MFC Project Report

Group 6 – AIE A Batch



Center for Computational Engineering and Networking

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by

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# 1. Title and Introduction

## A) Title: Face Recognition: A Journey through PCA and SVD

## B) Introduction:

## Face recognition is a pivotal application in the realm of computer vision and image processing, with numerous real-world applications such as security systems, authentication processes, and human-computer interaction. This project delves into the utilization of Principal Component Analysis (PCA) and Singular Value Decomposition (SVD) as mathematical techniques to enhance the efficiency and accuracy of face recognition systems.

# As the field of artificial intelligence continues to advance, the need for robust and efficient facial recognition methods becomes increasingly crucial. PCA and SVD, both rooted in linear algebra, offer powerful tools for dimensionality reduction and feature extraction. By employing these techniques, we aim to improve the recognition performance of facial recognition systems, making them more adaptive and resilient to variations in facial expressions, lighting conditions, and other environmental factors.

# 2. A) Objective

# The primary objective of this project is to implement and evaluate the effectiveness of face recognition using Principal Component Analysis (PCA) and Singular Value Decomposition (SVD). Specific goals include:

1. Understanding the theoretical foundations of PCA and SVD in the context of face recognition.
2. Implementing a facial recognition system using these mathematical techniques.
3. Evaluating the performance of the system in terms of accuracy, speed, and robustness.
4. Investigating the impact of variations in facial expressions, lighting conditions, and pose on recognition accuracy.

# 2. B) Scope

This project focuses on the mathematical aspects of face recognition, emphasizing the role of PCA and SVD in feature extraction and dimensionality reduction. The scope encompasses the development and implementation of a face recognition system using these techniques, with an evaluation of its performance under various conditions. While the project emphasizes mathematical principles, the implementation will be carried out using relevant programming languages and tools.

# 3. Literature Review

Research Paper explaining the theory behind using PCA for face recognition: <https://www.researchgate.net/publication/318362885_Face_recognition_using_principal_component_analysis_method>

Article explaining the origin of the implementation of PCA for face recognition:

<https://machinelearningmastery.com/face-recognition-using-principal-component-analysis/>

Article demonstrating each step of the process of face recognition using matrices:

<https://www.geeksforgeeks.org/ml-face-recognition-using-eigenfaces-pca-algorithm/>

YouTube video demonstrating each step of the process of face recognition using matrices with examples:

<https://youtu.be/61NuFlK5VdU?si=khH2kzxI_AT5zPZb>

GitHub repository containing python code for face recognition, albeit using the webcam of a computer for real time application:

[GitHub - gadm21/Face-recognition-using-PCA-and-SVD: In this project, facial recognition algorithm is implemented with python using PCA and SVD dimensionality reduction tools.](https://github.com/gadm21/Face-recognition-using-PCA-and-SVD)

AI such as ChatGPT, Bard, and Bing for researching required libraries and their documentation

# 4. Methodology

**Data Collection:** Gather a diverse dataset of facial images, including variations in expressions, lighting conditions, and poses, to ensure the robustness of the recognition system.

**Preprocessing:** Perform preprocessing tasks such as image normalization, resizing, and grayscale conversion to enhance the quality and consistency of the dataset.

**Feature Extraction:** Implement Principal Component Analysis (PCA) and Singular Value Decomposition (SVD) for dimensionality reduction and feature extraction from the facial images.

**Feature Comparison:** Comparing the obtained features, extracted from the image, and comparing them with the features of the dataset of facial images, and obtaining a difference between them.

**Identification:** Identifying the identity of the individual in the facial image, by evaluating the obtained feature difference, and selecting an identity if the difference is below the threshold value

# 5. Implementation

The implementation phase involves translating the theoretical concepts into a functional face recognition system. Key steps in the implementation process include:

* **Coding:** Implement PCA and SVD algorithms using a programming language such as Python, leveraging libraries like NumPy and scikit-learn for efficient computation.
* **Integration:** Integrate the implemented algorithms into a cohesive face recognition system, incorporating necessary modules for data input and pre-processing.
* **Testing and Debugging:** Rigorously test the system on different subsets of the dataset, identifying and resolving any issues related to accuracy, speed, or robustness.
* **Optimization:** Fine-tune the system parameters and algorithms to optimize its performance, ensuring a balance between accuracy and computational efficiency.

# 6. Project Progress

The major steps and tasks include:

* Dataset Acquisition
* Data Preprocessing
* Implementation of PCA and SVD
* Feature Extraction
* Debugging
* Testing and Evaluation
* Optimization

Of the aforementioned tasks, here are the completed ones:

* Dataset Acquisition
* Data Preprocessing
* Implementation of PCA and SVD
* Feature Extraction
* Debugging

# 7. Contributions

JAYAN S (23033): - Researching prerequisite topics and methods of implementation. Contributed to coding part of taking coefficients of eigenvectors and compilation into matrix.

JAGAN K S (23034): - Researched methods of implementation, and libraries used for such methods.

KEERTHIVASAN S V (23037): - Collaborated in researching in parts of the project and contributed to coding part of finding the average face vectors of images and compilation of matrix.

KRISH S (23040): - Helped in the coding part of the project by contributing to reducing dimensions of matrix and finding the covariance matrix.