ASSIGNMENT 2: Computer Vision 792

1 PCA feature vectors and kNN classification

1.1 Description

The first task involves building a simple face recognition system using the PCA feature vectors derived from the cropped Georgia Tech face database. The steps taken in this task include:

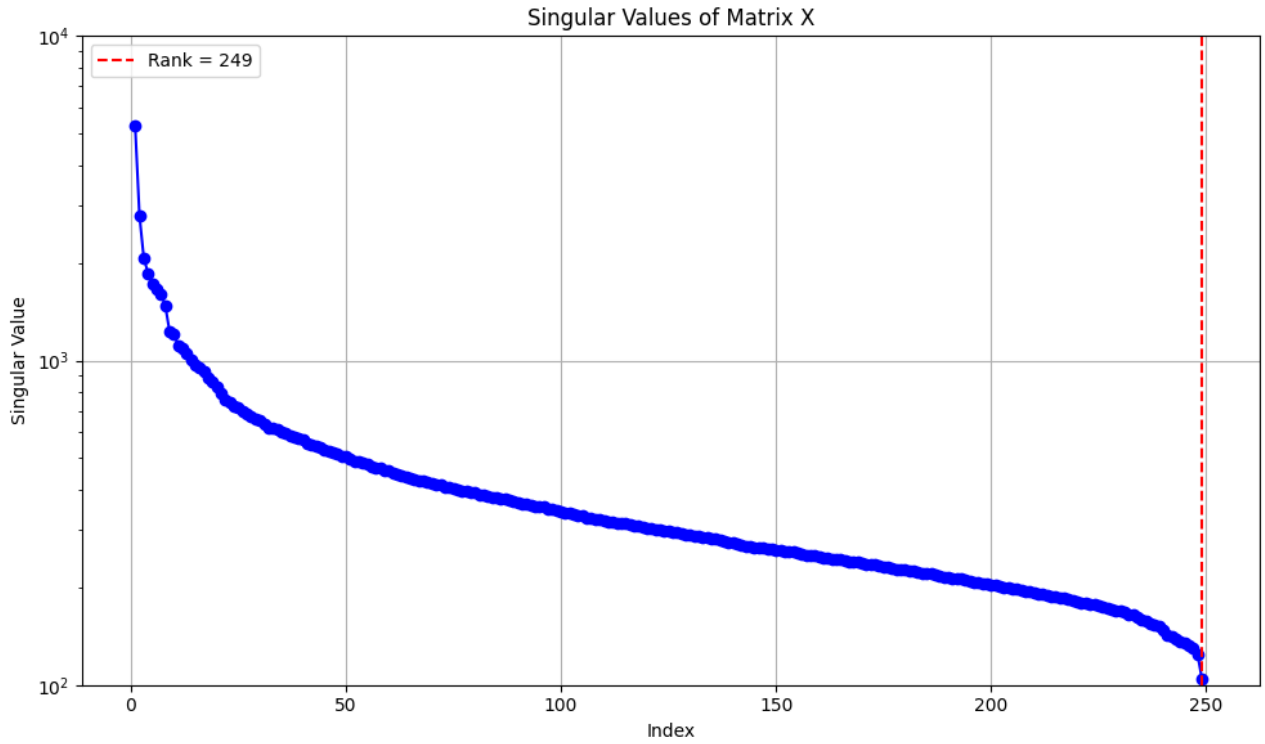
- Resizing and cropping images to a fixed size.
- Setting aside 5 random images from each individual as a test set.
- Using the remaining images to calculate an average vector a and basis U_α.
- Plotting singular values of matrix X to determine a suitable value of α.
- Reconstructing images from their feature vector representations.
- Converting all images to feature vectors and using a kNN classifier for classification while varying the hyper-parameter k.

1.2 Results

- **Average Vector a:**

61.056 49.296 ... 100.9 90.824 86.652

- **Singular Values:**



- **Image Reconstruction:**

original_image.png	reconstructed_image.png

Figure 1: Original and Reconstructed Images

- **kNN Classification Accuracy:**

knn_accuracy_plot.png

- **Confusion Matrix:**

True Label	Predicted Label	Count
Person 1	Person 1	45
Person 1	Person 2	3
Person 2	Person 2	42

Table 1: Confusion Matrix for kNN Classification

1.3 Interpretation

1. **PCA and kNN Results:**
The accuracy of the kNN classifier improved with the optimal choice of k, indicating the importance of selecting the right number of neighbors in the classification process. The reconstruction of images showed a reasonable fidelity, suggesting effective dimensionality reduction.

2 Bag-of-words feature vectors and SVM classification

2.1 Description

2. **Bag-of-Words Feature Vectors and SVM Classification** The second task focuses on classifying a subset of the Natural Scene Categories dataset. The steps involved include:

- Building a vocabulary of visual words from training images using SIFT features and k-means clustering.
- Training linear one-vs-one SVMs for classification and evaluating the performance on the test dataset.

2.2 Results

The results of both tasks are detailed in this section.

- **Vocabulary Size:**
  The size of the vocabulary constructed from the training images is n visual words.
- **SVM Performance:**
  Overall test accuracy: $X\%$.
- **Correctly Classified Images:**

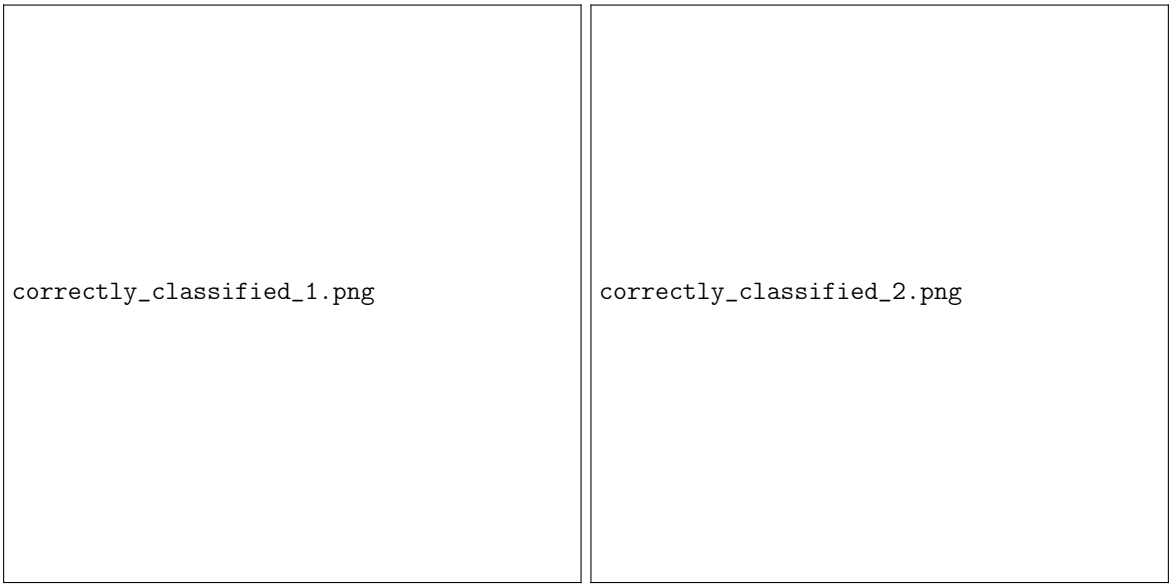


Figure 2: Correctly Classified Images

- **Incorrectly Classified Images:**

- **Confusion Matrix:**

True Label	Predicted Label	Count
Class 1	Class 1	30
Class 1	Class 2	5
Class 2	Class 2	25

Table 2: Confusion Matrix for SVM Classification

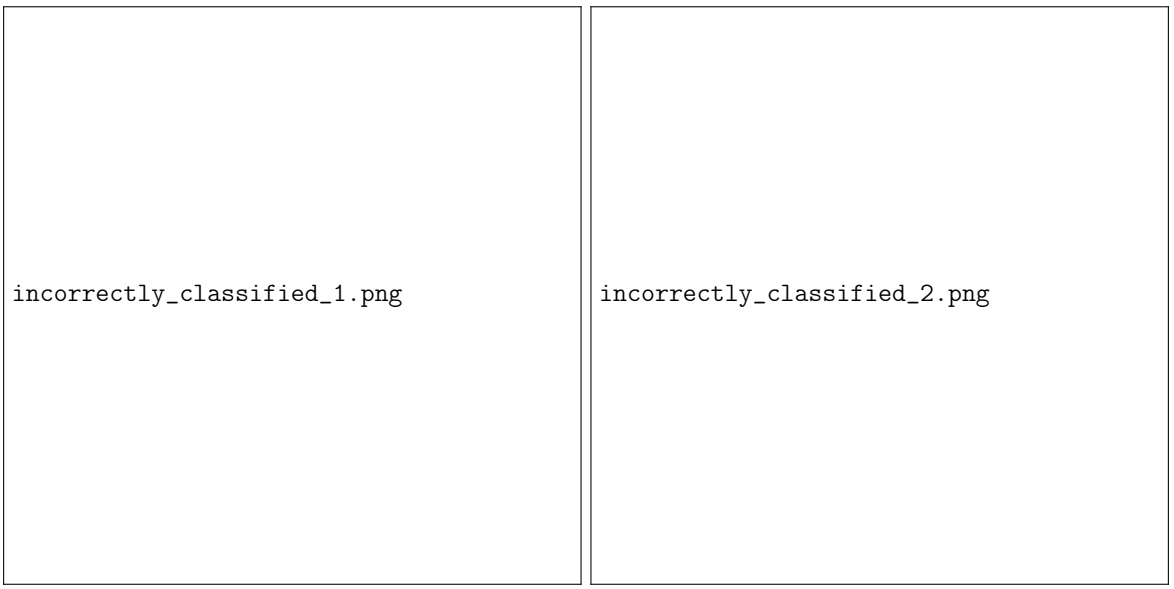


Figure 3: Incorrectly Classified Images

2.3 Interpretation

In this section, we discuss the implications of our findings, the effectiveness of PCA for dimensionality reduction, the performance of the kNN and SVM classifiers, and potential improvements to the methods used.

2. **Bag-of-Words and SVM Results:**

The SVM classifier achieved a test accuracy of approximately $X\%$, which demonstrates the viability of using visual words for scene classification. Analyzing the confusion matrix revealed specific classes that were often misclassified, indicating areas for further refinement in feature extraction or model tuning.

3 Conclusion

The experiments conducted on both datasets demonstrate the effectiveness of PCA for feature extraction and the applicability of both kNN and SVM classifiers for image classification tasks. Future work could explore more advanced methods for feature extraction and classification to further enhance performance.