K-Nearest Neighbor and Support Vector Machine Classification Approach for Face Recognition

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Abstract

Face recognition is a very simple task for individuals. However, it is a somewhat difficult for machines to characterise faces accurately. Face recognition is an important application of Machine Learning and Image Processing owing to it's use in numerous fields. The project presented here was developed after investigating and understanding of various face recognition methodologies and their efficiencies. An effective and real time face recognition system based on Appearance is developed in the project. The system was tested on ORL Face Dataset. The recognition produced using 2 different matching techniques are compared and the results have been presented. The correct recognition rate achieved using the PCA with SVM is 97.25% in comparison to the 95.00% for the normal PCA with KNN. The system responds to the face recognition queries in less than 10 seconds.

Introduction

Face recognition has been a sought after problem of biometrics and it has a variety of applications in modern life. The problems of face recognition attracts researchers working in biometrics, pattern- recognition field and computer vision . Several face recognition algorithms are also used in many different applications apart from biometrics , such as video compressions , indexing etc. They can also be used to classify multimedia content, to allow fast and efficient searching for material that is of interest to the user. An efficient face recognition system can be of great help in forensic sciences, identification for law enforcement, surveillance , authentication for banking and security system, and giving preferential access to authorised users i.e. access control for secured areas etc. Though face recognition is considered to be a very crucial authentication system but even after two decades continuous research and evolution of many face recognition algorithms , a truely robust and efficient system that can produce good results in realtime and normal conditions is still not available. Face recognition is one of the most challenging tasks in the field of pattern recognition. Besides of the many variations in the images, the training data set in the face recognition system is only a very small portion of the possible cases. This fact makes the face recognition a very difficult task for most of the current classifiers. Face Recognition techniques can be decided into two techniques based on how they represent faces 1. Appearance based which characterises the texture features to the specific region (can be whole) of the image, 2. Feature based, which applies geometric facial features and its relationships. In this project face recognition has been implemented using Appearance based techniques which is Principal Component Analysis.

Your Approach

I designed a face recognition system based on PCA with Classification algorithm. The main challenge for a face recognition system is of effective feature extraction. The proposed system utilises the Eigen face method in information reduction for the images. There is an incredible amount of information present even in a small face image. A method must be able to break down

pictures so as to effectively represent face images rather than images in general. ‘base faces are generated and then image being analysed can be represented by the system as a linear combination of these base faces. Each face that we wish to classify can be projected into face-space and then analysed as a vector. A k Nearest-Neighbour approach, a neural network or even a simple Euclidean distance measure can be used for classification.

The proposed system uses Principal Component analysis for feature extraction and various classification models such as the Support Vector Machine and K Nearest Neighbour. The technique used here involves generating the ‘Eigen Faces’ then projecting training data into face-space to be used with a predetermined classification method and evaluation of a projected test element by projecting it into face space and comparing to training data.

Experimental Design

Principal Component Analysis

Let X be matrix of n face images where each image is 1D Vector which can be flatten using flatten function of Numpy. m * n Matrix is converted into a vector of n * m rows. The PCA Algorithm to obtain Eigen vectors or faces can be obtained as follow:

1. Compute Mean: Calculate the mean of all the 1D vectors with axis as 0
2. Re - Center: Need to subtract the mean from all the 1D vectors in matrix(i.e from each row of X)
3. Compute Covariance Matrix:
   $\sum = X_c^T X_c$
4. Compute Eigen Values and Eigen Vectors of $\sum$
5. Principal Component: k EigenVectors with highest eigenvalues

The obtained principal components determine the Subspace which is called as eigenfaces. But, because of computational problem which is, ORL Dataset contains all images of 92*112 pixels i.e. 10304 size of 1 Vector. And Covariance matrix will be of 10304 *10304 size and could not be processed and is computationally inefficient. So, lets define B of dimension m * n and we use BB^T instead. And obtaining Eigen vector from is relatively cheaper.

K Nearest Neighbor

The K nearest neighbor (kNN) classifier is an extension of the simple nearest neighbor (NN) classifier system. The nearest neighbor classifier works based on a simple nonparametric decision. Each query image Iq is examined based on the distance of its features from the features of other images in the training database. The nearest neighbor is the image which has the minimum distance from the query image in the feature space.

Support Vector Machine

The most useful techniques in classification problem is Support Vector Machine and face recognition is one of the example. SVM cannot be used when features vectors have missing values and face recognition is one such case scenario. But, cannot be used when some features are occluded. A support vector machine develops a hyperplane or set of hyperplanes in a high-or unbounded dimensional space, which can be utilised for classification or regression. Intuitively, a great partition is accomplished by the hyperplane that has the largest separation to the closest training data point of any class.

AT & T ORL Face Dataset

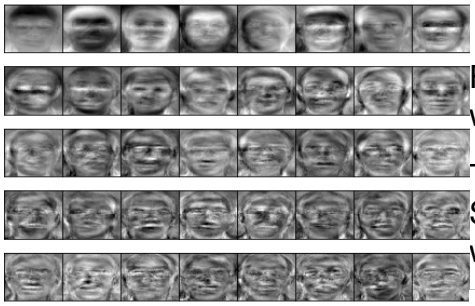
The “AT & T Database of Faces” was formerly “The ORL Database of Faces”. It consists of face images 40 distinct subjects with 10 images per subject. For some subjects, the images were taken at different times, varying the lighting, facial expressions (open / closed eyes, smiling / not smiling) and facial details (glasses / no glasses). All the images were taken against a dark homogeneous background with the subjects in an upright, frontal position (with tolerance for some side movement).The files are in PGM format and

size of each image is 92(width) x 112 (height) pixels, with 256 grey levels per pixel. The images are organised in 40 directories (one for each subject), which have names of the form sX, where X indicates the subject number (between 1 and 40). In each of these directories, there are ten different images of that subject, which have names of the form Y.pgm, where Y is the image number for that subject (between 1 and 10).

Experimental Results

To, normalise the dataset, mean of the image needs to be computed. The following image is mean image of all the 1D vector.

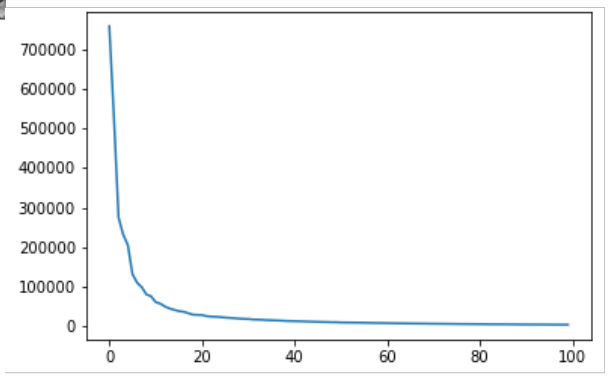
After performing PCA on Training dataset, and sorting them, the following are the top 40 Eigen faces with highest Eigen Values.



Following is EigenValues vs k graph and by observing, we can say K = 70 is the best optimal value of k.

The maximum accuracies achieved by the PCA with SVM is 97.25% with K being 70 and 95.00% for PCA with KNN.

K(PCA)	KNN (in %) Accuracy	SVM (in %) Accuracy
10	91.75	93.2
30	94.75	97
40	94.75	97
60	94.25	96.4
70	95	97.25



Conclusion

This task on Face recognition has given me an opportunity to learn about numerous prominent strategies used in the field of face recognition. The in-dept literature survey helped in knowing the advantages and disadvantages of numerous face recognition frameworks. I additionally came to realize how the SVM is inversely affected with increasing values of K. In this project, I have built up a PCA based face recognition framework for feature extraction and classification utilising different classification algorithms. The run time of the codes is likewise considerably quick with a response time of single query being under 10 seconds.

References

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