Face Mask Detection Using PCA, LDA, and KNN

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Introduction

This project presents a face recognition system that utilizes classical machine learning techniques to detect and recognize human faces. The system is GUI-based and integrates dimensionality reduction techniques such as PCA and LDA, combined with K-Nearest Neighbors (KNN) for classification.

Project Objectives

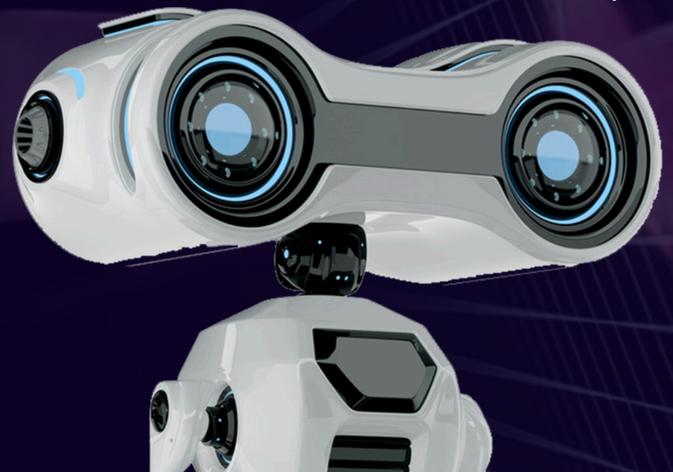
- Build a complete face recognition system with a simple and interactive GUI.
- Classify face and non-face images using PCA, LDA, and KNN.
- Visualize accuracy and prediction results for better understanding.
- Ensure flexibility through different data splitting strategies.

Tools & Technologies Used

- Python – for development and implementation.
- OpenCV – for image processing.
- Scikit-learn – for machine learning models.
- Matplotlib – for plotting performance graphs.
- NumPy – for numerical operations.
- Tkinter – for the graphical user interface (GUI).

Dataset Description

- Face Dataset: 40 subjects (s1 to s40), each with 10 grayscale .pgm images.
- Image Size: All images resized to 56×46 pixels.
- Non-Face Dataset: Collection of .jpg, .png, .jpeg, and .pgm images labeled as non-face.
- Labeling: Subjects labeled from 1 to 40; non-faces labeled as 0.



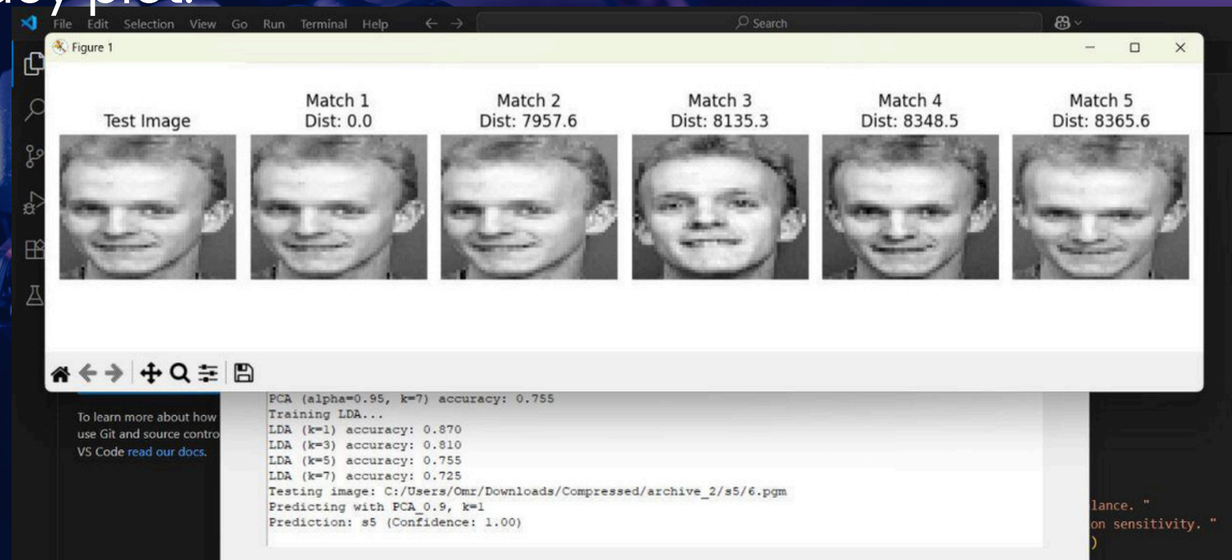
System Architecture

- Load dataset (faces & non-faces).
- Apply dimensionality reduction (PCA or LDA).
- Train KNN model.
- Test with input image.
- Display top matches with distances and prediction confidence.

User Interface

The application was developed using Tkinter. It allows the user to:

- Load datasets.
- Choose PCA or LDA.
- Train the model.
- Test an image.
- View prediction and accuracy plot.



PCA Recognition Results

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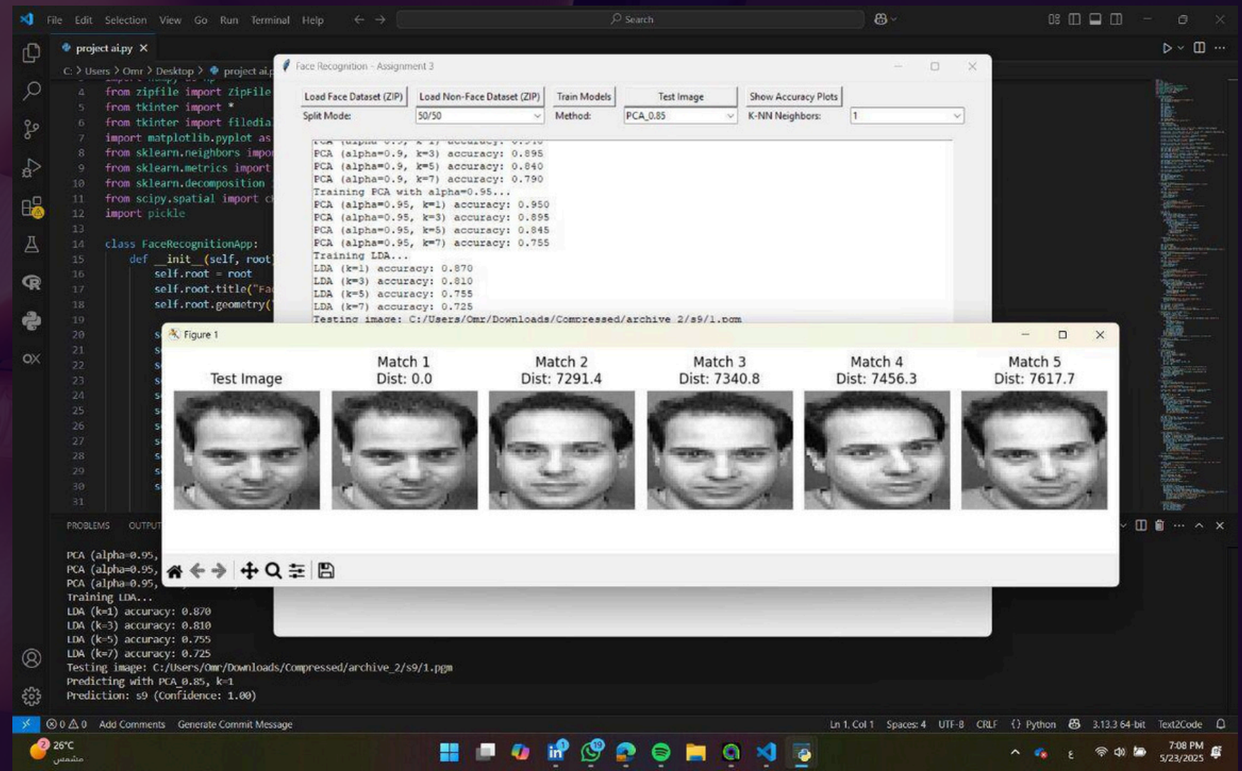
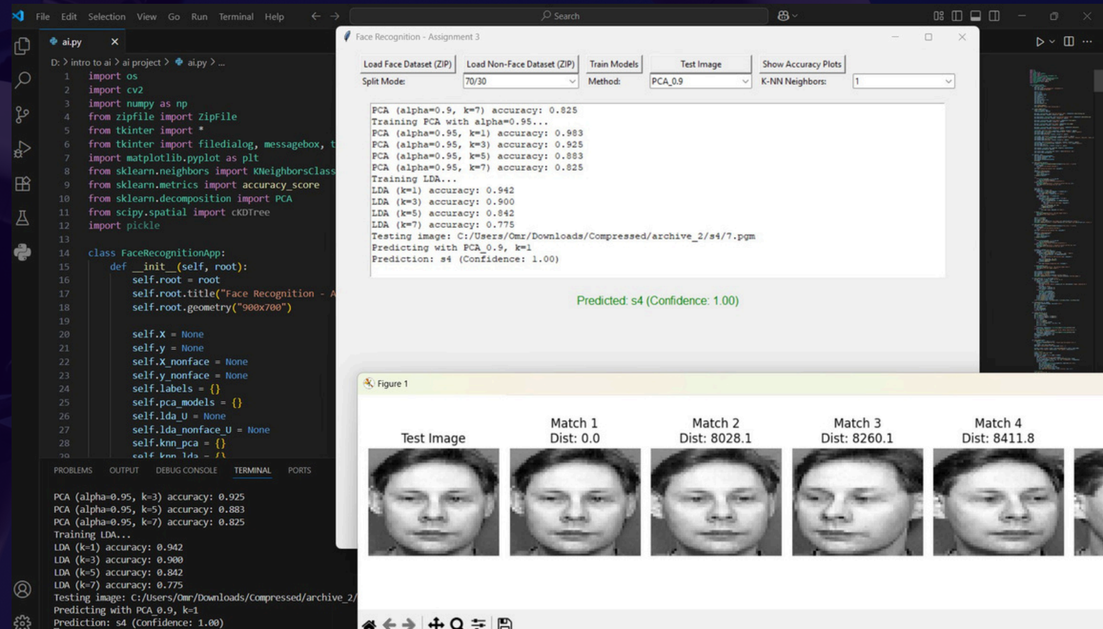
Example of PCA-based face recognition using different k values and alpha thresholds.
Results show that lower k tends to produce better accuracy with certain PCA configuration



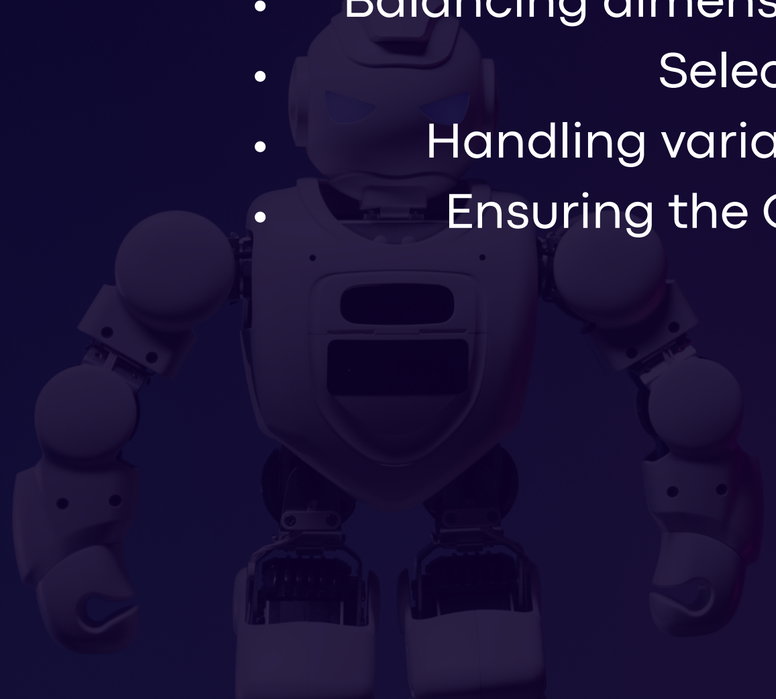
LDA Recognition Results

LDA model was evaluated with varying values of k.
Despite being more complex, LDA achieved high accuracy for k=1.



Challenges Faced

- Balancing dimensionality reduction without losing critical features.
- Selecting optimal values for k and alpha.
- Handling variations in lighting, angles, and face orientation.
- Ensuring the GUI remained responsive with large datasets.



Conclusion

- PCA and LDA are effective in extracting facial features.
- KNN classifier performs well with optimal parameters.
- GUI provides an intuitive and accessible interface.
- Accuracy can be further improved with more preprocessing and fine-tuning.

Future Enhancements

- Integrate deep learning models (e.g., CNN).
- Use larger and more diverse datasets.
- Add live face detection using webcam.
- Improve GUI design and responsiveness.

Thank You!

We appreciate your attention.

Any questions?