Robust Face Recognition Using An Ensemble of Different Methods

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Intro

- Face recognition is one of those challenging problems and up to date, there is no technique that provides a robust solution to all situations and different applications that face recognition may encounter.
- In many applications (specially those related to defense and security) the face recognition task must be robust to misclassifications.
- Ensembles are a great way to improve robustness. Using ensembles we can be sure that the final definite answer is the result of different models.

5 Different methods combined

- Eigenface (PCA)
- Fisherface (LDA)
- Local Binary Patterns (LBP)
- Discrete Cosine Transform (DCT)
- Nearest centroid classifier

Eigenface (PCA)

- The eigenvectors are derived from the covariance matrix of the probability distribution over the high-dimensional vector space of face images.
- Principal Component Analysis (PCA) tends to find a t-dimensional subspace whose basis vectors correspond to the maximum variance direction in the original image space.
- Classification can be achieved by comparing how faces are represented by the basis set.

Eigenface (PCA) Cont.

- Drawbacks :
  - The pictures constituting the training set should have been taken under the same lighting conditions
  - Must be normalized to have the eyes and mouths aligned across all images.
- Benefits :
  - Fast.
  - The resulting dimension is so much lower.

Fisherface (LDA)

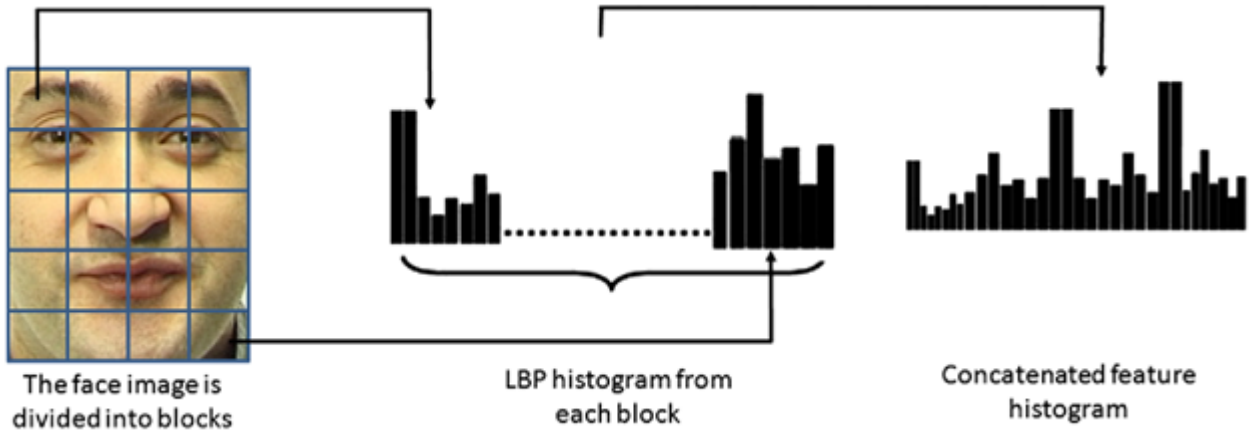
- Look for dimension reduction based on discrimination purpose.
- When the goal is classification rather than representation one wishes to find a subspace that maps the sample vectors of the same class in a single spot of the feature representation and those of different classes as far apart from each other as possible.
- Maximizes the ration of between-classes to within-classes scatter. The idea is that same classes should cluster tightly together.

Fisherface (LDA) Cont.

- Drawbacks :
  - The data must be labeled. (Although we tested with unlabeled and got good results.)
  - The dimension of projection in face space is not as compact as Eigenface.
- Benefits :
  - More accurate than Eigenfaces.
  - Solves the illumination problem by maximizing the ratio of between-class scatter to within-class scatter

Local Binary Patterns (LBP)

- Take a pixel as center and threshold its neighbors against. If the intensity of the center pixel is greater-equal its neighbor, then denote it with 1 and 0 if not.
- The procedure consists of using the texture descriptor to build several local descriptions of the face and combining them into a global description.
- Texture descriptors (histograms) are extracted from each region independently.



Local Binary Patterns (LBP) Cont.

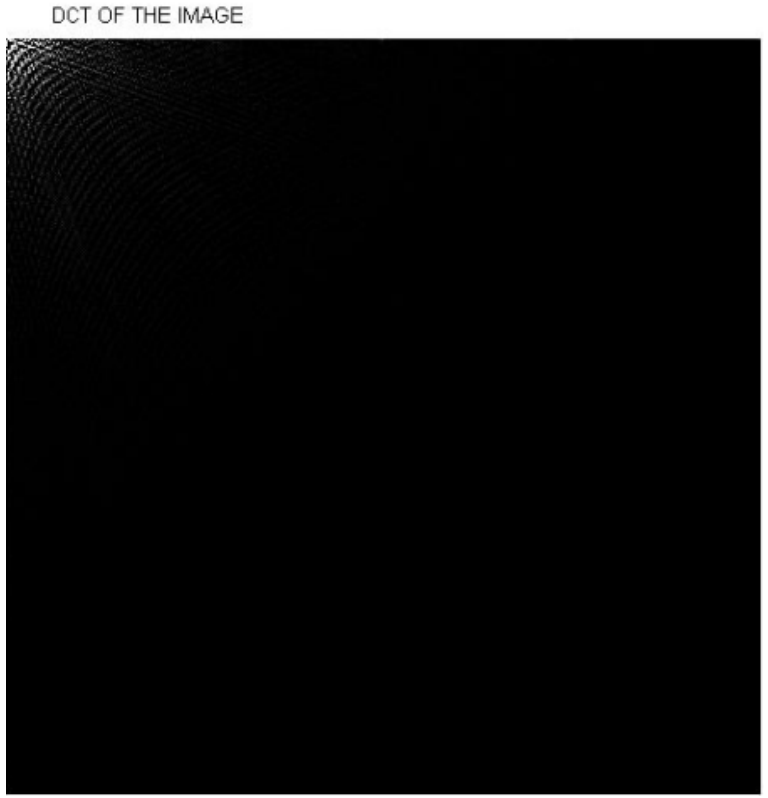
- Drawbacks :
  - Deciding the best parameter setup can be tricky.
- Benefits :
  - Discriminative power and computational simplicity.
  - More robust against variations in pose or illumination than holistic methods.
  - Partially robust against image rotation and aging of persons.

Discrete Cosine Transform (DCT)

- A discrete cosine transform (DCT) expresses a finite sequence of data points in terms of a sum of cosine functions oscillating at different frequencies.
- The use of cosine rather than sine functions is critical for compression, fewer cosine functions are needed to approximate a typical signal.
- Only a subset of the obtained coefficients is retained. The size of this subset is chosen such that it can sufficiently represent a face.

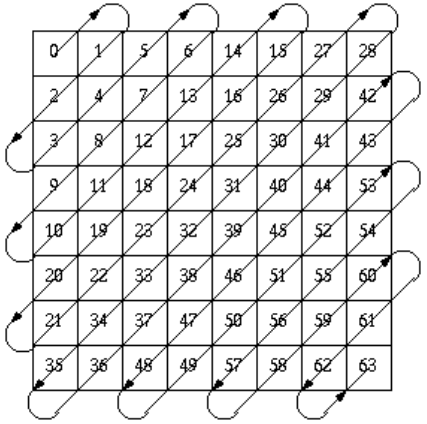
Discrete Cosine Transform (DCT) Cont.

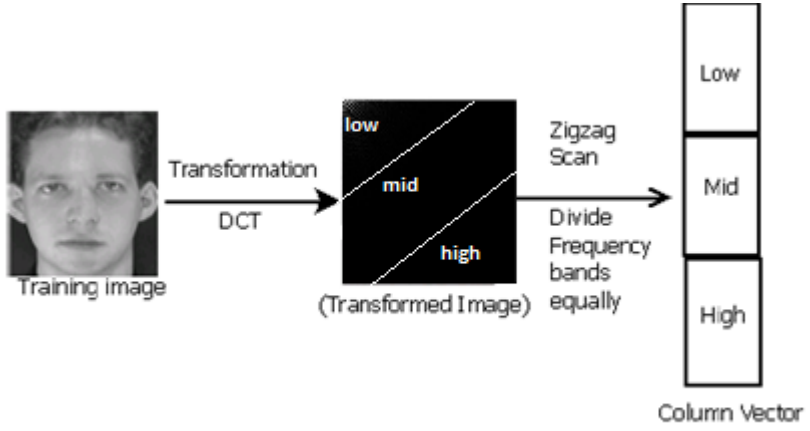
- The coefficients with large magnitude are mainly located in the upper left corner of the DCT matrix.
- Low frequency coefficients are related to illumination variation and smooth regions (like forehead cheek etc.) of the face.
- High frequency coefficients represent noise and detailed information about the edges in the image.
- The mid frequency region coefficients represent the general structure of the face in the image.



Discrete Cosine Transform (DCT) Cont.

- We do a zigzag scanning so that in the vector the components are arranged according to increasing value of frequency.
- we divide the whole range of frequency into three equal sections and derive the coefficient of feature vector from each section.
- In case of low frequency section we reject the 1st three terms and consider the next 2000 terms.
- In case of mid and high frequency we are considering 2000 coefficient from each section. So for each image we have obtained a feature vector of size 6000.



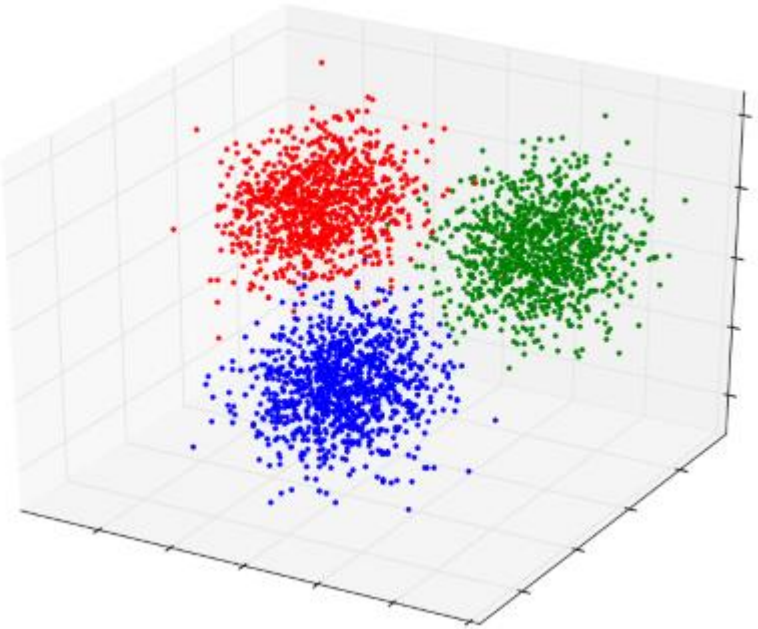


Discrete Cosine Transform (DCT) Cont.

- Drawbacks :
  - Calculating the DCTs can be time consuming.
  - Deciding how many terms to consider is experimental.
- Benefits :
  - Extreme dimension reduction.
  - More robust against illumination.

Nearest Centroid Classifier

- The method computes a standardized centroid for each person.
- The class whose centroid that it is closest to, in euclidean distance, is the predicted class for that new face image.
- This method is in fact quite good for our application, since we usually take up to 50 images per person for the training phase.



Nearest Centroid Classifier Cont.

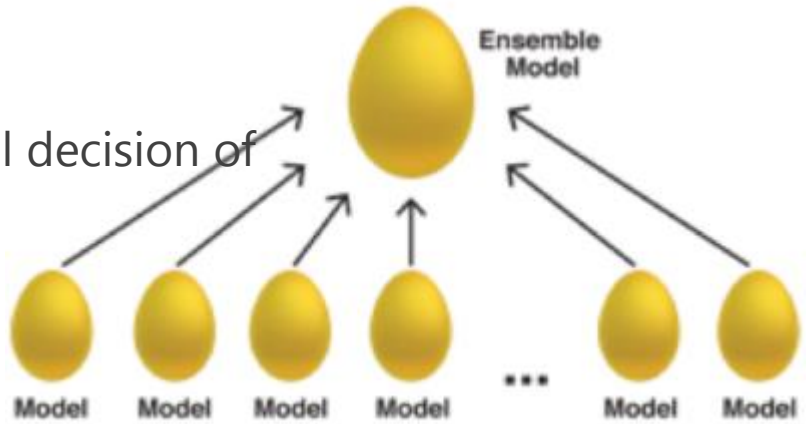
- Drawbacks :
  - Faces must be fully aligned.
  - Needs many faces of a person.
  - Prone to aging and accessories.
- Benefits :
  - Quite fast.
  - It’s simple and needs very low storage.

Face Capturing and Detection

- The algorithm takes up to 50 images of a person and then detect their faces from those images.
- Each image is taken after a 0.3 second interval, this allows individuals to have different facial expression and orientation.
- Face detection is done using the frontal face Haar cascade to identify where the face is in an image.
- To improve accuracy and lessening the effect of illumination each face is then receives the histogram equalization treatment.

Ensemble of 5 Methods

- These methods are mostly different from each other so they can be good elements of an ensemble to improve the final model's robustness.
- Using a majority vote algorithm we decide which answer is the final decision of the whole ensemble.
- Major votes which are less or equal to 2 will be ignored.
- The final classification of the model is done whenever the major vote of the ensemble classifies the new face to a class for 30 times.



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