



PCA-Based Facial Recognition Using Eigenface Algorithm in Scilab GUI

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Abstract

Facial recognition systems are a critical component of modern biometric security and access control. While deep learning architectures dominate the current landscape, classical statistical methods remain highly efficient, computationally lightweight, and mathematically transparent. This case study implements the Eigenfaces algorithm for face recognition using Principal Component Analysis (PCA) entirely within Scilab. To make the system interactive and user-friendly, a custom Graphical User Interface (GUI) was developed natively in Scilab, allowing users to train the model, upload test images, and view recognition results in real-time without touching the command line.

The project uses the AT&T ORL Face Database, which contains 400 grayscale images of 40 different subjects. To ensure the system actually learns to generalize rather than just memorizing pictures, we split the data: the model is trained on the first 8 images of each person (320 images) and the remaining 2 images per person are hidden for testing. The workflow is straightforward but mathematically rigorous. First, all images are flattened into high-dimensional vectors and an "average face" is calculated. Then, we use a linear algebra trick to extract the top 50 "Eigenfaces"—the core underlying patterns that distinguish one face from another. When a user uploads a new photo through the GUI, the system projects that face onto the 50 Eigenfaces, compressing 10,304 pixels into just 50 numbers. It then measures the Euclidean distance between these numbers and the training set to find the

closest match. The GUI also features a reconstruction module, visually proving that a complex facial image can be heavily compressed into 50 weights while still retaining its exact identity.

References

Eigenfaces for Recognition - Matthew Turk and Alex Pentland

Link: <https://www.face-rec.org/algorithms/PCA/jcn.pdf>