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Approach for Face Recognition using Local and Global Features

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ABSTRACT - *Face Recognition using Discrete Cosine Transform (DCT) for Local and Global Features involves recognizing the corresponding face image from the database. The face image obtained from the user is cropped such that only the frontal face image is extracted, eliminating the background. The image is restricted to a size of 128 × 128 pixels. All images in the database are gray level images. DCT is applied to the entire image. This gives DCT coefficients, which are global features. Local features such as eyes, nose and mouth are also extracted and DCT is applied to these features. Depending upon the recognition rate obtained for each feature, they are given weightage and then combined. Both local and global features are used for comparison. By comparing the ranks for global and local features, the false acceptance rate for DCT can be minimized*
Keywords - *Discrete Cosine transform, Local feature, Global feature.*

I. INTRODUCTION

A face recognition system is essentially an application intended to identify or verify a person either from a digital image or a video frame obtained from a video source. Although other reliable methods of biometric personal identification exist, for e.g., fingerprint analysis or iris scans, these methods inherently rely on the cooperation of the participants, whereas a personal identification system based on analysis of frontal or profile images of the face is often effective without the participant's cooperation or intervention. One of the many ways for automatic identification or verification is by comparing selected facial features from the image and a facial database. This technique is typically used in security systems.

For e.g., This technology could be used as a security measure at ATM's; instead of using a bank card or personal identification number, the ATM would capture an image of the person's face, and compare it to his/her photo in the bank database to confirm the identity of the relevant person. On similar lines, this concept could also be extrapolated to computers; by using a web cam to capture a digital image of a person, the face could replace the commonly used password as a means to log-in and thus, authenticate oneself. Given a large database of images and a photograph, the problem is to select from the database a small set of records such that one of the image records matched the photograph. The success of the method could be measured in terms of the ratio of the answer list to the number of records in the database.

The recognition problem is made difficult by the great variability in head rotation and tilt, lighting intensity and angle, facial expression, aging, etc. Some other attempts at facial recognition by machines have allowed for little or no variability in these quantities. A general statement of the problem of machine recognition of faces can be formulated as: given a still or video image of a scene, identify or verify one or more persons in the scene using a stored database of faces. Available collateral information such as race, age, gender, facial expression, or speech may be used in narrowing the search. The solution to the problem involves segmentation of faces, feature extraction from face regions, recognition, or verification. In identification problems, the input to the system is an unknown face, and the system reports back the determined identity from a database of known individuals, whereas in verification problems, the system needs to confirm or reject the claimed identity of the input face.

Some of the various applications of face recognition include driving licenses, immigration, national ID, passport, voter registration, security application, medical records, personal device login, desktop login, human-robot-interaction, human-computer-interaction, smart cards etc.

One of its applications is Criminal Face Identification system. Establishing the identity of any criminal by constructing the image of the criminal based on information given by eyewitnesses and comparing it with existing criminal images in the database available with investigating agencies. Construction of the image of the criminal using segmented/sliced images of human face like mouth, eyes, nose, ..etc is available in the database with the help of eyewitnesses.

There are three approaches for Face recognition:

1.1 Holistic matching methods:

These methods use the whole face region (global feature) as a raw input to the recognition system. One of the most widely used representations of the face region is Eigen pictures, which is inherently based on principal component analysis.

1.2 Feature-based matching methods:

Generally, in these methods, local features such as the eyes, nose and mouth are first extracted and their locations and local statistics are fed as inputs into a classifier.

1.3 Hybrid methods:

It uses both local features and whole face region to recognize a face. This method could potentially offer the better of the two types of methods.

Our aim is to extract local features from a given frontal face. The local features are left eye, right eye, nose and mouth. These local features will be extracted manually. Discrete Cosine Transform (DCT) will be applied to each of these local features individually and also to the global features. Finally, the results obtained in both cases will be compared.

II. PROPOSED ALGORITHM

For creating the database Microsoft Access is used. Frontal images are extracted from the database. Frontal face image extraction is carried out in order to reduce the effect of varying backgrounds on the proposed face recognition system. The frontal face image is acquired. From the given frontal image, local features like eyes, nose and mouth region are extracted manually. DCT is applied to each of these features. The DCT coefficients of these regions are stored. These coefficients are then used for comparison. The recognition rates obtained with these local features are compared to the recognition rate obtained when DCT is applied to the global image.

DCT is an accurate and robust face recognition system and using certain normalization techniques, its robustness to variations in facial geometry and illumination can be increased. Face normalization techniques are also incorporated in the face recognition application discussed. Namely, an affine transformation is used to correct scale, position, and orientation changes in faces. Due to this a tremendous improvements in recognition rates can be achieved with such normalization. In order to the prevent problem of illumination variations, faces in the databases used for the tests are uniformly illuminated. That is, certain illumination normalization techniques are used to make all faces have the same overall gray-scale intensity. An alternative approach to the DCT is KLT (Karhunen-Loeve transform). This transform exhibits pattern recognition properties that were largely overlooked initially because of the complexity involved in its computation. This transform produces an expansion of an input image in terms of a set of basis images or the so-called “Eigen images.” But DCT is better than KLT because of following comparisons.

A complexity comparison between the DCT and the Karhunen-Loeve transform (KLT) is that, in the proposed application, using DCT, training essentially means computing the DCT coefficients of all the database faces. On the other hand, using the KLT, training entails computing the basis vectors of the transformation. This means that the KLT is more computationally expensive with respect to DCT. However, once the KLT basis vectors have been obtained, it may be argued that computing the KLT coefficients for recognition is trivial. But this is also true of the DCT, with the additional provision that the DCT may take advantage of very efficient computational algorithms.

DCT is a well-known signal analysis tool used in compression due to its compact representation power. It is known that the KLT is the optimal transform in terms of information packing, however, its data dependent nature makes it infeasible to implement in some practical tasks. Moreover, DCT closely approximates the compact representation ability of the KLT, which makes it a very useful tool for signal representation both in terms of information packing and in terms of computational complexity due to its data independent nature. DCT helps to separate the image into parts of differing importance (with respect to the image's visual quality). DCT is conceptually similar to Discrete Fourier Transform (DFT), in the way that it transforms a signal or an image from the spatial domain to the frequency domain.

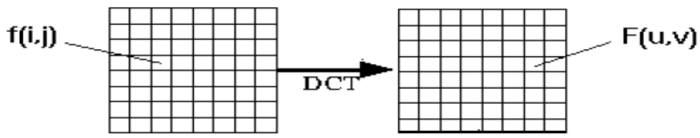


Fig 1: Image transformation from spatial domain to frequency domain

Discrete Cosine Transform Encoding

The basic encoding operation of the DCT is as follows:

• The size of the input image is $N \times M$.
• $f(i, j)$ is the intensity of the pixel at $x(i, j)$.
• $F(u, v)$ is the DCT coefficient for the pixel at $x(i, j)$.
• For most images, much of the signal energy lies at low frequencies. These appear in the upper left corner of the DCT.

• Compression is achieved since the lower right values represent higher frequencies, and are often small enough to be neglected with little visible distortion. The output array of DCT coefficients contains integers; these can range from -1024 to 1023.

Computationally, it is easier to implement and also efficient to consider the DCT as a set of basis functions which given a known input array size, for e.g., 8 × 8, can be pre-computed and stored. This involves simply computing values for a convolution mask (8 × 8 window) that get applied.

III. EXPERIMENTS AND RESULT

4 test images is compared with the database that consists of a set of images of 25 people. There are 4 different test-methods: GLOBAL, LOCAL, GLOBAL+LOCAL and GLOBAL AND LOCAL. But we use GLOBAL + LOCAL. In proposed application images are filtered using Gaussian low pass filter, sharpened and converted to grayscale images. Finally intensity is adjusted and image is segmented and sliced to store both global face image and also its local features such as eye nose and mouth separately in the database after the images are normalized.

1) Normalization

Since the facial images are captured at different instants of the day or on different days, the intensity for each image may exhibit variations. To avoid these light intensity variations, the test images are normalized so as to have an average intensity value with respect to the registered image. The average intensity value of the registered images is calculated as summation of all pixel values divided by the total number of pixels. Similarly, average intensity value of the test image is calculated. The normalization value is calculated as:

Normalization Value = Average value of registered Image /Average value of tested Image.

This value is multiplied with each pixel of the test image. Thus we get a normalized image having an average intensity with respect to that of the registered image.

Next is to perform zigzag scanning and apply DCT.

2) Zigzag scanning:

The purpose of Zigzag Scanning is to:

- Map M x N dimension vector to 1 x N dimensions
- Group low frequency coefficients present at the top of the vector

Local features such as eyes, nose and mouth are extracted manually from the given face image. The image is used as an input. Local feature extraction, especially eye extraction, helps reduce the effect of varying characteristics such as pose, expressions etc. on the face recognition system.

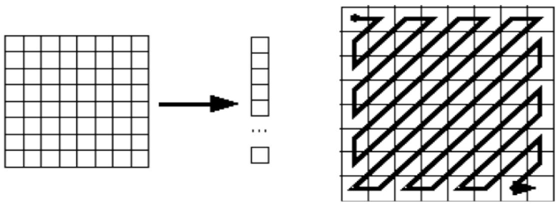
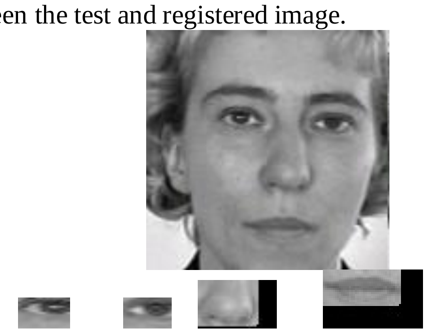


Fig 2: Zigzag scanning

After extracting the features, the images are compared using DCT and the comparison is done by taking the Euclidean distance between the test and registered image.



Eye-R *Eye-L* *Nose* *Mouth*

Fig 3: Test image

For e.g., we take 50 coefficients of test image and 50 coefficients of registered image. The Euclidean distance of each of the 50 coefficients of the test image and 50 coefficients of the registered image are calculated. Add all the Euclidean distance of the 50 coefficients. Let the value of this addition be ‘X’. Since there are 15 registered images, each of the test images will be compared with the 15 registered images. Thus we have X1, X2, X3, . . . , X15 values. All these 15 values of 'X' are sorted in ascending order, and the one with the minimum value of 'X' is given as the 'rank 1'. The next in the order is given 'rank 2', 'rank 3', till 'rank 15'. This 'rank 1' image is regarded as the best match. If the 'rank 1' image is the same as the input image, the person has been recognized correctly. Thus, the recognition rate is calculated as the ratio of number of images correctly recognized to the total number of images tested. The number of coefficients is varied and the recognition rate is calculated for each of them using the following equation:

Recognition rate = Number of correctly recognized image/ Total number of persons test image.

Results of the approach are,Face is identified with more accuracy and by comparing the ranks for global and local features; the false acceptance rate for DCT is minimized.

IV. CONCLUSION

When using local features for recognition, the false acceptance rate should be minimized and false rejection rate should be maximized as compared to that of global features. The recognition rate for local features and the recognition rate for global features using DCT are calculated. Comparison between DCT global features and DCT local features is done. The recognition rate improves when images are normalized. When local and global features are combined, DCT gives a relatively high recognition rate.

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