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Block Based Face Recognition Algorithm

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Abstract

Face recognition is the compulsory task in many public as well as private sectors. In the last two decades, there are several researches has been carried out. The objective of this paper is to identify the face with a single training image for each class. Texture property is extracted as feature using Gray Level Co-occurence matrix (GLCM). Block matching algorithm such as Full Search, Diamond Search, hexagon search and octagon search are used for classification. Experimental were conducted for all these algorithms and Full Search is proved to be best when compared to all other algorithms. These results are compared with recent face recognition techniques. The proposed method recognizes 99% of the face correctly.

Keywords: *Block matching algorithm, correlation*

1. Introduction

In general, a single face will be stored for each class. But during identification, the person may be in different posture, different light condition etc. Hence, identifying the face at any level is a challenging task. Many face recognition algorithms have been proposed. Face recognition falls under three main categories namely holistic approach, feature-based approach and hybrid approach. Holistic method uses the original image as an input for the face recognition system. The examples for holistic methods are Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Independent Component Analysis (ICA) and so on. The main advantage of the holistic approaches is that they do not destroy any of the information in the images by concentrating on only limited regions or points of interest [1]. This same property is its greatest drawback, too, since most of these approaches start out with the basic assumption that all the pixels in the image are equally important [2]. Consequently, these techniques are not only computationally expensive but require a high degree of correlation between the test and training images, and do not perform effectively under large variations in pose, scale and illumination, etc. [3]. In the latest comprehensive FERET evaluation [4] [5], the probabilistic Eigenface [6], the Fisherface [7] and the EBGM [8] methods were ranked as the best three techniques for face recognition. Even though the EBGM method is feature-based in general, its success depends on its application of holistic neural network methods at the feature level. In Feature based method, the local feature point such as eye, nose, and mouth are first extracted, then it will be send to the classifier. The main advantage offered by the featured-based techniques is that since the extraction of the feature points precedes the analysis done for matching the image to that of a known individual, such methods are relatively robust to position variations in the input image [1]. In principle, feature-based schemes can be made invariant to size, orientation and/or lighting [9]. Other benefits of these schemes include the compactness of representation of the face images and high speed matching [10]. The major disadvantage of these approaches is the difficulty of automatic feature detection and the fact that the implementer of any of these techniques has to make arbitrary decisions about which features are important [2]. After all, if the feature set lacks discrimination ability, no amount of subsequent processing can compensate for that intrinsic deficiency [9]. .Finally a Hybrid method is used to recognize both the local feature and whole face region [11-16]. If the face is to be recognized, three processes should be done. They are face detection, dimensionality reduction and face recognition. The dimensionality reduction is used to solve the curse of dimensionality. It can be divided into two parts they are Feature Extraction and Feature Selection. The feature extraction process can be broadly classified into four types they are linear method, non linear methods, Multi linear methods and tensor space methods. Face images have more texture property. This paper extracts texture feature from face images using Gray Level Co-occurence Matrix (GLCM). Features are extracted by dividing the image into blocks. This block based approach extracts the features around neighbours. Earlier approaches extract features for whole image. It may not give fine detail of the image. But block based approach fine detail of the image. Section II explores the working architecture of the proposed method. Section III explains feature extraction process. Section IV briefly describes Block matching algorithm. Section V describes how the face is classified using the extracted features demonstrates experimental results followed by Conclusion in Section VI.

II. SYSTEM ARCHITECTURE

The concept behind the proposed work is to identify the features within a specified distance around the pixel. The functional block diagram is shown in Fig. 1. Initially, the face image is reshaped to a standard size (128 x 128). This reshaping is done as the image is to be divided into equal-sized blocks. The next step is to divide the face image into blocks of equal size 4 x 4. Features are extracted for each block. This feature block is compared with the feature block of the training image in the database.

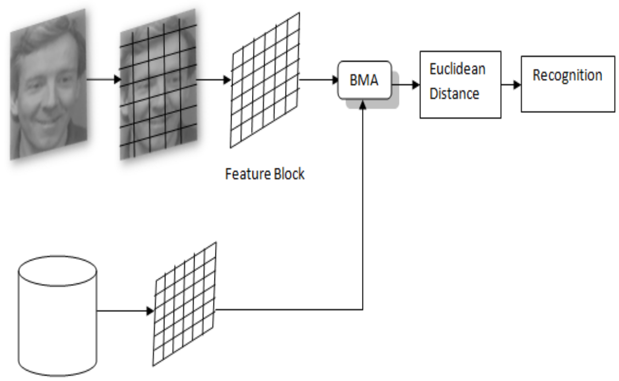

Fig. 1 System Architecture

The proposed work uses Gray Level Co-occurence matrix (GLCM) for each block. The gray level co-occurrence matrix (GLCM) is one of the most popular second-order statistical featured Texture property. Haralick in [17] described the use of GLCMs for texture analysis. Usually, this analysis is carried out separately for each image by using macroblocks, each with N x N pixels. The G x G gray level co-occurrence matrix P_d for a displacement vector defined as $d = (d_x, d_y)$ (polar coordinates, $d = (r,\theta)$): The entry (i,j) of P_d is the number of occurrences of the pair of gray levels i and j which are d distance apart. It is given by

$$P_d(i,j) = \left|\{\{(r,s),(t,v)\} I(r,s) = i, I(t,v) = j\}\right| \tag{1}$$

where $(r,s),(t,v) \in$ N x N $(t,v) = (r + d_x, s + d_y)$ and | . | is the cardinality of the set. Instead of using the number of occurrences, we used the probability of occurrence. Thus, we can define the normalized co-occurrence matrix P,P : G x G → [0,1] for an image as

$$P(i,j) = \frac{P_d(i,j)}{R} \tag{2}$$

where R is the number of pixels in the frame video. Once we obtain the GLCM, we need to form the feature vectors by extracting texture parameters such as those proposed by Haralick [17]. These include the *Angular Second Moment (ASM), dissimilarity, correlation, entropy and sum of squares*. In this work, sum of squares is used.

$$SOS = \sum_{i,j=0}^{N-1} P(i,j)(i-j)^2 \tag{3}$$

IV. BLOCK MATCHING ALGORITHM

The features obtained in the previous section are termed as feature block. This feature block is created for one image from each class in the database. The feature block obtained from the query image is compared with the feature block obtained from the database. The comparison is done using Block Matching Algorithm. There are several block matching algorithms developed in the last two decades. Block matching can only be implemented for the picture having a single object moving in the training picture to form corresponding objects in the testing picture. To implement block matching algorithm testing picture is to be divided into a matrix of 'macro blocks' that are then compared with corresponding block in the training picture to create a vector. The search area is defined around a macro block for a search parameter of p (which is usually taken to be 7 pixels on all four sides of the corresponding macro block in the training picture but can vary as per the movement in the pictures) shown in Fig. 1. The larger the motions, the larger are search parameter p. For each MB in the testing picture (current MB), one reference block that is the most similar to current MB is sought in the searching range of size [-P, P] in the training picture. There are many cost function to compare the blocks like Mean Square Error (MSE), Mean Absolute Difference (MAD), Sum of Absolute Difference (SAD). SAD is defined as Full search [18] is the basic block matching algorithm which searches the query image block with all the blocks in the training image. Diamond Search [19] has no limit on the number of steps that the algorithm can take but the search should remain inside the defined search range. The end result should see a PSNR close to that of Full Search while computational expense should be significantly less. Diamond Search block matching algorithm uses four points around the center pixel. Hexagonal Search Pattern [20] uses six points for comparing the blocks. Octagon search pattern [21] uses 8 pixels around center pixel. All these search patterns are shown in Fig. 2, 3 and 4.3. Tables,

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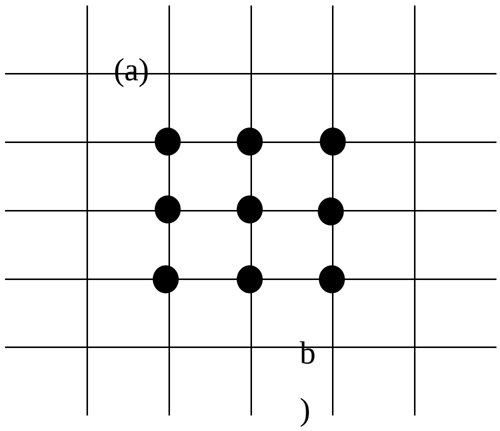
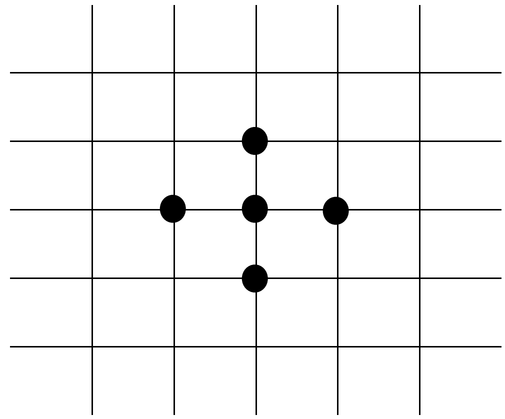


(a)



(b)

Fig. 2 (a) Full Search (b) Diamond Search

Fig. 3 Hexagon Search

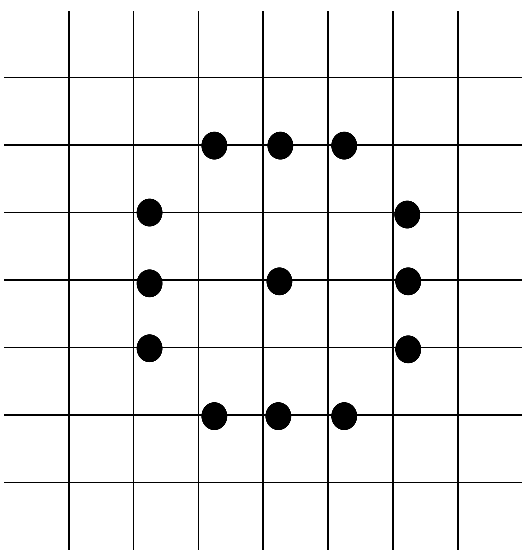
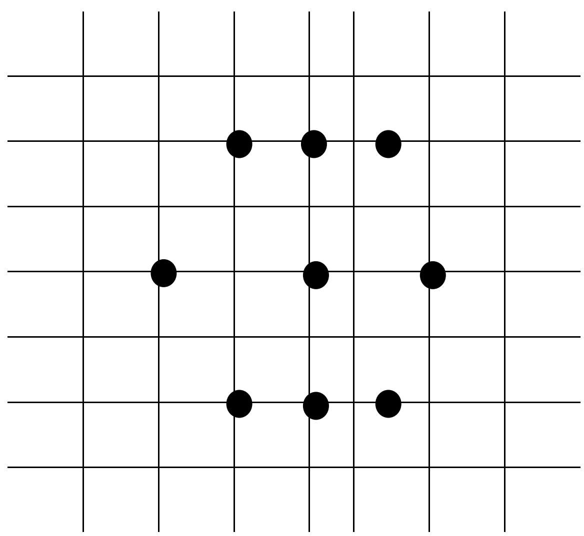


Fig. 4 Octagon Search



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The block matching algorithms generate motion vectors (Vx, Vy). The distance is calculated to identify how far the feature block is deviated from the current feature block. It is given by

$$d = (x - x_1)^2 + (y - y_1)^2$$

where x,y indicates the current location i.e. (0,0), (x_1, y_1) denotes deviated location.

V. FACE RECOGNITION

As the original image is resized to 128 x 128 and the image is divided into 4 x 4 equal sized blocks, total number of blocks obtained are 32 x 32. So, after calculating the distance, we have 1024 blocks.

To identify the face, mean value of the distance is calculated. It is given by

$$mean = \frac{d_1 + d_{2+\cdots} d_{1024}}{1024} \quad (4)$$

The class with less mean is matched as the recognized face.

VI. EXPERIMENTAL RESULTS

Experiments are conducted in ORL database. In ORL database, there are 40 classes. Only one image is used to compare with the query image. The sample images from ORL database are shown in Fig. 5. The efficiency of the proposed method is evaluated using recognition rate. Recognition rate is calculated as

$$Recognition\ Rate = \frac{No.of\ correctly\ classified\ face\ images}{Total\ no.of\ images}\ x\ 100 \quad (5)$$

The recognition rate obtained for various search patterns are shown in Table I. The results are shown pictorially in Fig. 5. Table I also shows the recognition rate obtained for various number of training images.

(a)

(b)

Fig. 5 Samples of ORL database

From the Fig. 6, it is clear that full search method achieves better recognition rate than other algorithms.

Table I Recognition rate for various search patterns

Method	Recognition Rate (%)		
	N=1	N=3	N=5
Full Search	100	100	100
Diamond Search	99.85	99.9	100
Hexagon Search	98.17	99.12	99.35
Octagon Search	98.42	97.3	97.9

N= Number of training images

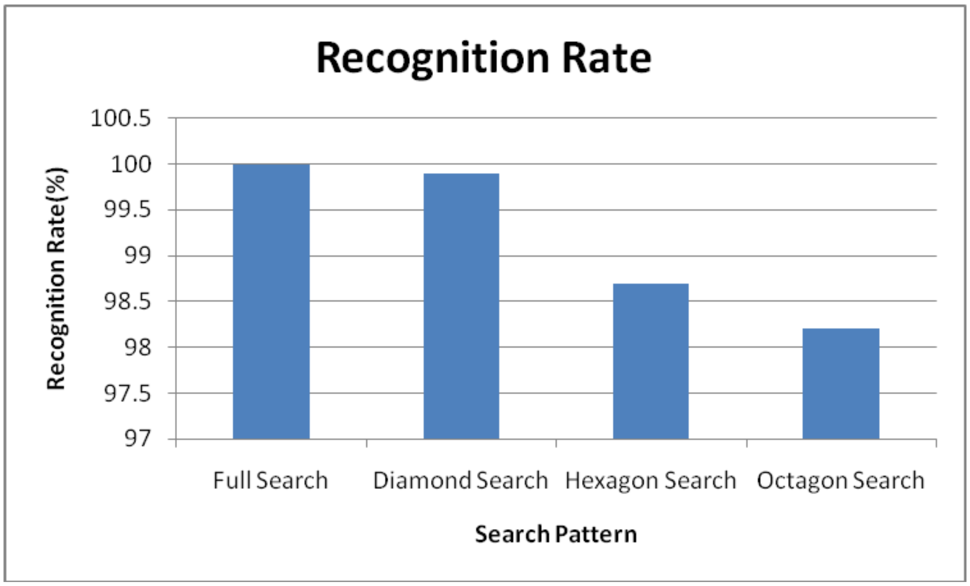

Fig. 6 Recognition Rate comparison

Recognition rate comparison for various search patterns for single training image

VII. CONCLUSION

Face recognition is a challenging task as it contains different gesture, illumination etc. Face recognition is more efficient if it identifies the face using single training image. This paper introduces block based face recognition technique using various search patterns. It is proved Full Search pattern achieves better recognition rate than other search patterns. The full search method is tested with various number of training images. Experimental results proved that Full search method achieved better recognition rate even with single training image.

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