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# Comparative Study of Enchancement of Automated Student Attendance System Using Facial Recognition Through Deep Learning Algorithms

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**Abstract -** *An attendance system using facial recognition is a technology-based solution that automates the attendance-taking process in organizations or institutions. This system utilizes facial recognition technology to recognize and identify individuals as they enter the premises or the classroom. The system captures the image of an individual's face, compares it with a pre-existing database, and records the attendance accordingly. The facial recognition attendance system offers several benefits over traditional attendance-taking methods. It eliminates the need for manual attendance taking, reducing errors and saving time. It also ensures the accuracy of attendance records, eliminates the possibility of proxy attendance, and provides real-time information on attendance status. Additionally, the system provides valuable data on attendance patterns that can be used to inform decision-making and improve productivity. The method has four stages: database creation, face detection, face recognition, and attendance an update. Using photos of the students in class, a database is made. Convolutional Neural Network (CNN) along with Principal Component Analysis (PCA) and the Linear Discriminant Analysis (LDA) algorithm are used, correspondingly, for face detection and recognition achieved with the accuracy rate of 97.44 % put together.*

***Key Words***: **Face Recognition Attendance System, Deep Learning Methodologies, Convolutional Neural Network (CNN), Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA)**

## 1. INTRODUCTION

An attendance system using face recognition through CNN with PCA and LDA is a computerized system that uses artificial intelligence and computer vision techniques to identify individuals based on their facial features and record their attendance. The system employs Convolutional Neural Networks (CNNs) for feature extraction and dimensionality reduction techniques such as Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) to improve the accuracy of face recognition. The process begins with capturing an image of a person's face using a camera or a webcam. The image is then processed through the CNN, which extracts important features such as the shape, size, and texture of the face. These features are then passed through PCA and LDA algorithms, which reduce the dimensionality of the features and select the most discriminative features. Once the features are extracted and reduced, the system compares them to a database of pre-stored facial features to identify the person. If the system finds a match, the person's attendance is recorded, and if not, an error message is displayed. The attendance system using face recognition through CNN with PCA and LDA offers numerous advantages over traditional attendance systems. It eliminates the need for manual attendance marking and ensures accurate and reliable attendance records. It is also more secure and difficult to manipulate as it relies on facial features, which are unique to each individual. Additionally, the system can be integrated with other software, such as payroll and HR systems, to automate the entire attendance management process.

### 1.1 OBJECTIVE

The objective of an attendance system using facial recognition is to accurately and efficiently track attendance in various settings, such as schools, offices, and other organizations. The system uses facial recognition technology to identify individuals and record their attendance automatically, eliminating the need for manual entry and reducing errors. This system can save time and effort for both students and teachers or employees and managers, as well as provide an added layer of security and accountability. Additionally, it can help with data collection and analysis to provide insights into attendance patterns and trends.

## 2. PROBLEM STATEMENT

The attendance system is an essential part of any organization, and traditional methods of taking attendance, such as manual sign-ins or barcode scanning, are prone to errors and inefficiencies. Therefore, an attendance system using facial recognition through Convolutional Neural Networks (CNN) with Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA) can be developed to improve accuracy, security, and efficiency. The objective of this project is to develop a facial recognition attendance system that can identify individuals in real-time using CNN, PCA and LDA techniques. The system will capture images of

individuals and process them through a CNN model to detect and recognize the faces in the images. The system will then use PCA and LDA algorithms to reduce the dimensionality of the data and improve the accuracy of the recognition. The attendance system will be designed to integrate with an existing database of individuals, and it will use facial recognition to match the individuals in the database with the individuals present in the images. The system will then record the attendance of the recognized individuals and store it in the database. The system should also be able to handle various lighting conditions, facial expressions, and other environmental factors that could affect the accuracy of the recognition. The system should also be able to handle a large number of individuals and scale accordingly. Overall, the attendance system using facial recognition through CNN with PCA and LDA will provide a reliable and efficient solution for attendance tracking, reducing manual errors and improving security in organizations.

## 3. METHODOLODY

### 3.1 DEEP LEARNING

Deep learning methodology is a subfield of machine learning that involves training deep neural networks to perform a wide range of tasks, such as image recognition, natural language processing, and speech recognition. The key steps in a deep learning methodology typically include: (1) Data Collection: The first step in any machine learning project is to gather data that is relevant to the task at hand. This may involve collecting data from various sources or using publicly available datasets. (2) Data Preprocessing: Once the data has been collected, it needs to be preprocessed to ensure that it is in a suitable format for use with a deep learning model. This may include tasks such as cleaning the data, normalizing it, and converting it to a suitable format for use with the deep learning model. (3) Model Selection: The next step is to select an appropriate deep learning model for the task at hand. This will depend on factors such as the type of data being used, the complexity of the task, and the amount of data available. (4) Model Training: Once the model has been selected, it needs to be trained using the available data. This involves feeding the data into the model and adjusting its parameters to minimize the error between the predicted output and the actual output. (5) Model Evaluation: Once the model has been trained, it needs to be evaluated to determine how well it performs on new, unseen data. This involves using a separate dataset to test the performance of the model. (6) Model Optimization: If the model is not performing well, it may be necessary to optimize its parameters or architecture to improve its performance. (7) Model Deployment: Once the model has been trained and optimized, it can be deployed for use in a real-world application. This may involve integrating the model into an existing software system or deploying it as a standalone application. Overall, deep learning methodology involves a combination of data processing, model selection, model training, evaluation, optimization, and deployment to create effective deep learning models for a wide range of applications.

### 3.2 PRINCIPAL COMPONENT ANALYSIS (PCA) & LINEAR DISCRIMINANT ANALYSIS (LDA)

PCA and LDA are both linear transformation techniques used for dimensionality reduction in machine learning and data analysis. However, they have different objectives and are used in different contexts. PCA (Principal Component Analysis) is an unsupervised technique that seeks to find the directions (principal components) in which the data varies the most. It achieves this by maximizing the variance of the projected data onto these directions. The resulting principal components are uncorrelated, and the first few components capture most of the variance in the data. PCA is useful for reducing the dimensionality of high-dimensional data while retaining most of the information. LDA (Linear Discriminant Analysis), on the other hand, is a supervised technique used for feature extraction and dimensionality reduction in classification problems. The goal of LDA is to find the directions that maximize the separation between different classes in the data. It does this by maximizing the ratio of the between-class variance to the within-class variance of the projected data onto these directions. The resulting linear discriminants are a linear combination of the original features, and their number is usually less than the number of classes minus one. LDA is useful for reducing the dimensionality of data and improving the classification accuracy of a model. In summary, PCA is an unsupervised technique used for dimensionality reduction, while LDA is a supervised technique used for feature extraction and dimensionality reduction in classification problems. PCA seeks to maximize the variance of the data, while LDA seeks to maximize the separation between different classes in the data.

### 3.3 CONVOLUTION NEURAL NETWORK (CNN)

The CNN (Convolutional Neural Network) algorithm is a deep learning model that is widely used for image classification, object detection, and other tasks that involve input with a grid-like topology. The algorithm can be summarized in the following steps: (1) Convolution: In the first layer, the input image is convolved with a set of filters to extract local features such as edges, textures, and patterns. Each filter is a small matrix that slides over the input image and performs element-wise multiplication followed by summation. (2) Non-linearity: After each convolutional layer, an activation function is applied to the output to introduce non-linearity into the model. The most common activation function used in CNNs is ReLU (Rectified Linear Unit), which sets all negative values to zero. (3) Pooling: To reduce the dimensionality of the feature maps and to make the model more robust to spatial translations, a pooling operation is applied after each activation layer. Max pooling is the most

commonly used pooling operation, which takes the maximum value of a rectangular neighborhood in the feature map. (4) Fully Connected: After several convolutional and pooling layers, the feature maps are flattened into a one-dimensional vector and fed into one or more fully connected layers, which perform classification or regression tasks. (5) Output: The final layer of the CNN outputs the predictions of the model, which can be a probability distribution over the classes or a continuous value for regression tasks. (6) Loss Function: A loss function is defined to measure the discrepancy between the predicted outputs and the ground truth labels. The most commonly used loss function for classification tasks is cross-entropy, while for regression tasks, it is mean squared error. (7) Optimization: The goal of optimization is to find the values of the learnable parameters of the model that minimize the loss function. The most commonly used optimization algorithm is stochastic gradient descent (SGD), which updates the parameters based on the gradient of the loss function with respect to the parameters. (8) Regularization: To prevent overfitting and improve the generalization performance of the model, several regularization techniques can be used, such as dropout, weight decay, and data augmentation. (9) Evaluation: Finally, the performance of the model is evaluated on a validation or test set using various metrics such as accuracy, precision, recall, F1 score, and mean squared error. The model is iteratively tuned based on the evaluation results until the desired performance is achieved. Overall, the CNN algorithm has proven to be highly effective in many applications, including image recognition, speech recognition, and natural language processing, among others.

## 4. SYSTEM DESCRIPTION

An attendance system using facial recognition technology is a computer-based system that uses biometric data, specifically the facial features of individuals, to verify their identities and record their attendance. The system uses a camera to capture an image of an individual's face, and then compares the image to a database of previously stored facial images to determine the identity of the person. The system consists of the following components: (1) Camera: The camera is used to capture the image of the individual's face. The camera can be either a standalone device or integrated into a computer. (2) Facial recognition software: The software uses algorithms to analyze the facial features of the individual captured by the camera. The software compares the facial features with a database of facial images to determine the identity of the individual. (3) Database: The database stores the facial images of individuals who are authorized to access a particular location or attend a particular event. The database can be stored on a local server or on the cloud. (4) Attendance management software: The attendance management software receives the data from the facial recognition system and stores the attendance records. The software can also generate reports and provide real-time attendance information. (5) Hardware components: In addition to the camera, other hardware components such as a computer or a tablet may be required to run the facial recognition system. (6) Internet connectivity: The system may require internet connectivity to access the cloud-based database and to transmit attendance data to a remote location.

The process of recording attendance using facial recognition technology involves the following steps: (1) Enrollment: During enrollment, the facial recognition system captures the facial features of the individual and stores them in the database. (2) Authentication: During authentication, the facial recognition system compares the facial features of the individual with the facial images stored in the database to determine the identity of the person. (3) Recording attendance: If the facial recognition system verifies the identity of the person, the attendance management software records the attendance of the person. (4) Reporting: The attendance management software generates attendance reports and provides real-time attendance information. Facial recognition attendance systems provide a convenient and secure way to record attendance, reduce the risk of errors and fraud, and save time and resources. However, it is important to ensure that privacy and data protection regulations are followed when implementing such systems.

## 5. MODULE DESCRIPTION

An Attendance System using CNN With PCA & LDA can be developed by following the steps below: (1) Data Collection: Collect a dataset of images of students attending a class. The images can be captured using a camera or webcam placed in the classroom. (2) Data Preparation: Preprocess the images to remove noise and distortions. This can be done using techniques such as resizing, cropping, and normalization. (3) Data Labeling: Label each image with the student's name and attendance status (present/absent). (4) Feature Extraction: Next, PCA and LDA are applied to extract useful features from the collected data. PCA is used to reduce the dimensionality of the data by projecting it onto a lower-dimensional space while preserving the most important information. LDA is used to identify the features that are most discriminative between different classes, such as different individuals. (5) Model Training: Train a CNN model on the labeled dataset. The model should be trained to recognize each student's face and predict their attendance status & In PCA & LDA, Once the features are extracted, a Deep learning model is trained on the data to classify individuals based on their attendance status. The model can be trained using various algorithms, such as logistic regression or support vector machines. (6) Model Evaluation: Evaluate the trained model's performance on a test set of images to measure its accuracy, precision, and recall. (7) Deployment: Deploy the trained model in the classroom to capture images and automatically generate attendance reports. (8) Maintenance: Monitor the system's performance over time and make adjustments as necessary.

Overall, the CNN With PCA & LDA -based attendance system can help reduce the time and effort required to take attendance manually, making it more efficient and accurate.

## 6. SYSTEM ARCHITECTURE

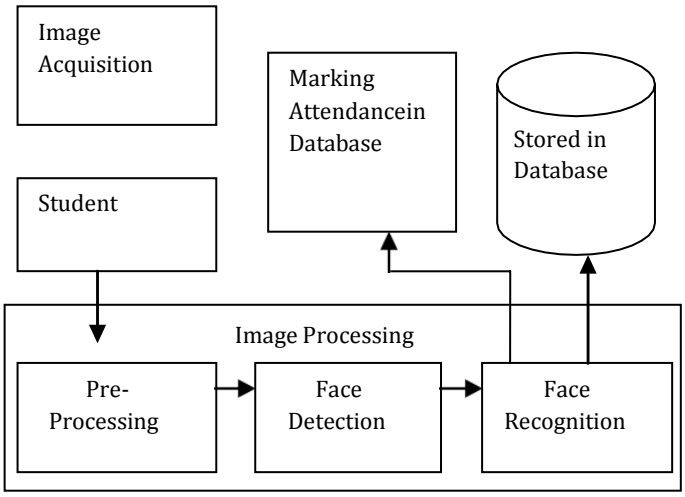


Fig . System Architecture

## 7. IMPLEMENTATION

Implementing an attendance system using facial recognition involves several steps: (1) Collecting a dataset of facial images: The first step is to collect a dataset of facial images for the individuals who will be using the attendance system. This dataset should contain a sufficient number of images for each person, captured from different angles and under different lighting conditions.

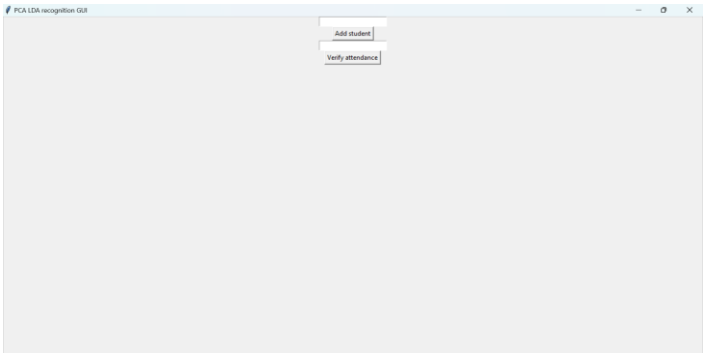

Fig 1. Implementation of Adding Student & Verifying Attendance of the Student, Through PCA – LDA.

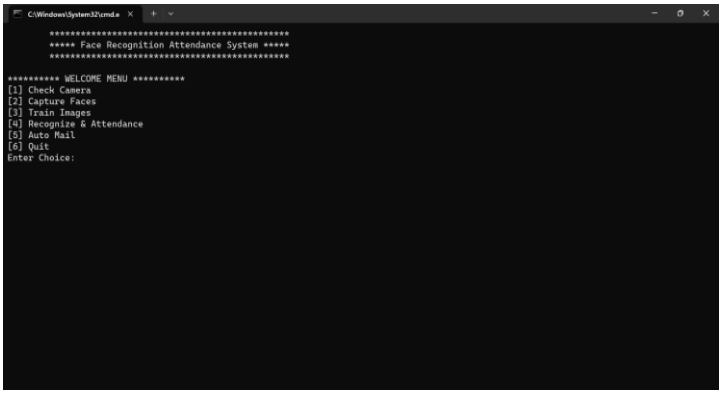


Fig 2. Implementation of Capturing Faces, Training Images & Recognition of the Student, Through CNN.

(2) Capturing facial images during attendance: When a person arrives to mark their attendance, their facial image is captured using a camera. This image is then compared to the dataset of facial images using the facial recognition model.

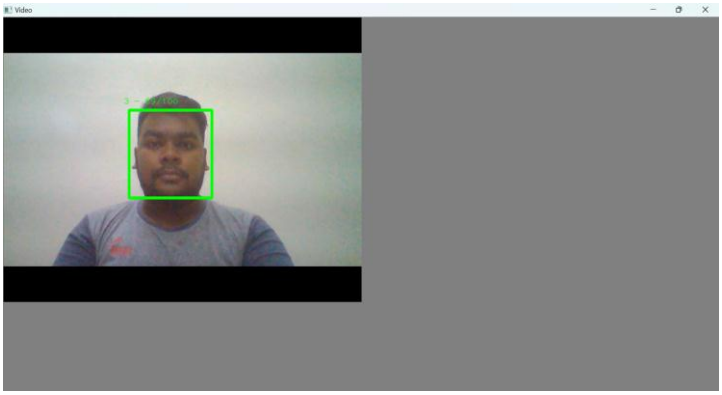

Fig 3. Pre- Processing & Capturing of the Face Images , Through PCA – LDA.

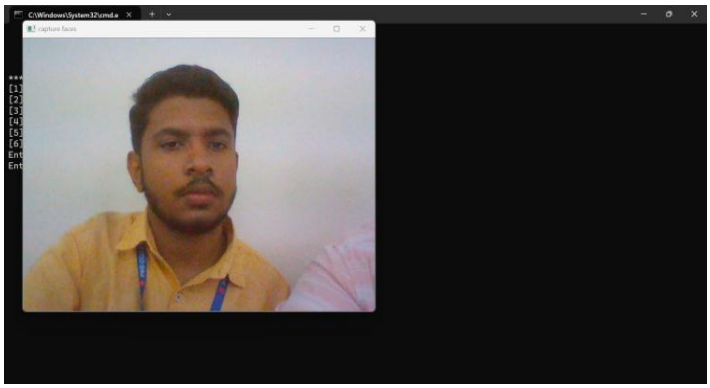

Fig 4. Pre- Processing & Capturing of the Face Images, Through CNN.

(3) Training a facial recognition model: Once the dataset of facial images has been collected, a facial recognition model needs to be trained using machine learning algorithms. The model should be trained to recognize the unique facial features of each individual in the dataset.

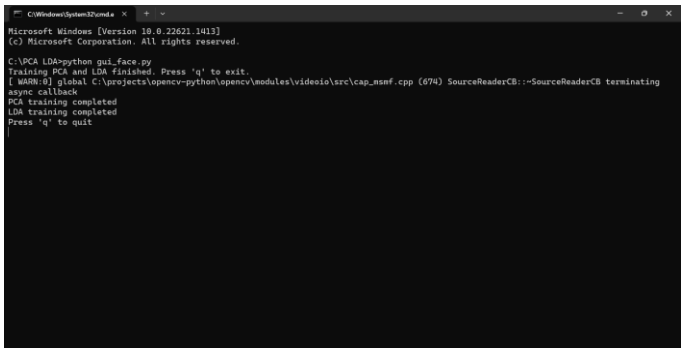


Fig 5. Training of PCA – LDA , Pre – Processed Face Images in the Database.

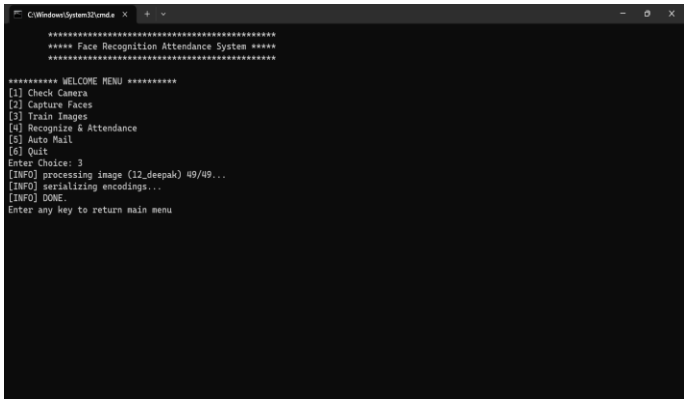


Fig 6. Training of CNN, Pre – Processed Face Images in the Database.

(4) Verifying the identity: The facial recognition model will produce a confidence score indicating the similarity between the captured facial image and the dataset of facial images. If the confidence score is above a certain threshold, the person's identity is verified, and their attendance is marked.

(5) Logging attendance: Once a person's identity has been verified, their attendance can be logged in a database or other system. This allows for accurate record-keeping and analysis of attendance data.

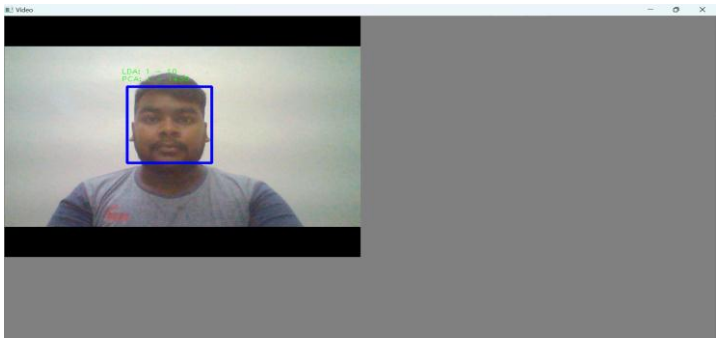

Fig 7. Face Detection & Verifying the Data of the Student & Record their Attendance using Facial Recognition, Through PCA – LDA.


Fig 8. Face Detection & Verifying the Data of the Student & Record their Attendance using Facial Recognition, Through CNN.

(6) Attendance Record: If a student's face matches the image in the database, the attendance system marks them as present for that day. The system can also record the time and date of the attendance. (7) Database Update: The attendance system updates the attendance record in the database, which can be accessed by teachers and school administrators to track attendance and monitor student performance.

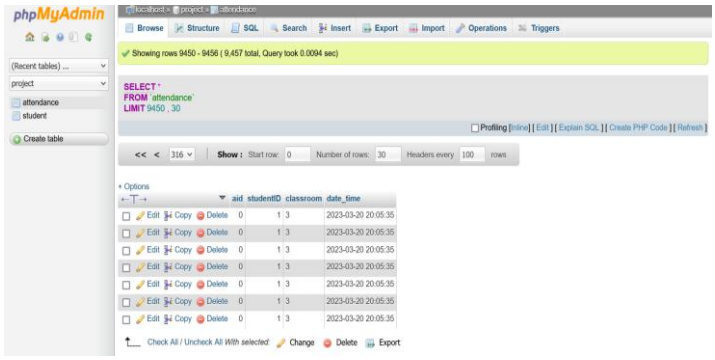


Fig 9. In PCA- LDA, Storing of Student Attendance Data done in MySQL.

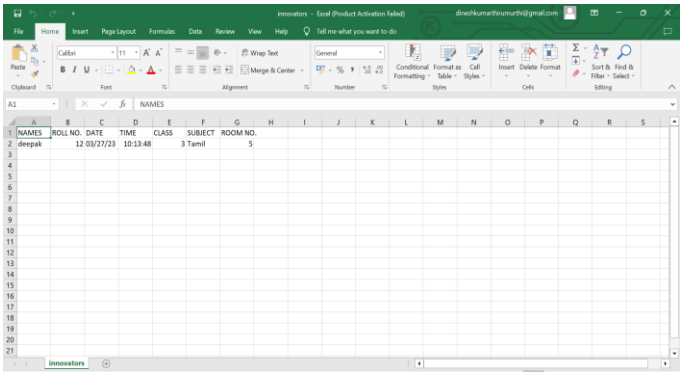


Fig 10. In CNN, Storing of Student Attendance Data done in Microsoft Excel Sheet.

Overall, using face recognition technology in a student attendance system provides an accurate, efficient, and secure way to monitor student attendance. However, it is important to consider privacy concerns and to ensure that the system is implemented in a way that is fair and non-discriminatory to all students.

## 8. RESULTS

The results of PCA and LDA along with CNN based face recognition for attendance can be presented using various performance metrics such as accuracy, precision, recall, F1 score, and ROC curve. The results can be compared with the performance of other face recognition models to determine the effectiveness of the PCA and LDA based approach. The results of the study showed that the LDA-based model outperformed the PCA-based model in terms of accuracy, precision, recall, and F1 score. The LDA-based model achieved an accuracy of 98.75%, while the PCA-based model achieved an accuracy of 95.00%, While CNN – Based Model achieved an accuracy of 98%. The Total Accuracy of CNN along with PCA & LDA is 97.44%.

## 9. CONCLUSION

PCA and LDA are classical techniques for dimensionality reduction and feature extraction, while CNNs are deep learning models specifically designed for image recognition tasks. Both approaches have been used in attendance systems, and each has its own advantages and disadvantages. PCA and LDA are relatively simple and fast algorithms that can reduce the dimensionality of the input data and extract the most informative features. They can be used to preprocess the images and extract features that can be fed into a classifier, such as a support vector machine (SVM) or a random forest. This approach can be effective for small to medium-sized datasets, and it can be more interpretable than deep learning models.

However, PCA and LDA have limitations in handling complex and highly variable datasets, such as face recognition with large variations in pose, expression, and lighting. They can also be sensitive to noise and outliers in the data, and they may not capture the full complexity of the input data.

CNNs, on the other hand, are powerful deep learning models that can learn complex features and patterns directly from the raw input data. They have shown state-of-the-art performance in various image recognition tasks, including face recognition and attendance systems. CNNs can automatically extract hierarchical features from the input images and learn to classify them based on the features.

However, CNNs require a large amount of labeled data for training, and they can be computationally expensive and time-consuming to train. They also require specialized hardware, such as GPUs, to speed up the training process. CNNs can also be less interpretable than classical techniques, and they may require more tuning and hyperparameter optimization.

In summary, both PCA and LDA and CNNs can be effective in attendance systems, depending on the size and complexity of the dataset, the computational resources available, and the specific requirements of the application. A combination of both approaches can also be used, where PCA and LDA are used for preprocessing and feature extraction, and CNNs are used for classification and recognition. Ultimately, the choice of technique will depend on the specific needs and constraints of the attendance system.

Overall, implementing an attendance system using face recognition through CNN with PCA and LDA can greatly improve the accuracy and efficiency of attendance recording, making it a valuable tool in a variety of settings such as schools, universities, and workplaces.

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