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Face Recognition Based on Multi- Scale Face Components by Artificial Neural Networks

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Abstract: Face is a complex multidimensional visual model and developing a computational model for face recognition is difficult. Face recognition is a challenge in image analysis and computer vision and received a great attention in last few years. Here we have mentioned some of the face recognition techniques that are worth useful and there are many like these techniques. Recognizing objects from large image databases, histogram based methods have proved simplicity and usefulness in last decade. Initially, this idea was based on color histograms. For achieving the perfection in accuracy of proposed system, the merger of histogram and Phase-Only Correlation (POC) techniques is used in implementation of suggested system. For training, grayscale images with 256 bins are used.

Index Terms: Face recognition, Phase-Only Correlation (POC) techniques. Processed Histogram Phase Only correlation. Principal Component Analysis (PCA). Olivetti Research Laboratory (ORL)

I.INTRODUCTION

A human can recognize thousands of Faces learned throughout the lifetime and identify familiar faces at a glance even after years of separation. This skill is quite robust, despite of large changes in the visual stimulus due to viewing conditions, expression, aging, and distractions such as glasses, beards or changes in hair style. Face recognition has become an important issue in many applications such as security systems, credit card verification, criminal identification etc. Even the ability to merely detect faces, as opposed to recognizing them, canbe important. Although it is clear that people are good at face recognition, it is not at all obvious how faces are encoded or decoded by a human brain. Human face recognition has been studied for more than twenty years. Developing a computational model of face recognition is quite difficult, because faces are complex, multi-dimensional visual stimuli. Therefore, face recognition is a very high level computer vision task, in which many early vision techniques can be involved. For face identification the starting step involves extraction of the relevant features from facial Images. A big challenge is how to quantize facial features so that a computer is able to recognize a face, given a set of features. Investigations by numerous researchers over the pastseveral years indicate that certain facial characteristics are used by human beings to identify faces.

II. LITERATURE REVIEW OF RELATED WORK

Turk and Pentland [7] proposed a face recognition method based on the Eigen faces approach. An unsupervised pattern recognition scheme is proposed in this paper which is independent of excessive geometry and computation. Recognition system is implemented based on Eigen face, PCA and ANN. Principal Component analysis for face recognition is based on the information theory approach in which the relevant information in a face image is extracted as efficiently as possible. Further Artificial Neural Network was used for classification. Neural Network concept is used because of its ability to learn ' from observed data. The method is based on extracting feature vectors from the basic parts of a face such as eyes, nose, mouth, and chin, with the help of deformable templates and extensive mathematics. Then key information from the basic parts of face is gathered and converted into a feature vector.

Smriti & Nitin [1] used deformable templates in contour extraction of face images. Another method is based on the information theory concepts viz. principal component analysis method. information that best describes a face is derived from the entire face image. Based on the Karhunen-Loeve expansion in pattern recognition, Kirby and Sirovich [5], [6] have shown that any particular face can be represented in terms of a best coordinate system termed as "eigenfaces". These are the eigen functions of the average covariance of the ensemble of faces.

III.HISTOGRAM PROCESSING

Histogram is defined as the frequency of each gray level present in the image. Number of bins in the histogram is specified by the image type which means histogram of binary image will be using two bins.

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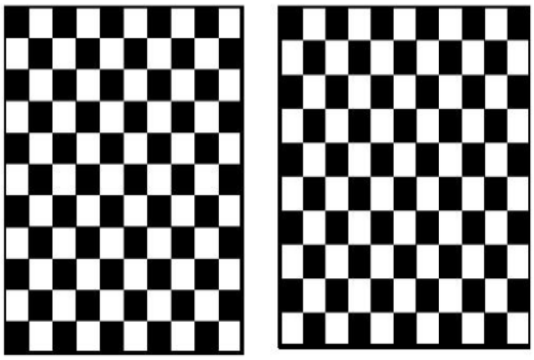

Figure 1

In Figure.1 two binary images are shown giving a look of checkerboard in which black boxes represent binary 0 and white boxes represents binary Histogram of face images used for training is unique, but it is possible that any real life test image's histogram will match any one of trained image's histogram most of the time. As such for catering to this issue, mean of consecutive nine frequencies of bins is computed and is stored for comparisons so that finer discrimination is made between trained and test image's histogram by considering chunk of nine bins. For clarity, the rectangular border around every nine peaks is also depicted in Figure 2. Furthermore, the set of computed mean values are used for calculating absolute differences between the corresponding means of trained images and testing image. Finally the minimum difference found out of test image with checking all trained images values is considered to be the matched image. The above philosophy is blind but rotation invariant in nature and is considered to be a global approach for face recognition. In worst case scenario two altogether different images may have almost same histograms, so this ambiguity is further verified using Phase-Only Correlation discussed in next section.

Recognizing objects from large image databases, histogram based methods have proved simplicity and usefulness in last decade. Initially, this idea was based on color histograms that were launched by Swain and Ballard [2]. Following this idea numerous developments were made by different people, exploiting this idea, such as texture histograms for 2D object recognition suggested by Gimelfarb and Jain [3], shape-index histograms for range image recognition proposed by Dorai and Jain [4] and relational histograms used by Huet and Hancock [5] for line-pattern recognition. Similarly, one dimensional (ID) and two dimensional (2D) histograms are also proposed with diverse variations like ID shape index histogram, 2D maximum and minimum curvature histogram, 2D mean and Gaussian curvature histogram and 2D shape index and curvedness histogram in [6]. Another category known as energy histogram counts the occurrence of the DCT (Discrete Cosine Transform) coefficients in the corresponding bins ratherthan counting pixel color. Popularity of this approach is its low computational cost. The algorithm of energy histogram for image retrieval has been suggested in [7]. Similarly, overlapping energy histogram measures the distribution of DCT coefficients of an image. Its performance is elaborated and analyzed in [8]. Closest distance between histograms of different face images can be used for recognition purposes. Different distance measures may affect the recognition rate [5].

Euclidean distance can be used as it produces stable and satisfactory results [6]. In the proposed system, bin based histogram is used for processing. Frequency of every bin is calculated and mean of consecutive nine frequencies is then computed for every face image that is later on used for testing. Computed mean vectors are used for calculating the absolute differences among the mean of trained images and the test image.

Phase Only Correlation (POC) function.

This section shows the definition of a Phase-Only Correlation (POC) function.

Consider two $N_1 \times N_2$ images, $f(n_1, n_2)$ and $g(n_1, n_2)$, where we assume that the index ranges are $n_1 = -M_1 \cdots M_1$ ($M_1 >$ 0) and $n_2 = -M_2 \cdots M_2$ ($M_2 > 0$) for mathematical simplicity, and hence $N_1 = 2M_1 + 1$ and $N_2 = 2M_2 + 1$. Let $F(k_1, k_2)$ and $G(k_1, k_2)$ denote the 2D Discrete Fourier Transforms (2D DFTs) of the two images. $F(k_1, k_2)$ and $G(k_1, k_2)$ are given by

$$\begin{aligned} F(k_1, k_2) &= \sum_{n_1, n_2} f(n_1, n_2) W_{N_1}^{k_1 n_1} W_{N_2}^{k_2 n_2} \\ &= A_F(k_1, k_2) e^{j\theta_F(k_1, k_2)}, \end{aligned}$$

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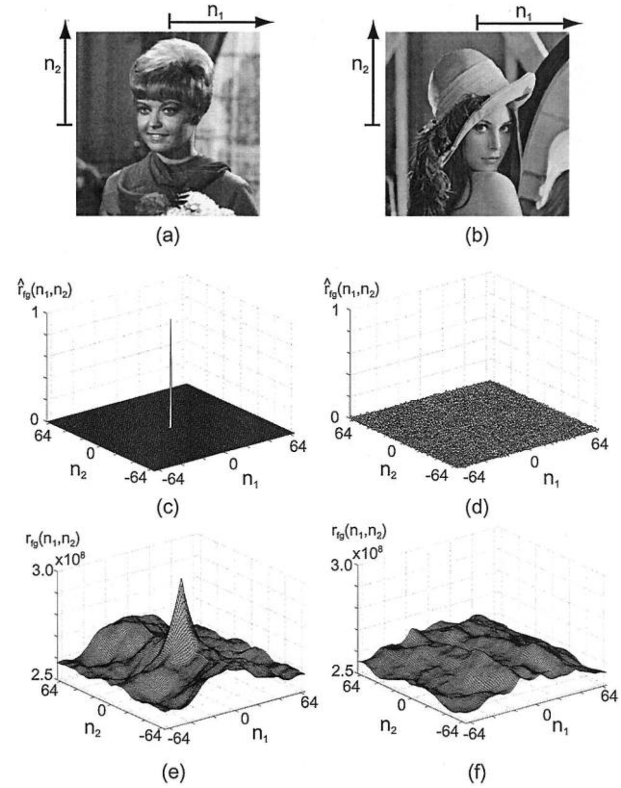

Fig. 2 Examples of the POC function $\hat{r}_{fg}(n_1, n_2)$ and the ordinary correlation function $r_{fg}(n_1, n_2)$: (a) image $f(n_1, n_2)$, (b) image $g(n_1, n_2)$, (c) POC function between the two identical images (the image $f(n_1, n_2)$), (d) POC function between $f(n_1, n_2)$ and $g(n_1, n_2)$, (e) ordinary correlation function between the two identical images (the image $f(n_1, n_2)$), and (f) ordinary correlation function between $f(n_1, n_2)$ and $g(n_1, n_2)$.

The most remarkable property of POC compared to the ordinary correlation is its accuracy in image matching. Figure 2 shows an example of image matching using the POC function. When two images are similar, their POC function $\hat{r}(n_1, n_2)$ gives a distinct sharp peak. When two images are not similar, the peak drops significantly. Thus, the POC function exhibits much higher discrimination capability than the ordinary correlation function. The height of the peak can be used as a good similarity measure for image matching. Other important properties of the POC function used for fingerprint matching is that it is not influenced by image shift and brightness change, and it is highly robust against noise.

Peak signal for variation in same image

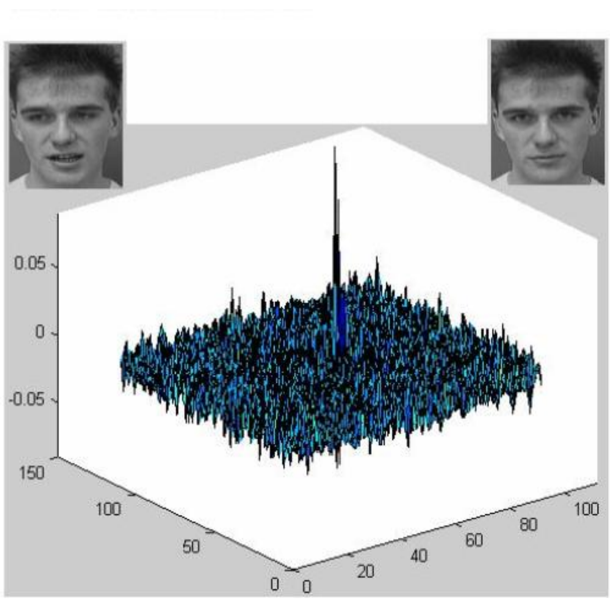

Figure 3 POC Function - Distinct sharp peak at centre for same image types Histogram

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No Peak signal for variation in different image

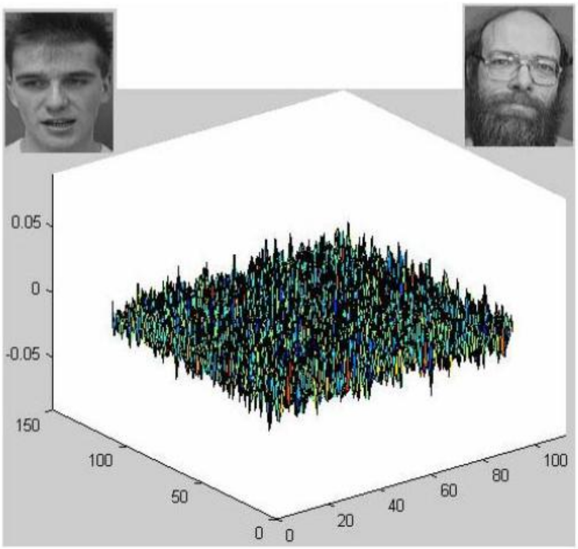

Figure 4 POC Function - No distinct peak for two different images Histogram

The above system is trained and tested using MATLAB and is executed on Pentium- IV, 3.20 GHz processor with 512MB of memory. For checking the correctness of proposed technique ORL (Olivetti Research Laboratory) database was used, which consists of 40 subjects with 10 images per subject, total of 40 X 10 = 400 images. Out of 400 images, 200 images were used for training and remaining 200 used for testing purposes. The total training time for 200 images was found to be 1.625 seconds. The total testing time was found to be 22.715 seconds for remaining 200 images. Processed Histogram & Phase-Only

IV. PROPOSED ALGORITHM & IMPLEMENTATION FUNCTION

Procedure: Training
Input: Five (5) images from every subject (40) of ORL
Begin
1. Calculate frequency of every bin and store in matrix.
2. Calculate mean of consecutive nine frequencies and store in matrix for later comparison.
end

Proposed Algorithm

1. Select image from dataset
2. Apply POC function
3. Compare Histogram
4. Detect distinct sharp Peak
5. Compare result

POC FUNCTION

$$\hat{r}_{fg}(n_1, n_2) = \frac{1}{N_1 N_2} \sum_{k_1,k_2} \hat{R}_{FG}(k_1, k_2) W_{N_1}^{-k_1 n_1} W_{N_2}^{-k_2 n_2}.$$

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Procedure: Testing
Input: Five (5) images from every subject (40) of ORL (Not used in Training)
Output:
** Absolute processed histogram differences.*
** POC values with matched subject.*
Begin
1. Calculate frequency of every bin of test image.
2. Calculate mean of consecutive nine frequencies of test image.
3. Compare the means of test image with all trained matrix mean values in (2) of training algorithm.
4. Identify the image with minimum absolute difference.
5. Calculate POC values with that identified image in step (4).
6. Compare POC values with cutoff value for verification.
End

Correlation (PH-POC) system is compared with **other** existing face recognition techniques such Principal Component Analysis (PCA) [10],

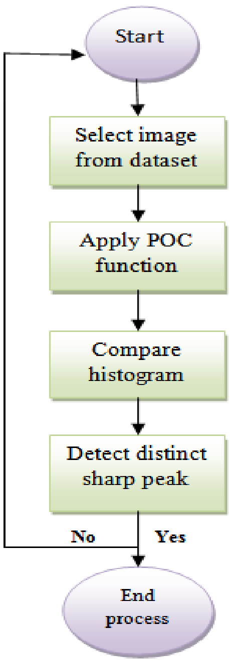

Fig .5 Flow Chart for Face Detection using POC Function

V. RESULT ANALYSIS

The POC function exhibits much higher discrimination capability than the ordinary correlation function. The height of the peak can be used as a good similarity measure for image matching. The most remarkable property of POC compared to the ordinary correlation is its accuracy in image matching. When two images are similar, their POC function $\hat{r}(n_1, n_2)$ gives a distinct sharp peak. When two images are not similar, the peak drops significantly.

VII.CONCLUSION & FUTURE WORK

Face recognition is the most challenging tasks for machine recognition. Although humans seem to recognize faces in muddled scenes with relative ease, machine recognition is more daunting task. In this proposed technique, we have proposed a very simple yet highly reliable face recognition technique called Processed Histogram and POC approach.

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The goal was to devise time inexpensive and more accurate system. Separate processing on histogram works fine and produces the results with the same accuracy found in our system. POC gives us the strong verification result that filters out objects other than faces.

In future, the proposed algorithm can be applied on different databases and colored histogram based approaches so that more efficient results can be obtained

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