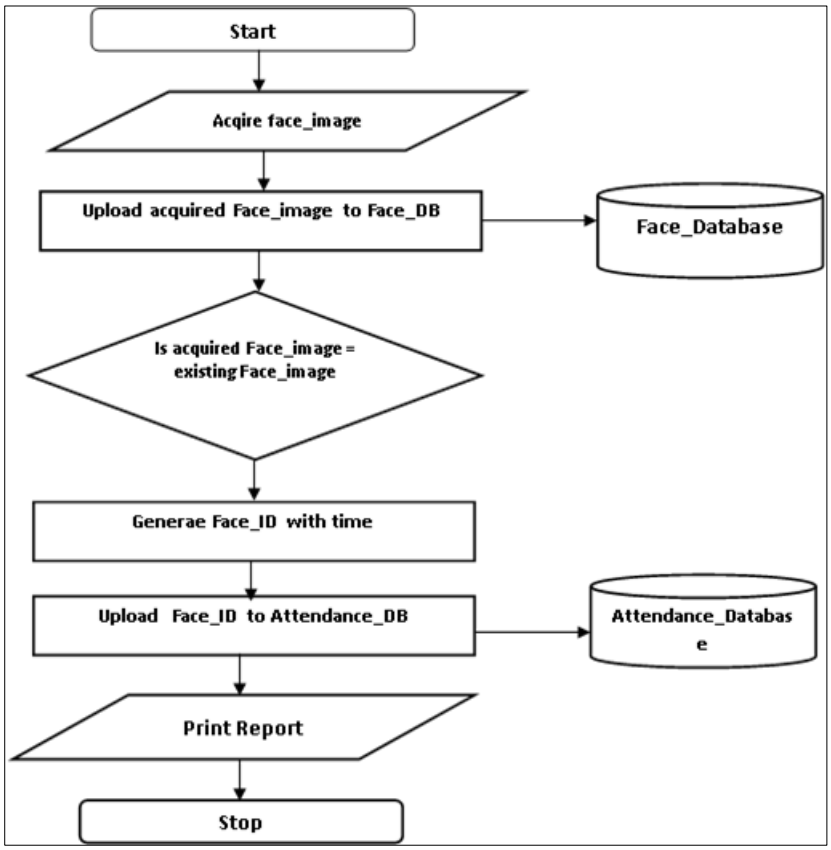

Figure 3 Flowchart of the System

- Start
- Acquire Face_image

- Upload acquired Face_image to Face_DataBase
- If acquired Face_image = existing Face_image Generate Face_ID with time & goto 5Else Print "Record not found" & goto 7
- Upload Face_ID to Attendance_Database
- Print the report
- Stop

2.4. System Use Details

The use case diagram is shown in Figure 4. It is used to describe the system's use and also shows the basic requirements that the system needs to achieve the specified objectives of this paper. The different actors in the system are shown in turn. It can also be seen that the system administrator is responsible for adding and editing students' records.

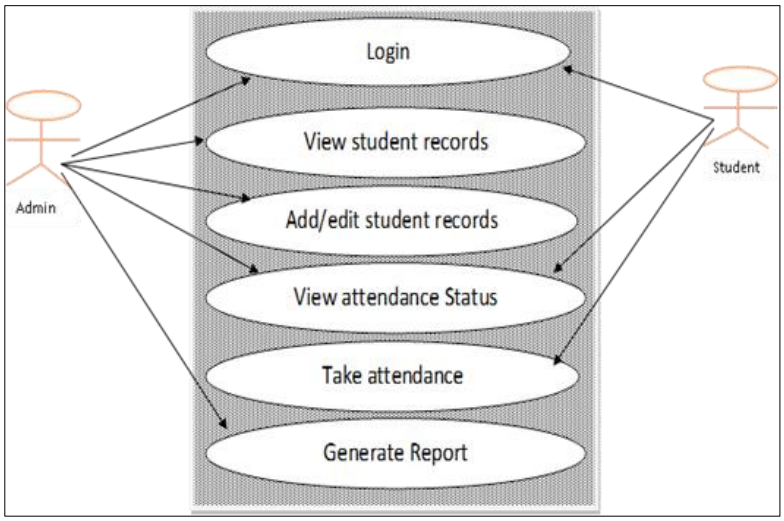

Figure 4 Use case Diagram of the New System

The system administrator is also responsible for viewing and generating student's attendance reports. However, only the administrator can make subsequent changes in the student records and other details.

3. Results

3.1. Implementation Details of the System

The proposed system is implemented in this article using Python, OpenCV, JavaScript, and Cascading Style Sheets (CSS). It may be accessed via a web browser on a range of computer devices, including mobile phones, tablets, and phablets, because it is web-based software. Furthermore, the system was created on a Windows machine before being tested on a Mac and Linux machine. It was found to function correctly and fulfill the needed functions as expected, with no compatibility concerns. SQL was also utilized to create a database that was designed to hold facial characteristics extracted from webcam photographs and allow for quick retrieval via the interface. The storage facility is crucial because it houses all of the documents needed to preserve and manage all of the information.

3.2. Homepage

There were five items on the homepage navigation menu: Home, About, Contact, Admin login (sign up), and a brief explanation of the project and library used. As shown in Figure 5, a user cannot access the login page unless they are logged in or registered.

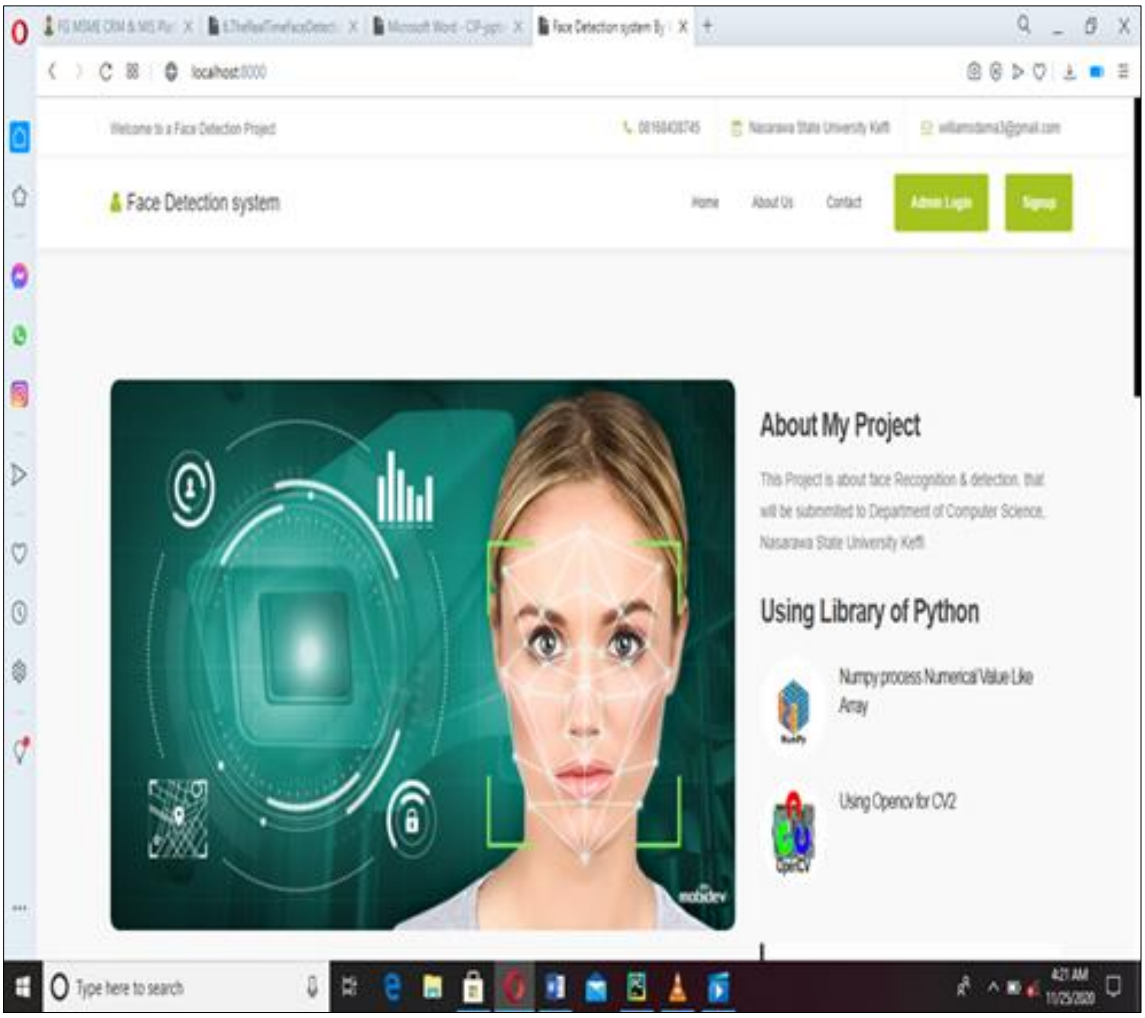

Figure 5 Homepage

3.3. Users Registration Page

Before gaining access to the system, the new user must first register. The user must also create an account by entering a username, password, first name, last name, email, phone number, address, and user image/picture on the Sign Up (Register) page (save inside the system). The user then clicks the submit button, which opens the PC webcam for numerous snaps, with the snapped image being utilized for training to detect and recognize the user's face. The users' registration page is depicted in Figure 6.

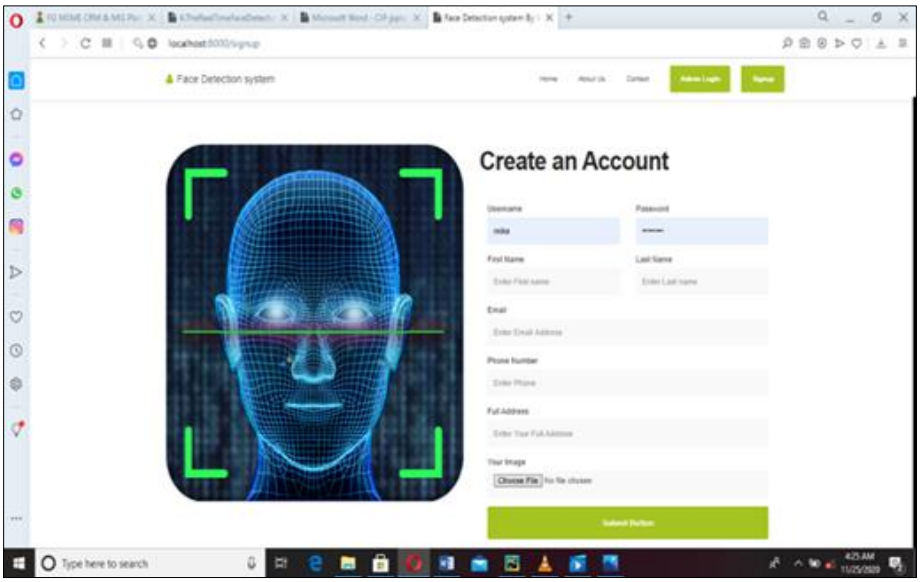

Figure 6 User's Registration Page (signup)

3.4. Admin & Users Log in Page

The admin login page is the same as the user login page but with different privileges, indicating that the admin has greater control. As seen from Figure 7, the user is required to login by supplying their username and password. However, the system is saddled with the responsibility of displaying system interfaces depending on the user's responsibility.

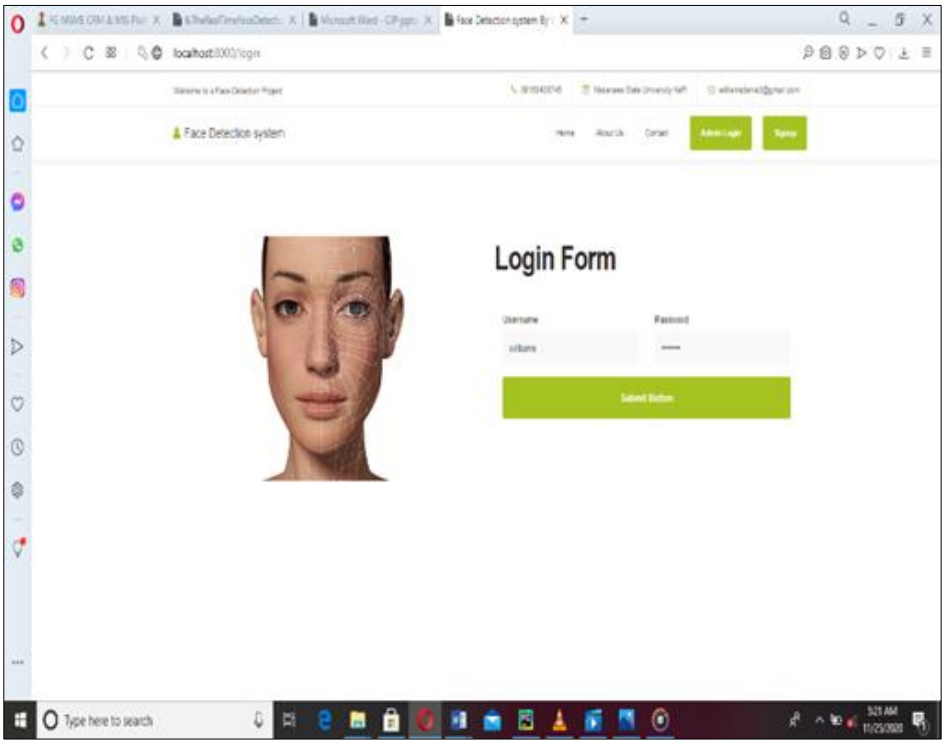

Figure 7 Admin and User Login Page

3.5. Admin Dashboard

This is the admin home for the administrator, where he can manage users, manage system login and edit other system configuration. The admin page was designed in such a way that the admin will oversee the activities carried out on the

system. This page is only available to the admin. As shown in Figure 8, the side menu of this page is higher in number than that of a user.

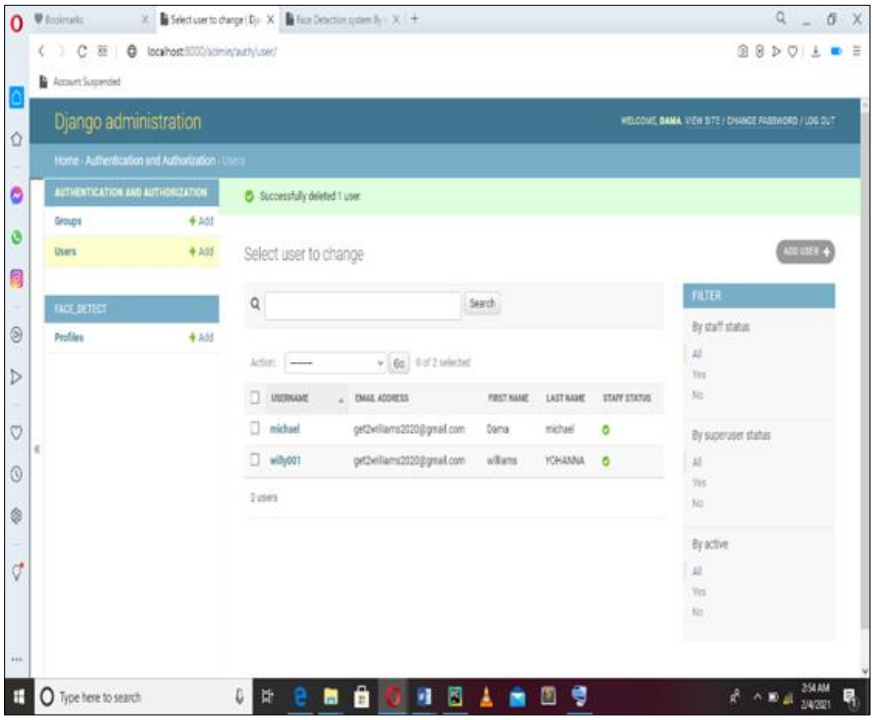

Figure 8 Admin Dashboard

3.6. Admin View Users Page

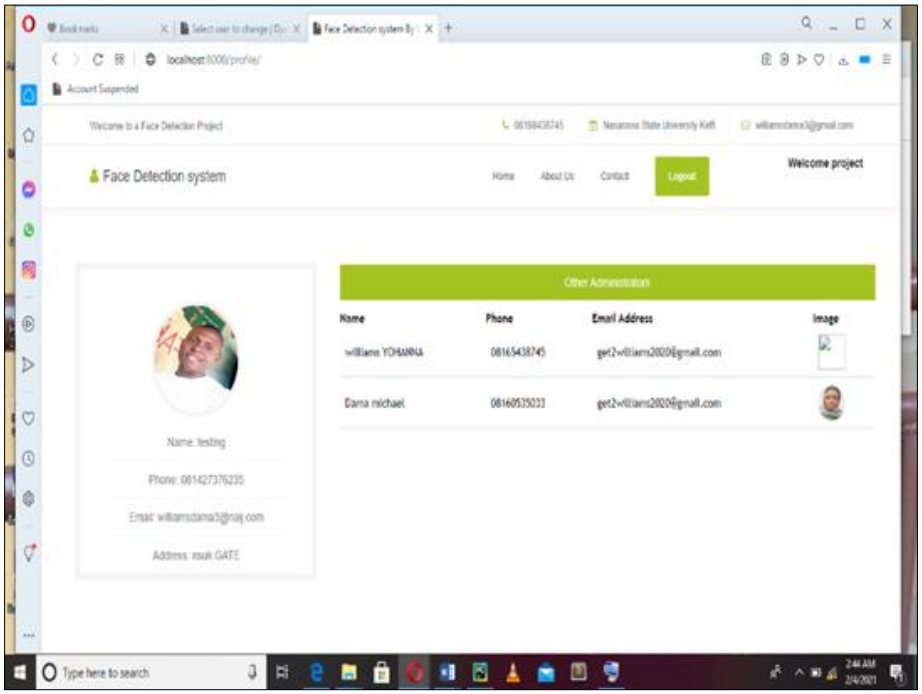

Figure 9 Admin Dashboard

This page allows admin access to a user's information and also the right to view the user's activity in the system. This page displays the logs of the user's access to the system as shown in Figure 9.

4. Discussion

In this paper, the combination of both PCA and OpenCV was effective and efficient due to the high recognition rate of the two methods. In Hepani et al. (2018)'s work, the recognition accuracy rate ranges between 45 and 50 percent, which is technically low. Similarly, in the work of Schiller et al. (2020), the time dimension of visual attention deployment is a crucial problem when utilizing saliency maps to determine the possibility of fixating a certain spot in a seen scene. Correspondingly, in the work of Nandhini et al. (2019), the speed and time taken for transforming acquired images into frames is also a challenging task. However, this new system is fast and performs better at both the detection and recognition stages of capturing and enrolling students' records into the system. . Finally, a final test was performed to ensure that the proposed redesigned system performs the intended functions without posing any compatibility issues.

5. Conclusion

Almost all academic institutions demand students' attendance records, and keeping attendance physically may be a stressful and time-consuming process. As a result, keeping attendance automatically using facial recognition will be extremely valuable and less prone to mistakes or errors than the manual process. This will also decrease student attendance record tampering as well as time usage. The Automated Attendance System based on Face Recognition is easy, accurate, and effective. Once the administration creates the registration of different students, this system operates automatically. To boost system performance and improve identification accuracy, a few algorithms that can sense appearances must be used. When a user stands in front of the camera, these measurements are saved in a database and utilized as a comparison. Facial recognition is non-intrusive, which is one of its main advantages. Identification may be verified from a distance of two feet or more without the need for the user to wait extended amounts of time or do anything other than glance at the camera. Traditionally, attendance is recorded on a paper attendance sheet. The current techniques for recording attendance are tedious and time-consuming. Attendance that is manually recorded can be readily influenced. Furthermore, in a large business with many branches, it is quite difficult to check students one by one. As a result, this study aimed to address all of these concerns.

Recommendation

Face recognition is one of the most effective applications of image processing in both the technological and security domains. Human face recognition is a crucial sector for verification, especially when it comes to student attendance. This research used a computerized approach to track attendance. The current techniques for recording attendance are tedious and time-consuming. Attendance that is manually recorded can be readily influenced. Utilizing facial recognition technology, an electronic attendance system was implemented to overcome all of these challenges. Facial recognition, or simply face recognition, analyzes the attributes of a person's facial picture supplied by a camera. Besides assessing the shape of the face, it also examines the distance between the borders of the eyes, nose, mouth, and jaw.

Future work

The future extent of the proposed work can be determined by capturing numerous clear pictures of the staff and utilizing any cloud innovation to store these pictures. This framework can be designed and utilized in ATMs. Also, the framework can be utilized at the time of elections, when the voters can be distinguished by perceiving the face.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

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