ENEE 633 Statistical Pattern Recognition- Project 1
REPORT

Problem Statement

The two classification tasks are to be performed
1) identifying the subject label from a test image (for datasets DATA, POSE, and ILLUMINATION) and
2) neutral vs. facial expression classification (for dataset DATA).

Dataset

Data Cropped images of 200 subjects, 3 images each, each image of size 24x21. The file data.mat has a variable face of size (24x21x600). The images corresponding to the person labelled n, n = 1, . . . , 200 can be indexed in Matlab as face(:,:,3*n-2), face(:,:,3*n-1) and face(:,:,3*n). The first image is a neutral face, the second image has a facial expression, and the third image has illumination variations.

Implementation

1) The following classifiers were implemented for Task 1-Identifying the subject label from a test image

- Maximum Likelihood estimation with Gaussian assumption followed by Bayes classifier
- k-NN classifier
- PCA followed by Bayes Classifier
- PCA followed by k-NN classifier
- MDA followed by Bayes classifier
- MDA followed by k-NN classifier

The dataset used for Task 1 was DATA. 2/3rd of the dataset was used for training and 1/3rd for testing. Three cases were considered in total. The neutral and the facial expression data was taken for training and the illumination variation image was considered for testing. Similarly, the neutral face was considered for testing in case 2 and the facial expression was considered for testing in case 3.

2) The following classifiers were implemented for Task 2- Neutral vs. facial expression classification

- Maximum Likelihood estimation with Gaussian assumption followed by Bayes classifier
- k-NN classifier
- PCA followed by Bayes Classifier
- PCA followed by k-NN classifier
- MDA followed by Bayes classifier
- MDA followed by k-NN classifier
- Kernel SVM using the RBF and Polynomial Kernel
- Boosted linear SVM

The dataset used for task 2 was the DATA dataset. Only the facial expression and the neutral face images were considered for the task and the 80% of the dataset was used for training and 20% for testing.

Results

TASK 1

Three cases of dataset variations were presented before all the 6 types of classifier types.

Case 1: Training- Neutral and facial expression, Testing- Illumination variation

Case 2: Training- Facial expression and illumination variation, Testing- Neutral

Case 3: Training- Neutral and illumination variation, Testing- Facial expression

ACCURACY TABLE

Classifier	ML-Bayes	k-NN	PCA + Bayes	PCA + k-NN	MDA + Bayes	MDA + k-NN	Average
Case 1	0.6400	0.5950	0.6350	0.5850	0.5850	0.5750	0.6025
Case 2	0.7200	0.5550	0.7100	0.5550	0.8850	0.8850	0.7183
Case 3	0.6650	0.6500	0.6600	0.6500	0.7800	0.7800	0.6975
Average	0.6750	0.6000	0.6683	0.5967	0.7500	0.7467	

DISCUSSION:

The maximum likelihood estimate followed by the bayes classifier yields the most accuracy in case 1. The pair of multiple discriminant analysis followed by nearest neighbour classifier and the Bayes classifier yields the best accuracy in both case 2 and 3. On average, the highest accuracy was obtained in case 2, where the neutral face data was considered for testing and the facial expression and the illumination variation data was used for training. This might be because the training data had good variance to correctly classify the test data.

In terms of the best performing classifiers, the multiple discriminant analysis followed by the Bayes classifier gave the maximum accuracy on average compared to all other classifiers. It was followed closely by the multiple discriminant analysis followed by the nearest neighbour classifier.

TASK 2

ACCURACY TABLE

Classifier	ML-Bayes	k-NN	PCA + Bayes	PCA + k-NN	MDA + Bayes	MDA + k-NN	Kernel SVM	Boosted SVM	Average
Accuracy	0.6750	0.7625	0.4875	0.5125	0.50	0.525	0.80 (RBF) 0.80 (Poly)	0.8375	0.6555

DISCUSSION:

For task 2, the maximum accuracy was achieved for the Boosted SVM, followed by the Kernel SVM using both the RBF kernel and polynomial kernel of degree 2. PCA followed by both Bayes and k-NN classifiers gave a lesser accuracy compared to just ML- Bayes or k-NN classifier. This might be due to the data points having a lesser variance. A similar result is seen in the case of MDA as well. It can be attributed to small sample size of the dataset.

Conclusion

The two tasks for facial recognition, recognizing subject label and recognizing if the face has a neutral or some facial expression were carried out using classifiers like Bayes and Nearest Neighbour. PCA and MDA techniques were also applied before the classifiers. Kernel SVM and Ada-boost and linear SVM were also used for Task 2. The result is task 1 indicate that a greater variance in data samples lead to a greater accuracy. The result in task 2 suggested that a larger training size with good variance might lead to a better accuracy.