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Face Recognition for Students' Attendance System

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Abstract: Face recognition is a technique for identifying a human face using technology that maps facial features from a photo or video using biometrics. It compares the data with a database of recognized faces to identify a match. A comparison study of the effect of different types of cameras depending on the distance and intensity of indoor face recognition systems is presented in this paper. The purpose of developing this face recognition system is to track student attendance in the classroom. In the current approach, attendance is recorded manually using paper, and lecturers must enter the attendance records into a polytechnic database system called SPMP. Recording attendance manually using paper can result in several issues, including wasting time and paper, and less data accuracy. This system was designed entirely in the Python programming language, and the haar cascade-frontalface_default technique was utilized to recognise faces for the training module and record attendance. First, students must capture images and save their profiles in the training module. Then, the attendance was taken using data from the training module. The system was successfully developed and efficient to be used to record attendance. Based on the results, the quality of an image detected depends on the camera type, the light intensity (indoor), and the distance of the image taken. In the future, this system can be upgraded by developing an interface for admin by using backup data in cloud storage.

Keywords: *Face Recognition, Python, haar cascade-frontalface_default, Attendance, Intensity, Distance*

1. Introduction

Over time, there has been an evolution in how attendance is tracked in an institution or organization. From manually recording attendance using handwriting to RFID, fingerprints, and most recently, facial recognition. Manually recording attendance on paper can cause several issues, including wasted time and paper, as well as worse data accuracy. Therefore, as time has passed, some of the most recent technologies, such as those stated above, have been developed to record attendance to replace traditional techniques.

The first approach after the traditional method is Radio Frequency Identification (RFID), which is wireless technology. An RFID system typically consists of an RFID reader, an RFID tag, and an antenna. RFID provides consistent tracking and tracing in challenging environments. This technology allows for simple monitoring and real-time data delivery. However, the weakness of RFID technology is that the implementation software enables everyone to be analyzed by the primary database. This environment will be vulnerable to hacker assault [1]. Its application has also diminished recently.

As an alternative to an RFID, the subsequent approach utilized approach was fingerprint recognition, an example of biometric technology. Fingerprint recognition is an established field. However, identifying a person from registered fingerprints is time-consuming. Most databases used by fingerprint-based biometric systems keep user minutiae templates [2]. User minutiae templates are typically thought to contain no information about the original fingerprint. This assumption has now been debunked, and several researchers have proven that fingerprint

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reconstruction is a technique for resolving this issue.

Followed by the most recent biometric technology advancements, facial recognition. It is now widespread, and the demand is also increasing. In this work, we proposed designing and implementing an attendance record system that employs face recognition and detection technology to track students attending lectures automatically using the haar cascade-frontalface_default technique for face detection, and various type of camera is being compared based on distance and intensity. Python language and open CV have been used to implement this system. The face recognition system comprises a registration phase in which the unique traits of a person's face are stored in a database, followed by a recognition and verification process. Faces detected from the webcam are compared to previously stored faces. The main reason behind the development of this system is to analyze and find a solution to the imperfections of manual attendance recording practiced over the years.

2. Literature Review

It is necessary to switch from the traditional way of documenting student attendance to an automatic one that is more effective. Attendance records may be managed more rapidly by employing facial detection and automatic recognition. Since Turk & Pentland (1991) presented the eigenface technique in the early 1990s, facial recognition has gained popularity. In social relationships, the face is the primary center of human attention and plays a vital role in conveying identity and feelings. Although it is questionable if intelligence or personality can be inferred from facial appearance, the human ability to recognize faces is extraordinary. We can identify the faces of thousands of people we have met in our lives, and we can spot familiar faces even after years apart. Despite significant shifts in the visual stimuli brought on by viewing settings, emotions, aging, and distractions such as spectacles or changes in hairdo or facial hair, these abilities are surprisingly resilient. Therefore, until facial recognition technology was developed, scientists were interested in the visual processing of human features. Face computational recognition models are intriguing since they can contribute to theoretical understanding and practical implementations. Face recognition can handle many problems, including criminal detection, security systems, picture and video processing, and human-computer interaction.

In 2020, Chakraborty *et al*. developed an automatic student attendance system using face recognition using Principal Component Analysis (PCA) algorithm. This method uses Principal Component Analysis (PCA) algorithms to help in achieving the desired results with greater precision, doing away with the identification and recognition distance problem for both close and group images. Another work proposed by Yang & Han (2020) implemented a face recognition attendance system based on real-time video processing. Their research focuses primarily on the face recognition system's accuracy rate during real check-in and its stability when real-time video processing is used. Experiment results show that their video facial recognition system has an accuracy rate of up to 82%. Additionally, they claimed that the phenomenon of students leaving class early or skipping it could be reduced, help students quickly finish their tasks in the attendance check-in system, get rid of the problem of complex names being hard to write, and make the class much more efficient.

The more advanced development of an automated attendance system was proposed by P.C. Senthil Mahesh *et al*. (2020). Their automated attendance system is developed using deep learning to compute and compare students' facial features. Their system and algorithms are realized using Raspberry Pi, Python, and MySQL servers. Another researcher who also uses deep learning that is more innovative is Chirde *et al.* (2022). The Haar-Cascade classifier and the built-in Binary Pattern chart algorithmic software are used for their face recognition attendance system. Their model method uses the CNN rule to instruct photos and the Local Binary Pattern Histogram (LBPH) visual descriptor for image classification. It is claimed that these models will be capable of giving a higher degree of accuracy compared to other automated attendance systems now in use.

An Android-based attendance system using a face recognition application is proposed by Susanto *et al.* (2021). The system also used the LBPH algorithm method to measure the face recognition system. Their testing and analysis of the false rate, error rate, and false refusal rate showed that the average level of LBPH accuracy reaches 95.71% better than through the Eigenface method, which is equal to 76.28%. Satpute *et al.* (2022) recently used Neural Network (NN) artificial intelligence for facial recognition. However, Devan *et al.* (2017) already employed AI long ago in their attendance system in 2017. NN is utilized in their project to train the Viola-Jones algorithm, and the mapping of photographs to the database is utilized by the attendance system, which updates the days of presence and alerts external parties of their existence. Last year, Hung & Nguyen Nhi Khang (2020) proposed a face recognition-based attendance system using a Convolutional Neural Network (CNN) for computer vision and Haar Cascade for face recognition.

3. Methodology

In this study, an attendance system based on facial recognition was developed using the haar cascade-frontal face default technique, OpenCV, Python language, and various types of cameras to compare performance and visual quality.

3.1 Face Recognition System Overview

The flowchart in Figure 1 provides an overview of the entire database life cycle. The work steps to build this attendance system involve programming, input images, face detection, face extraction, face classification, face recognition, and face database.

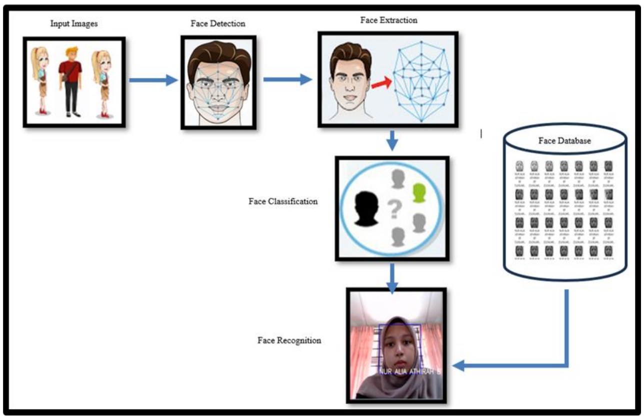

Figure 1 Database Life Cycle of Face Recognition Detection Process [12]

The design step begins with a system specification, which explains how a system should be built. While the implementation step entailed building a computer system and considering the environment in which the system would operate. Lastly, an initial system is validated and tested before a final system is issued for usage.

In this work, the system could quickly and accurately identify human faces in images or videos taken with the camera module. It measures the distances between the eyes, nose, and mouth, as well as the overall shape of the face. First, the software takes a picture of all the authorised people and stores that information in a database. The system then saves the image by mapping it into a face coordinate structure. The next time the registered person comes to class, the system will recognise him/her and mark their attendance.

3.2 Development of Face Recognition for Students' Attendance System Software

Flowchart of the entire system is shown in Figure 4. First, the student needs to enter their name and Matrix Number. Then, students need to click the "Take Image" button. During this process, about 101 photos of each student will be taken. Next, when the camera turns off automatically, click the "Save Profile" button. Students need to click "Take Attendance" in order to record attendance. After that, the student's name will appear on the camera. If your name shows up on the camera, press the "q" and "Quit" buttons. Otherwise, if the camera shows the other student's name, contact the Admin.

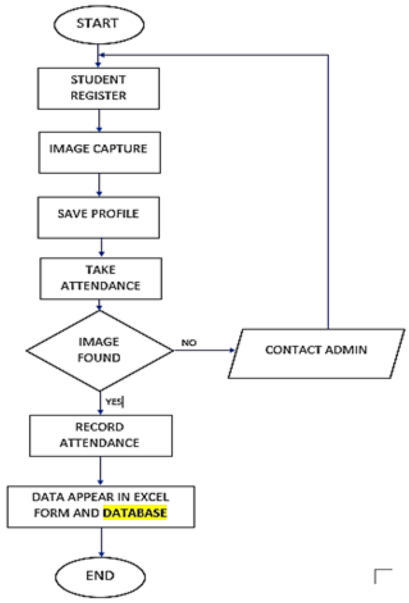

Figure 4 Flowchart for Face Recognition for Student's classroom Attendance System

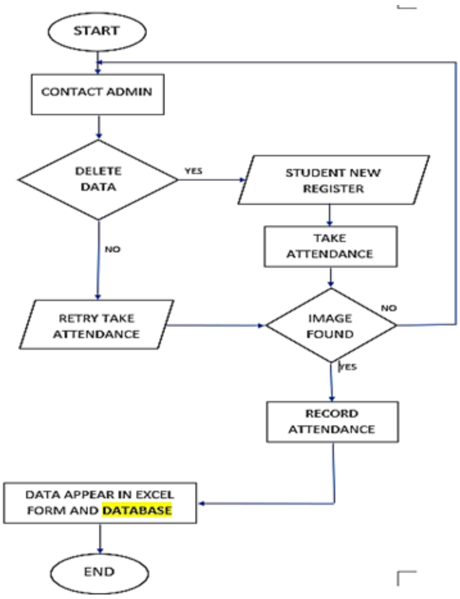

Figure 5 Flowchart for Administration Face Recognition for Student's Attendance System

Whereas, Figure 5 is shown about the flowchart of the Admin. To begin, each student is required to key in their own data as soon as they enter the classroom. After that, students are required to demonstrate that they are present in the classroom by taking attendance. However, in the event that there is an issue with the application, they will need to contact the administrator. Where a popup concerning admin information will be displayed. The administration needs to decide whether or not to erase the student data. If admin erase the student data, student need to register new data and if otherwise students are required to retake the attendance. Then, the process is end.

3.3 Image Processing

Image processing is a signal processing technique used to manipulate images to enhance their quality, extract valuable data from them, or produce specific characteristics/features of the input image as output [13]. Currently, image processing become one of the most quickly progressing technologies in the modern era. Image processing involves multiple phases, including:

i. Image acquisition: to acquiring a digital image,
ii. Image pre-processing: to improves the image for the subsequent operations,
iii. Image segmentation: to divides an image into items and converts input data for computer processing.
iv. Image description: to extracts features that result in quantitative information of interest by separating one class of objects from another.
v. Image recognition: to labels an object using its description.

Also, in this work, Visual Studio Code was used for write the code, help with debugging, and correct the code with the "intellisense" method. In simple terms, Visual Studio Code is an editor for writing code that is easy for users to write code. Many people say it's half an IDE and half an editor, but it's up to the coders to decide. It works with nearly every programming language. Its features let the users change the editor to fit their needs. For example, the user can download libraries from the internet and add them to their code as their sees fit.

Then, XAMPP is an open-source web server programme used to create this attendance management system. It's an abbreviation for "cross-platform," the Apache HTTP server, the MySQL database, the PHP scripting language, and the programming language. XAMPP was made so that web designers, developers, and programmers can preview their work locally, even when they don't have access to the internet. Therefore, XAMPP can be used independently of an internet connection to serve as a substitute for web pages. It's also possible to use MySQL and/or SQLite databases that you create and configure with it.

3.4 Haarcascade-frontalface Default Technique

Paul Viola and Michael Jones [14] developed an efficient method for detecting objects called the Haar Cascade classifier.. Ha-ar like properties provide the foundation of object detection with the Haar classifier as shown in Figure 6. Instead of using the intensity values of a pixel, these features employ the difference in contrast values between consecutive rectangular groupings of pixels. The contrast differences between pixel groups are utilised to estimate the relative brightness and darkness of a region.

A Haar-like feature is made up of two or three groups that are close together and have different levels of contrast. Features that are like Haar are used to detect an image. The size of Haar features can be easily changed by changing the size of the group of pixels being looked at. This lets features be used to detect objects of different sizes.

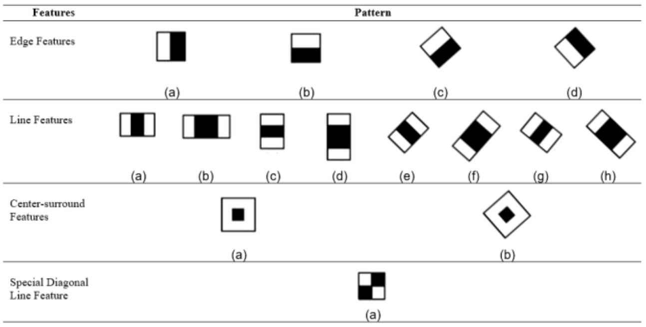

Figure 6 Haar Feature and Cascade Classification [15]

4. Result and Discussion

a) Graphic User Interface (GUI) of the Face Recognition for Students' Attendance System

The GUI Face Recognition Classroom Attendance system is shown in Figure 7. When a student registers, the system collects all of the student's information as well as training image captured 101 times of the student's face image, as shown in Figure 8. It then saves this information in a database, which is later accessed during the recognition stage and attendance recording process for the student who has registered. After recognising the students' faces, as illustrated in Figure 9, their matrix numbers and names are recorded into an excel file and also appear on a GUI as shown in Figure 10.

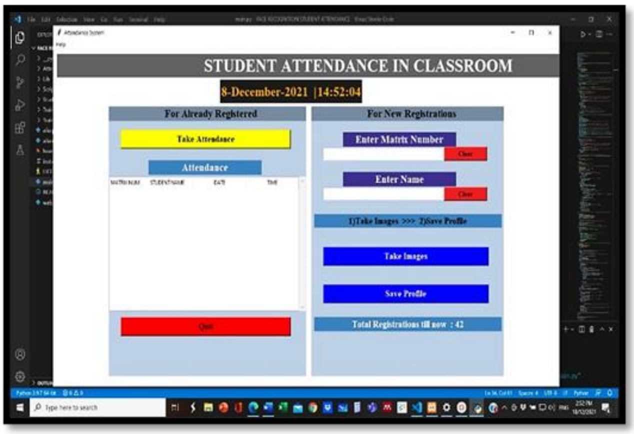

Figure 7 Graphic User Interface Face Recognition for Students' Attendance System

Figure 8 Training Image captured 101 images

Figure 9: Name of student who attend the class with date and time

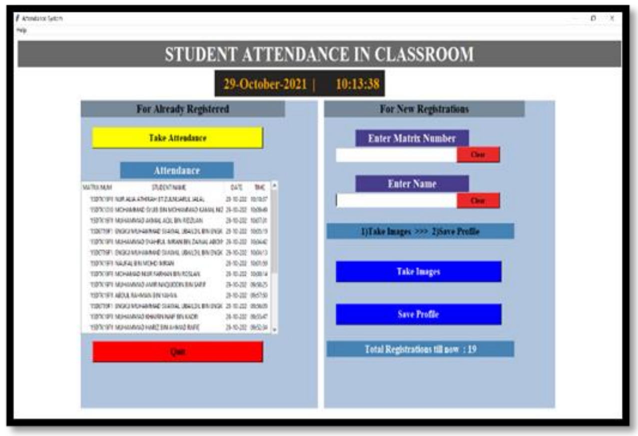

Figure 10: Training Image captured 101 images

b) Comparison of Different Types of Cameras Based on Distance and Intensity of Indoor Face Recognition for Students Attendance System

The purpose of this work is not only to develop the attendance system using haarcascade-frontalface_default technique but also to compare the performance of the system by using various camera including built-in camera and portable camera. Thus, the following is the result of the comparison between the camera.

This test is done to find out the effective distance of several different types of cameras to the system and the difference in quality. Based on the test results obtained in Table 1, it can be stated that HP TrueVision HD built-in camera, Xiaomi portable camera, and Minus 10MR portable camera are able to detect face images clearly at a distance of 1 meter but ov9734_azurewave built-in camera is unable to detect more than 50% of face images at a distance of less than 1 meter which is 29 inches or 0.74 meters.

This test was performed to examine the effect of light intensity on the face recognition system depending on the type of camera. Based on the results in Table 2, it can be stated that this system is better when detecting images in moderate intensity. If the images stored in the database are in high light conditions, the system will not recognize images captured in low light conditions and vice versa.

Table 1 Comparison of Different Types of Cameras Based on Distance of Indoor Face Recognition for Students' Attendance System

Elements		**Students' Attendance Data Images Capture From**			
Data Images Registered In HP Core i7 10th Gen HP TrueVision HD Camera		**Built-In Camera**		**Portable Camera**	
		HP Core i7 10th Gen HP TrueVision HD Camera	**Huawei Matebook D15 Ryzen 7 ov9734_azurewave_wave**	**Xiaomi**	**Minus 10MR**
Pixel		**0.92MP (HD)**	**1MP (720P HD)**	**1080 pixels**	**1080 pixels**
Detected Distance Face	50% (image detection)	39 inches / 1 meters	28 inches	39 inches / 1 meters	33 inches
					
	>50% (not detect the image)	42 inches	29 inches	41 inches	36 inches
					

Table 2 Comparison of Different Types of Cameras Based on Intensity of Indoor Face Recognition for Students Attendance System

Elements	Students' Attendance Data Images Capture From			
Data Images Registered In HP Core i7 10th Gen HP TrueVision HD Camera	**Built-In Camera**		**Portable Camera**	
	HP Core i7 10th Gen HP TrueVision HD Camera	**Huawei Matebook D15 Ryzen 7 ov9734_azurewave_wave**	**Xiaomi**	**Minus 10MR**
Pixel	**0.92MP (HD)**	**1MP (720P HD)**	**1080 pixels**	**1080 pixels**
Lighting Intensity with 50% Detection				
Low	25 inches	20 inches	Not detected	Not detected
				
Medium	39 inches / 1 meter	28 inches	39 inches / 1 meter	33 inches
				
High	42 inches	35 inches	Not detected	39 inches / 1 meter
				

5. Conclusion

It is possible utilise this student attendance system that is based on face recognition to assist lecturers in managing the attendance of their students. This system is created using Python and the haarcascade-frontalface_default approach. According to the results of the tests and analysis, the students face can be recognised accurately when there is between 0.25 and 1 metre of distance between the camera and the student. The result of face recognition might be affected by the level of light intensity in the environment. The accuracy of face recognition systems is 91.67% provided that the person being recognised is looking directly into the camera. Utilizing databases to store the output data allows for a reduction in the amount of time spent recording attendance.

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