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Recording Student Attendance and Recognizing Their Faces Using Deep Learning

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Abstract: There are several methods available to monitor student attendance in classes, such as biometric, radiofrequency, face recognition, and paper-based systems. However, the face recognition-based approach has been found to be both efficient and secure. In this study, a threshold to confi-dence has been implemented through Euclidean distance values to en-hance the identification process. The Local Binary Pattern Histogram (LBPH) algorithm has been utilized for this purpose, as it has been demonstrated to be more effective than other methods such as Eigenfaces and Fisher faces. The Haar cascade method has been used for facial de-tection due to its robustness. The system's performance has been assessed in various scenarios, including recognition rates, false-positive rates, and detecting unknown individuals with or without a threshold. The system has demonstrated an impressive 79% recognition rate for students, with a 24% false-positive rate, and can identify students wearing glasses or a beard. The LBPH algorithm and Haar Cascade method contribute to the system's exceptional performance. The recognition rate for unregistered individuals in facial recognition technology is noteworthy even without the use of a threshold value, sitting at a commendable 64%. Moreover, the rate of false positives is impressively low, remaining at approximate-ly 15% and 31%.

Keywords: csharp, OpenCV, Deep Learning, Face detection.

1. INTRODUCTION

Attendance plays a crucial role in most institutions and organizations, as it informs the recording of lectures, tracks working hours, and determines salaries. While some organizations still rely on manual methods and paper-based documentation, some have transitioned to using biometrics. For example, at the university, professors manually fill out forms or make phone calls to report student attendance, which is then forwarded to the administration for updating the final database on the SQL server. This process is both labor-intensive and time-consuming. Biometric systems are also used, but only for professors or employees. However, an automated attendance system that incorporates facial recognition technology could be a solution. This technology can mark the presence of students, professors, and staff using facial recognition algorithms such as the Convolutional Neural Network (CNN) algorithm. The main features of the technology include face detection and recognition. By implementing this technology, organizations can streamline the attendance-taking process and reduce the time and effort involved in manual tracking methods.

The process of taking attendance through a manual system can be both inefficient and time-consuming, especially when employees are required to queue up to input their names before and after office hours. Furthermore, employees assigned to record attendance are burdened with the task of transferring data from the time book to Microsoft SQL Server each month, which is a laborious and time-intensive process. Identifying latecomers from the time book also proves to be a challenge, as it is prone to inaccuracies due to potential misremembrance of information. Consequently, there is a possibility that attendance staff might overlook certain details, leading to incomplete records.

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Related Works

According to Xin Geng, face recognition systems often necessitate specific configurations in order to function properly. This comprises appropriate lighting, a specific location, a certain angle of view, and limited obstructions in the surrounding area. Such systems are known for their ability to recognize faces in controlled environments. However, these constraints impede the use of facial recognition in many real-time applications where such conditions cannot be guaranteed. Real-time systems necessitate input in the form of images, which in turn requires human intervention for processing. This paper presents a system that uses image input, but it is limited by its reliance on human processing and is therefore not optimal for real-time applications such as attendance systems. [1]

Edy Winarno, a member of the 3WPCA Anticheat Presence-System, has developed a technique using dual vision cameras that generates a composite image of an individual. The two images captured by each lens are combined to detect any signs of cheating. Winarno discovered this method by merging two separate photographs of a person's left and right halves into a single image. By analyzing this image, he was able to develop the 3WPCA approach, which has a remarkable 98% success rate in identifying fraudulent behavior. In a recent paper, an expert in the field details modifications made to a system that tracks attendance through image recognition. Since many students are easily identifiable by their faces, it is crucial to implement precise identification techniques swiftly. [2] This novel approach could potentially replace current biometric devices like fingerprint scanners. The school currently employs a picture-based registration system, requiring students to re-enroll periodically to maintain accuracy. Uploading photographs is a crucial aspect of the school's overall process. The existence of this program is supported by substantial evidence. Utilizing a sophisticated identification system, it can be employed for online certification exams. Biometric technology provides a superior alternative to traditional data collection methods due to its enhanced accuracy, despite its more complex and error-prone nature. Although this aspect is often overlooked due to the prevalence of similar systems, the author suggests incorporating a mobile attendance system and a facial recognition feature with NFC security functions to acquire fingerprint scans. Additionally, cloud storage for Raspberry Pi data and data collection through a mobile app are recommended to address challenges associated with dirty, wet, peeling, or dry fingers. The previous system is replaced with a new approach incorporating cloud space, NFC, facial recognition, and microcomputer to increase efficiency and minimize paper usage while reducing time spent searching for misplaced items. The mobile attendance system is inclusive of a clipboard.[3]

The capability of computers to interact with individuals from diverse angles and viewpoints is undeniable. However, this interaction is commonly accepted if the computer system is built on a specific framework. An essential aspect of the verification process is the integration and advancement of student identities. [4] Furthermore, facial recognition technology employs embedding to categorize faces. This system's applications encompass security, attendance, and other relevant fields. Once the system is established, its outcomes are exhibited in the designated workspace. [5]

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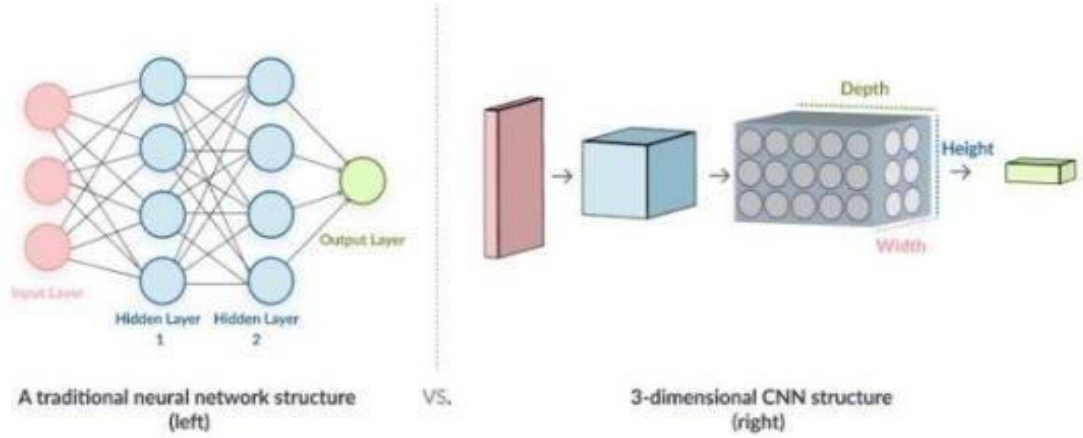

Fig 1 Comparison between a Conventional Neural Network and CNN

RadhikaC's article, entitled "A Facial Recognition-Based Attendance System Using ML Algorithms," outlines a system that monitors and records the attendance of each student through facial recognition technology.

During the time period in which the novel is set, facial recognition was the term used to describe the identification of individuals based on their facial features. Computer vision algorithms that utilize facial capabilities have been developed, such as emotion detection and facial recognition systems, which are utilized for surveillance purposes. Facial recognition systems have been examined by numerous scientists, who have explored various tools, including Support Vector Machine, Multilayer Perceptron, and Convolutional Neural Network. A Deep Neural Network, which is capable of recognizing faces, is created by utilizing features extracted through LDA and PCA. Machine learning algorithms such as MLP and CNN are used alongside SVM to extract features. CNN can identify images by inputting them as features, resulting in a high level of accuracy. CNN, MLP, and SVM achieve accuracy percentages of 86.5%, 86.5%, and 98%, respectively, on their respective databases.[6]

Priyanka Wagh submitted an image to a class face recognition system, claiming that it contained human faces. Upon analyzing the image's histogram, it was discovered that the last column of benches had more faces than the other columns. This document highlights the various advantages of Ada Boost computing. One such advantage is using this technology to isolate the efficiency of a specific task, like identifying the unique features of a college student's face. This process involves removing any extraneous characteristics such as facial hair, lines, textures, and any other additions like face art. The features are then separated and compared with databases containing information on faces and their appearances. Ultimately, the investigation aims to create a catalog of every face they encounter. [7]

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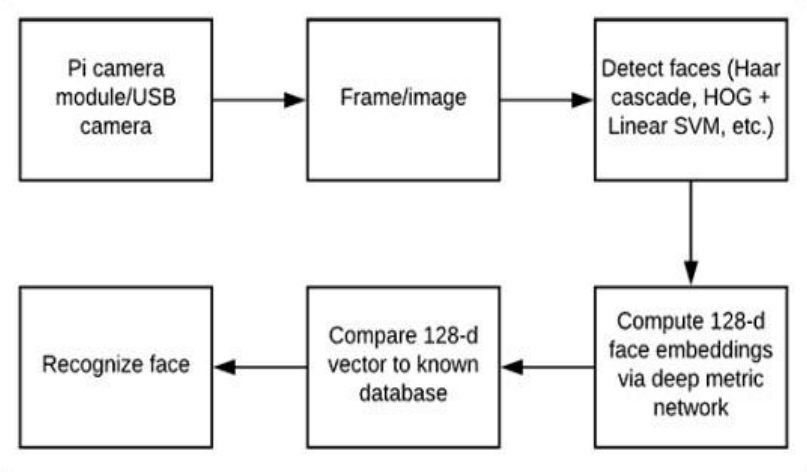

Fig 2 Model for Face Recognition

The ROCLY facial recognition technology and camera scene monitoring are the foundation of the attendance system. As a student swipes their campus card, an event is triggered that captures an image of their face, processes their information, and ensures that unauthorized individuals are not granted access to the classroom.

A novel framework called Akshara Jadaf, Akshay Jadaf Toshur Lah, Krishna Yelikar has been developed for face re-imaging. The first step of this framework involves separating and processing confined faces. Additionally, the scope of the extracted face images is expanded to 100 x 100 to eliminate graphs. The framework also includes updating the names that were previously re-planned, which exceeded expectations. To accomplish this, a schedule of expected outcomes is created using transactional tools within the database framework. Face detection accounts are utilized to identify faces in images, and the Rectangle FlexBox mutation is removed from the scene. Finally, the image is converted to dark scale, graphic modifications are applied, and its size is altered to 100x100. Alternatively, PCA/LDA/LBPH can be employed to extract highlighting. [8].

To teach the system how to reconfigure faces, specialists employ a method called the "hair workbook." The process begins with the camera detecting a face, which is then turned into grayscale before being processed with this technique. All subsequent images are saved on the server for later modification and enhancement. [9]

The authors propose utilizing a novel strategy that involves the frame serving as an online web server. This would allow the results of the particles to be accessed by authenticated web customers. The process of facial re-imaging is executed by updating the local bank patterns (LBP). First, the face serves as the initial point of purchase and editing language for the return on investment. Subsequently, successive accounts are applied based on hair features. The LBP is then used to extract the bright points of the images, and these are compared to a prepared data collection by the LBP account. Finally, the results in English language are stored in an SQL Server database using 'C' in Catch in the Console Box and can be accessed via a web server. [10]

The method for recording attendance relies on the process of taking a new photograph of an employee's face while they are at work.

According to Nandhini R., the primary function of the company is to convert recorded identity data and video footage into visual images. The process involves using CNN technology to identify faces, with CNNS (convolutional neural networks) employing a hierarchical perception model that enables faster hypothesis treatment. Once faces have been identified and organized, they are compared to those in the student database to accurately reflect the identities of the students in question. Any additional or alternate names are updated in

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a separate table to maintain accuracy. Finally, records of student participation can be maintained on a weekly or monthly basis according to the expectations set forth by the company. [11]

The attainment of proxy with a DCT factor of 16 is facilitated by utilizing a component-based approach which involves gray normalization, graphic equations, conversion of individual waves through DWT, and conversion of individual perfection pockets via DCT.

According to Venkata Kalyan PolaraSetty, Muralidhar Reddy Reddem, Dheeraj Ravi, and Mahith Sai Madala in their paper "The Attendance System," the homepage for home duty is reliant on the type of camera utilized.

Our next item of discussion is the presence of a minimum of 500 to 1000 traps. In order to produce more precise results, high-resolution cameras have been installed across various locations in the United States. To enhance facial recognition, the element category is utilized alongside B-Box technology. The faces that are identified are converted into small theme images that measure 112 x 92, which translates to an area of approximately 11 km. The Swix facts are then recorded within a database that is accessible within our workspace. It is here that we can capture images of the exhibition. The most notable pigs are individually archived and categorized in exhibition lists that can be modified to fit a particular message or purpose. [12]

Approach and Resources Tools and Technologies

Within this section of the thesis, an overview of the tools and techniques employed for the project will be presented. Specifically, the project centered around the development of C#-based Windows applications in conjunction with libraries and programming found within SQL Server Management Studio

The system is a Windows Form application designed to run on the Windows operating system, featuring two main areas: the Administrator Area and the Public Screen. The Administrator Area provides administrators with access to all system functionalities, while the Public Screen displays incoming employee information along with the date and time. The backend is supported by a database that facilitates the storage and retrieval of information in real-time.

Development Tools:

Visual Studio 2019:

An Integrated Development Environment (IDE) used for building the Windows Form application.

C# Programming Language:

The primary programming language employed in the development of the system, offering flexibility and compatibility with Windows applications.

Microsoft SQL Server 2012:

Chosen as the Database Management System (DBMS) for its seamless integration and communication capabilities with C#.

Photoshop: Utilized in the design process for creating and enhancing the graphical user interface (GUI) of the application.

Visio: Employed for designing diagrams, aiding in the visualization and planning of system components and interactions.

Eigen Face Library: An open-source library integrated with Visual Studio, enhancing C#'s capability to work with images and facilitate facial recognition.

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Emgu.CV Library: Another open-source library integrated with Visual Studio, specifically designed to assist C# in image processing, facial recognition, and detection tasks.

Development Process:

Frontend:

Platform: Visual Studio (C# Windows Form Application).

Resource Integration: Emgu.CV and Eigen Face libraries were imported to facilitate image processing, facial recognition, and detection within the application.

Backend:

Database: Microsoft SQL Server was employed to create and manage the database, ensuring efficient storage and retrieval of information.

The integration of these tools and technologies allowed for the creation of a robust Windows Form application that seamlessly combines frontend and backend functionalities. The choice of open-source libraries and established software applications contributed to the effectiveness and efficiency of the development process.

1.1. C-Sharp

C# (pronounced "C-sharp") is a versatile programming language developed by Microsoft. It is widely used for developing various types of applications, including desktop applications. When it comes to creating Windows applications using C#, the combination often involves utilizing the .NET framework, specifically the Windows Presentation Foundation (WPF) for creating rich and interactive user interfaces.

Windows applications developed in C# often leverage Visual Studio, Microsoft's integrated development environment (IDE). Visual Studio provides a comprehensive set of tools for C# development, including a powerful code editor, debugger, and designer for building user interfaces.

SQL Server Management Studio (SSMS) is a tool designed for managing SQL Server databases. While C# is primarily used for application development, SQL Server Management Studio is used for database-related tasks, such as creating and managing databases, writing and executing SQL queries, and performing database maintenance activities.

The integration of C# Windows applications with SQL Server Management Studio allows developers to build robust applications that interact seamlessly with a SQL Server database.

Here's a brief overview of how this integration works:

C# applications can use ADO.NET (Active Data Objects for .NET) to connect to a SQL Server database. ADO.NET provides a set of classes for data access, including Sql Connection and Sql Command.

Developers can establish a connection to a SQL Server database from their C# application using connection strings that specify the server name, database name, authentication method, etc.

C# code can include SQL queries to retrieve, insert, update, or delete data in the connected SQL Server database. Sql Command class is commonly used for executing SQL commands from C# code.

Windows applications often use data binding to display and manipulate data from a database. C# provides features for binding data to UI controls, ensuring that changes in the data source are reflected in the user interface.

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Entity Framework is an Object-Relational Mapping (ORM) framework that simplifies database interactions in C# applications. It allows developers to work with databases using .NET objects.

Proper error handling is crucial in database applications. C# provides exception handling mechanisms that allow developers to manage errors gracefully, providing feedback to users and logging information for debugging purposes.

C# Windows applications integrated with SQL Server Management Studio offer a powerful solution for creating feature-rich desktop applications with robust database functionality. This integration enables developers to build applications that efficiently manage and interact with SQL Server databases, providing a seamless and user-friendly experience

1.2. OpenCV

Back in 1999, Intel granted access to OpenCV, a software library designed for the processing of images and videos on computers. Cine paint, an open-source program, was developed with a significant focus on video and image analysis and was created to help computers handle more challenging applications. Cine paint is a cross-platform software program that utilizes both C-sharp and Java programming languages, and it offers features such as face and object detection. Its programming language, C++, is the language utilized by Cine paint. Huge companies, including Google, Yahoo, and Microsoft, frequently use OpenCV, which enables users to capture images and videos and identify faces, vehicles, and other objects.

1.3. Methodology

The fundamental information required for an attendance tracking system includes a person's identification number and facial features. In order to function effectively, this system needs to input this data. Thus, the first step is to capture a portrait photograph using a camera to determine the presence of a face. The system mandates 12 full facial images of the individual and prompts them to retake the photo if the face is not detected. Subsequently, several processing steps are executed to procure grayscale and equi-sized images. These images are crucial to the operation of the LBPH detector, which is a pivotal component of the project's overall process. A diagram outlining these prerequisites is provided below.

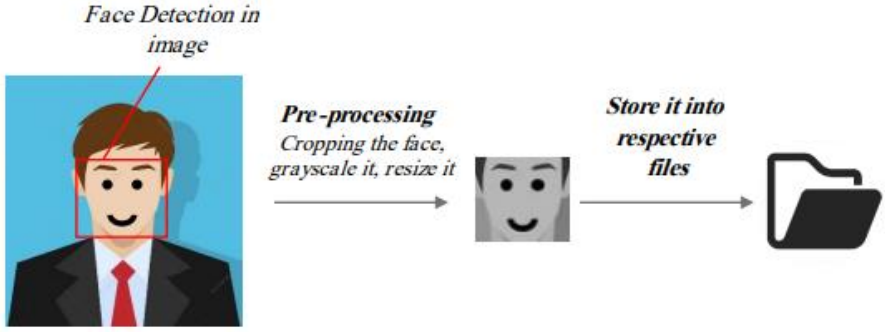

Fig 3 : Procedures for Image Acquisition and Preprocessing

The database folders store all faces hierarchically, with additional subfolders being added as more individuals are included in the database. Upon completion of the image processing, the resulting layers are saved in a file. In this particular project, all facial portraits of one individual are stored in a designated database folder, which is allocated a unique number that serves as a name for the subfolders. The organization's database contains a script that generates and archives the identities of all members within the group. This process is known as image retrieval, preprocessing, and storage.

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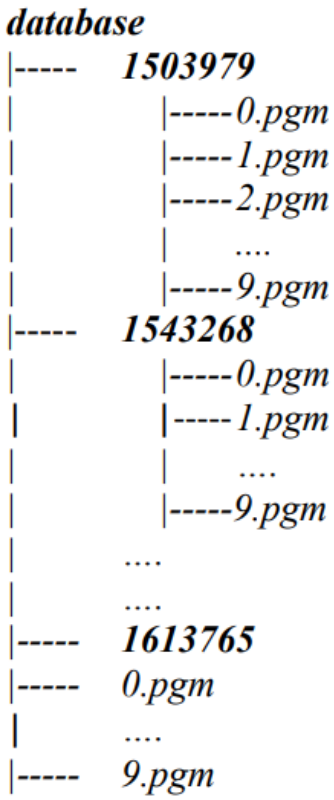

Fig 4 : Layering Method for Face Database

The following step in the extraction process involves the creation of a SQL QUERY file. This file is responsible for containing relevant data regarding the images that have been successfully extracted, as well as their designated directory path. The SQL QUERY file is then utilized in the subsequent step of the process, which entails the training of the facial recognition software. In this step, images are imported into the software using the SQL QUERY file. The image within the SQL QUERY file is illustrated below.

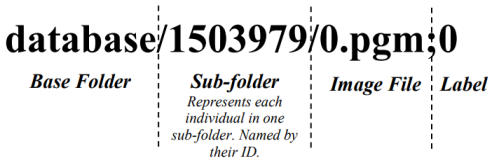

Fig 5 : Content Structure in SQL QUERY File

OpenCV 3.4 includes three distinct training mechanisms, namely LBPH, Fisher Faces, and LBPHs. Out of these three, this project will concentrate specifically on the LBPH training algorithm. Once a sufficient number of images are uploaded into the database, they are then fed into the training mechanism. LBPHs achieve this by creating histograms that accentuate facial features through their maximum differences between each image. They gather information by identifying particular faces and encoding their appearance changes into a data list for comparative analysis. During the training phase, a SQL QUERY file is utilized to load the images and their respective label definitions. This creates a list of lists called a Variable List, which is then passed to the training function along with the images and labels. The duration of this process is measured by the creation of the LBPH itself, which takes longer the more faces are present in the database. For instance, it

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takes about 50 seconds for a single subject to have their 400 images loaded into the training database. Each of these subjects provides 40 photos for training.

Upon the completion of training, a .xml file is created to ensure the system's efficiency. Rather than redoing the entire training process, this file is only utilized during recognition. The system's training process requires a total of 50,000 images, which would take approximately 1.3 hours to complete.

Flow Chart of the image acquisition process

In order to conduct face recognition, the first step involves the creation of a face database. This process entails collecting numerous photos of faces and merging them into a single database. Once this step is finished, the database entries can be compared to identify individuals. Note that the system only allows input of 12-digit numbers to prevent duplication in the database and solely permits unregistered IDs to be used. To ensure accurate identification, every image captured must undergo processing to eliminate dust, blur, and color distortion. The images are then organized into folders that correspond to each person, with each folder containing 12 portraits of the subject.

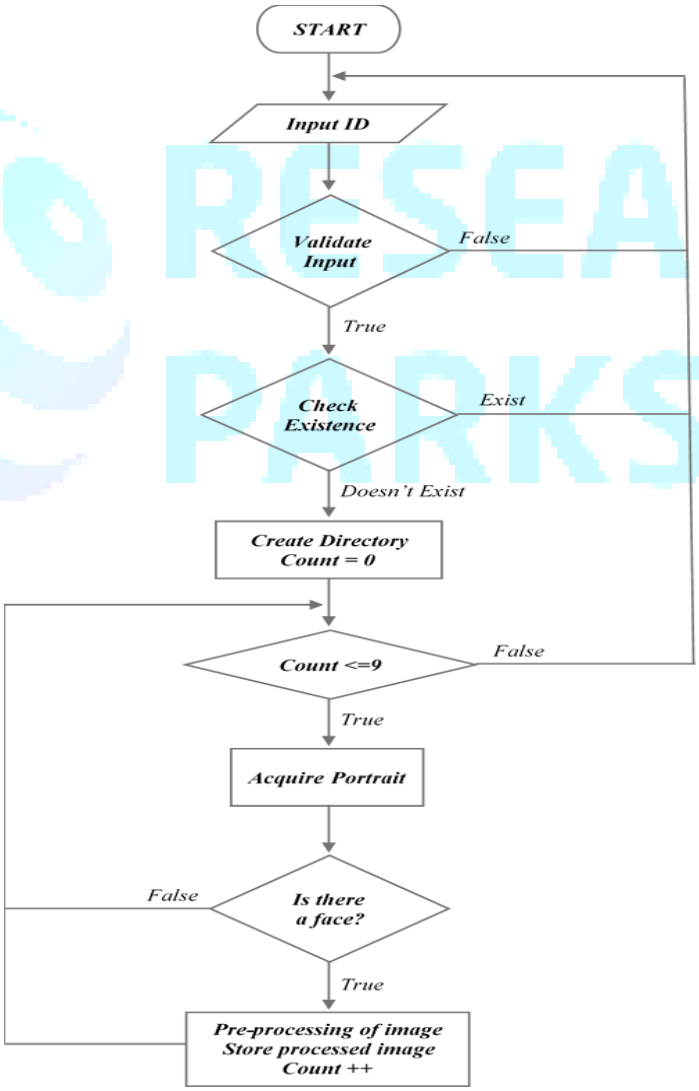

Fig 6 : Flowchart of Image Retrieval Process

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This chart represents the step-by-step program flow of the image capture process. The program itself is implemented by the ras_database.sql script. Meanwhile, two other scripts are responsible for handling the remaining procedures, which will be elaborated on in the upcoming section.

Design of the System

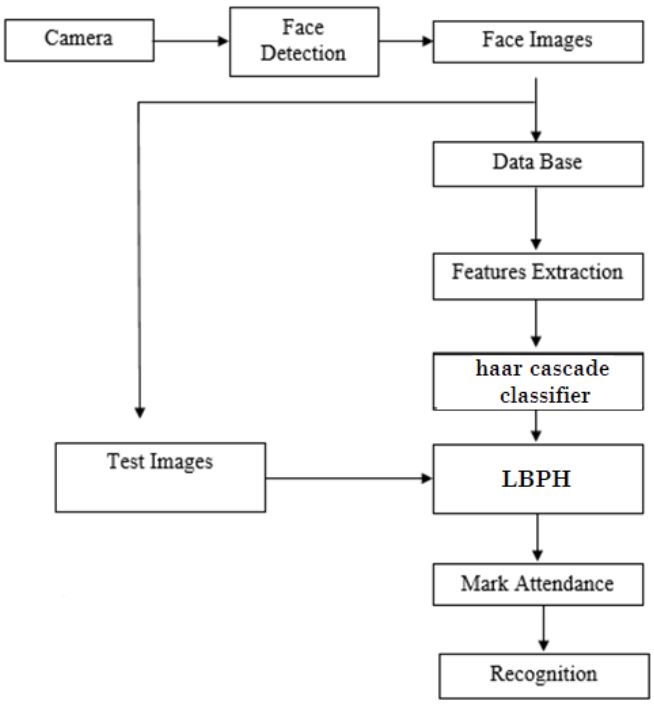

Fig 7: Flowchart Design for a Face Recognition-Based Attendance System

1.4. Discussion

Testing is a crucial step in successfully completing any project. Every aspect of a project must meet stringent quality standards to ensure its success. The new system undergoes rigorous testing to ensure that it performs as intended. The system is coded using Tinker GUI, and users test it for functionality. All parts of the user test the apps to ensure that no bugs are present before public release. In the event of bugs, the development team implements fixes before releasing the application. A comparison of the two forms' designs reveals numerous similarities. Financially, the project makes sense because no additional expenses are required. The cost and time invested in creating the new system are weighed against its expected returns to determine its viability. The new system is feasible if the benefits outweigh the costs and expenses.

1.5. Result and Analysis

System performance evaluation is a critical task involving the thorough analysis of a system's effectiveness, efficiency, reliability, durability, and overall functionality. This comprehensive assessment is essential to ensure the system meets the necessary standards and expectations. ensure accurate identification, we have established a parameter of a 3-foot distance. In Table 5.1, it is shown that students have a 79% success rate in recognizing faces with only a 24% chance of false positives, even if the subject is wearing glasses or has a beard. However, this success rate drops to 65% for unknown individuals in both the existing and proposed models, primarily due to the identification of non-faces as faces by the face detection algorithm.

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The false positive rate in the proposed model is 15%, while the existing model has a 31% false positive rate. Interestingly, the false positive rate only changes with threshold values when identifying unknown individuals. Nonetheless, the system is currently functioning well by using a favorable filter value of 50, which tags individuals as unknown if their head turns beyond a certain angle [15]. [16] typically sets the favorable filter value. The system operates under the premise that an individual is marked as unknown only if their degree of confidence is above 50 and 95. Upon being identified as such, the system proceeds to store a snapshot of the individual as an anonymous entity.

TABLE 1: System performance evaluation

System performance evaluation	percent
The act of delving into the daily lives of students through live webcams is an intriguing prospect.	79%
The frequency of erroneous positive outcomes in regards to students.	24%
The present model's success rate in accurately discerning the identity of an unfamiliar person.	65%
According to the present model, the rate of erroneous positive identifications for an unknown person is noteworthy.	31%
The proposed system's efficacy in identifying an unfamiliar individual success rate is under scrutiny.	64%
The proposed model examines the probability of an erroneous identification for an unidentified person.	15%

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