Minor Project - Mask Detection
Image Classification
Minor Project CSL 2050

Pattern Recognition and Machine Learning

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ABSTRACT

This document reports and states the results of the implementation of end to end pipeline of various machine learning algorithms namely Support Vector Machine, Multilayer Perceptron (Neural Network), K-nearest neighbour using SKlearn inbuilt libraries along with using Principal Component Analysis, Linear Discriminant Analysis evaluation using cross-validation and testing accuracy. We also analysed performance of the trained model on a Real time image dataset.

I. Introduction and Visualization

The dataset we selected had `2201` colour images(RGB) where each person is wearing a mask and `2160` colour images(RGB) where each person is not wearing a mask. Hence the images belong to 2 classes ‘wearing a mask’ or ‘not wearing a mask’. ‘Wearing a mask’ was encoded as 1 and ‘not wearing a mask’ was encoded as 0. Some images of the dataset displayed with the help of OpenCV are:

Some of the images contained in the real word dataset are as follows:

II. Preprocessing

We reshaped all images to 120x100 in order to bring uniformity to the number of features for every image. We decided not to perform standard scaling because the mean and variance of pixel colors do not provide an intuitive sense in terms of the current problem statement.

III. Feature selection & Feature extraction

For the real world dataset we extracted faces from the images with the help of OpenCV. Due to variable position of the face in the images we did not do further selection on the image of faces.

IV. Dimensionality Reduction:

We trained models after dimensionality reduction with Principal Component Analysis and Linear Discriminant Analysis. PCA was set to preserve 95% of the variance of the data. For every classifier, PCA gave more accuracy than LDA.

V. Training Different ML Models:

We trained in total nine models

1. Multilayer Perceptron without dimensionality reduction
2. Multilayer Perceptron with PCA
3. Multilayer Perceptron with LDA
4. SVM without dimensionality reduction
5. SVM with LDA

6. SVM with LDA
7. k-NN without dimensionality reduction
8. k-NN with LDA
9. k-NN with PCA

VI. Performance evaluation and Analysis

Model	5 fold Cross-Validation Results without dimensionality reduction	5 foldcrosss-Validation Results with PCA	5 foldcrosss-Validation Results with LDA
	Test Score	Test Score	Test Score
MultiLayer Perceptron	[0.91972477, 0.91972477, 0.92201835, 0.92431193, 0.91743119]	[0.92311927 0.91311927 0.92623853 0.90770642 0.92541284]	[0.99311927 0.99311927 0.98623853 0.99770642 0.99541284]
Support Vector Machine	[0.94972477, 0.91972477, 0.95201835, 0.92431193, 0.93743119]	[0.97706422 0.96330275 0.93577982 0.95412844 0.95642202]	[0.99311927 0.99541284 0.98394495 0.99770642 0.99311927]
kNN	[0.90389016 0.90137615 0.89449541 0.89220183 0.89678899]	[0.93348624 0.90366972 0.88990826 0.90137615 0.89678899]	[0.99082569 0.99082569 0.98623853 0.99541284 0.99541284]

* Values are rounded off up to 3 decimal digits.

Model	Testing Accuracy without PCA(Percentage)	Testing Accuracy with PCA(Percentage)	Testing Accuracy with LDA(Percentage)
Multilayer Perceptron	94.26	92.02	86.38
Support Vector Machine	96.47	96.79	86.24
kNN	90.46	91.52	86.47

Analysis: With PCA it can be seen that Support Vector Machine performs the best but also takes the most time. It can be seen that applying PCA in this case always yielded better accuracy. Here it appears that classifiers with LDA applied perform less since the number of linear discriminants will be only 1 (c-1 where c is the number of classes), hence is unable to discriminate better than other classifiers.

With PCA, performance classifiers improved. Reason behind this improvement could be less complexity of the models which were able to perform better after reduction in number of features due to PCA.

Without PCA also it can be seen that Support Vector Machine performs the best.

VII. Real World Image Testing

For this part we used images from a dataset which had people with masks as well as background noise. As mentioned earlier we extracted faces from these images using OpenCV.

A few real world images after extraction:

Then we used the kNN trained earlier to detect the number of faces in an image with a mask.

We have shown some of the results of the classification.

```
Number of masks detected in this image : 0
```

```
Number of masks detected in this image : 0
```

```
Number of masks detected in this image : 2
```


```
Number of masks detected in this image : 1
```

We can see that the classifiers trained on face images earlier did not give as good performance as they gave in ideal conditions.

VIII. Contributions

Thus CNN classifier performs best and also takes very less time taking approximately 2 mins to provide the results shown above.

The end-to-end implementation of the machine learning pipeline was thoroughly discussed among the team members. All minute details were debated over and decided using a sound mathematical basis. Every decision was made unanimously.

The work for writing the code was divided as below.

Hard Savani (B19CSE080) - Wrote the code implementing MLP, SVM and kNN with LDA and PCA and cross validation. Implemented classification on real world dataset. Helped in dataset preparation.

Darsh Patel (B19CSE115) - Prepared the dataset and converted it into data. Rescaled images and wrote code for with and without PCA implementation of MLP, SVM, and kNN. Helped in implementing classification for real world dataset.

Except for code writing, all the other activities were done together. Documentation, verification, and finalization were also done together.

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