Discriminative Robust Local Binary Pattern Based Face Recognition From A Single Sample Per Person

D.R.Monisha1, R.Pavithra2
Dept of PG CSE, CSI College of Engineering, Ketti, The Nilgiris, India

Abstract
Nowadays face recognition plays an important role in today's world. The core objective of this project is to extract the facial features using the local appearance based method for the accurate face identification with single sample per class. The face biometric based person identification plays a major role in wide range of applications such as Airport security, Driver's license, Passport, Voting System, Surveillance. This project presents face recognition based on Difference of Gaussian and feature extraction using Discriminative Robust Local Binary pattern Pattern(DRLBP)approach. The Median filter is used to extract the hybrid features and the pyramids are generated after the face granulation. Then, DoG pyramid will be formed from successive iterations of Gaussian images. By this granulation, facial features are segregated at different resolutions to provide edge information, noise, smoothness and blurriness present in a face image. In feature extraction stage, this binary face template act like a mask to extract local texture information using Discriminative Robust Local binary pattern. This method is efficient to face recognition since it is less sensitive to illumination and scaling. . It reduces the computational time complexity and space complexity. This proposed approach reduces the computation time and also increases the efficiency.

Index Terms:
Single sample per class, Median Filter, DoG pyramid, Discriminative Robust Local Binary Pattern.

1. Introduction

"Biometrics" means "life measurement" but the term is usually associated with the use of unique physiological characteristics to identify an individual. The application which most people associate with biometrics is security. However, biometric identification has eventually a much broader relevance as computer interface becomes more natural. Knowing the person with whom you are conversing is an important part of human interaction and one expects computers of the future to have the same capabilities.

A number of biometric traits have been developed and are used to authenticate the person's identity. The idea is to use the special characteristics of a person to identify him. By using special characteristics we mean the using the features such as face, iris, fingerprint, signature etc, this method of identification based on biometric characteristics is preferred over traditional passwords and PIN based methods for various reasons such as: The person to be identified is required to be physically present at the time-of-identification. Identification based on biometric techniques obviates the need to remember a password or carry a token.

A biometric system is essentially a pattern recognition system which makes a personal identification by determining the authenticity of a specific physiological or behavioral characteristic possessed by the user. Biometric technologies are thus defined as the "automated methods of identifying or authenticating the identity of a living person based on a physiological or behavioral characteristic".

A biometric system can be either an 'identification' system or a 'verification' (authentication) system, which are defined below.

A) Identification - One to Many: Biometrics can be used to determine a person's identity even without his knowledge or consent. For example, scanning a crowd with a camera and using face recognition technology, one can determine matches against a known database.

B) Verification - One to One: Biometrics can also be used to verify a person's identity. For example, one can grant physical access to a secure area in a building by using finger scans or can grant access to a bank account at an ATM by using retinal scan.

The process of receiving and analyzing visual information by the human species is referred to as sight, perception or understanding. Similarly, the process of receiving and analyzing visual information by digital computer is called as digital image processing and scene analysis. Processing of an image includes improvement in its appearance and efficient representation. So the field consists of not only feature extraction, analysis and recognition of images, but also coding, filtering, enhancement and restoration. The entire process of image processing and analysis starts from the receiving of the visual information and ends in giving out of description of the scene. The major components of the image processing system are image sensor, digitizer, processor, display unit and storage unit.

C) Face Recognition-A Survey : A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the

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image and a facial database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. Face recognition technology is used to extract information from facial images with the help of a face recognition device, without any human interaction. Unlike face detection technology, face recognition technology uses image processing algorithms to recognize, and then compare human facial images with the ones that are stored in the database of face recognition device. Face recognition technology enabled device analyzes the characteristics of overall structure of human face, including width of nose, shape of cheekbones, width between nose and jaw edges, and distance between eyes.

Discriminative Robust Local Binary Pattern (LBP) method was first proposed in an image texture descriptor .Now it's applied on face-recognition application. LBP method provides better result in terms of speed and discrimination performance [15]. One advantage of using LBP, it is less sensitive to Illumination variation and scaling variation. Gabor feature-based face recognition is used mainly in image processing, pattern recognition, computer vision etc. Gabor filter exploits spatial localization, orientation selectivity and spatial frequency characteristics .Gabor filter extracts essential features of face and creates binary face template.

Recognition algorithms [1, 3,5, 10, 12] can be divided into two main approaches, geometric, which look at distinguishing features, or photometric, which is a statistical approach that distills an image into values and compares the values with templates to eliminate variances. Popular recognition algorithms include Principal Component Analysis using Eigen faces [1, 3], Linear Discriminate Analysis [5], Elastic Bunch Graph Matching using the Fisher face algorithm, the Hidden Markov model, the Multi linear Subspace Learning using tensor representation.

2. Existing System

Discriminant analysis methods are tools for face recognition. But this is not be used for the single sample per person scenario because of "with- in subject variability". This variability is established using images in the generic training set for which more than one sample per person is available. When images are under drastic facial expression variation, the discriminant analysis method can't be used. LDA (Linear Discriminant Analysis) [5] is one of the discriminant analysis methods. It fails to improve the performance, because the complex distribution of the data set is caused by large intrapersonal variations, which still exist in each cluster of that method. LDA uses a Fisher face [1,5] algorithm. It uses the dataset to store multiple images (with- in variability) of a same person. PCA (Principal Component Analysis) [2] is also not suitable for the single sample per class problem. LBP (Local Binary Pattern) [12] is not only used for face detection but also for face recognition. But LBP is not a robust face finder. To digitally process an image, it is first necessary to reduce the image to a series of numbers that can be manipulated by the computer. Each number representing the brightness value of the image at a particular location is called a picture element, or pixel.

A typical digitized image may have 512 × 512 or roughly 250,000 pixels, although much larger images are becoming common. Once the image has been digitized, there are three basic operations that can be performed on it in the computer. For a point operation, a pixel value in the output image depends on a single pixel value in the input image. For local operations, several neighboring pixels in the input image determine the value of an output image pixel. In a global operation, all of the input image pixels contribute to an output image pixel value. These operations, taken singly or in combination, are the means by which the image is enhanced, restored, or compressed. An image is enhanced when it is modified so that the information it contains is more clearly evident, but enhancement can also include making the image more visually appealing. There are two popular approaches to face recognition. One approach transforms face images into specific transformation domains. Among the works that appear in the literature are Eigen face, Gabor filters, Fourier Transform, and wavelets. Another approach is to extract principal lines and creases from the face. However, this method is not easy because it is sometimes difficult to extract the line structures that can discriminate every individual well.

From the literature survey, it had been inferred that local matching method will be more efficient comparing to holistic matching method. Hence we can eliminate the high dimensionality problem. It had been found that multiple samples per class lead to increase space complexity. In order avoid this space complexity problem, single sample per class is considered. In this single sample per class single image of a person is used for matching the face image.

3. Proposed System

The proposed system uses a robust face finder called DRLBP (Discriminative Robust Local Binary Pattern). By using this feature the face can be fluently detected and recognized. Although only one classifier is trained, and using that frontal, occluded and profile faces are detected.

The proposed system includes four modules: (1) Image Preprocessing, (2) Feature extraction, (3) face granulation, (4) Face recognition or face identification.

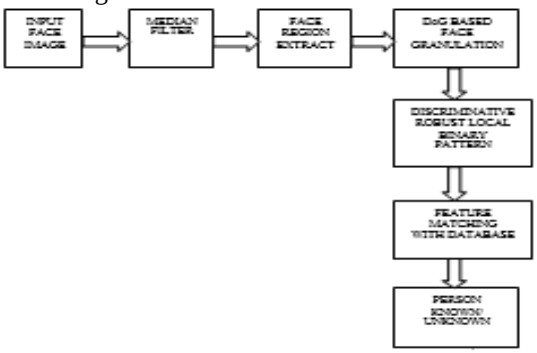


Fig 1 Detailed Architecture for Proposed System

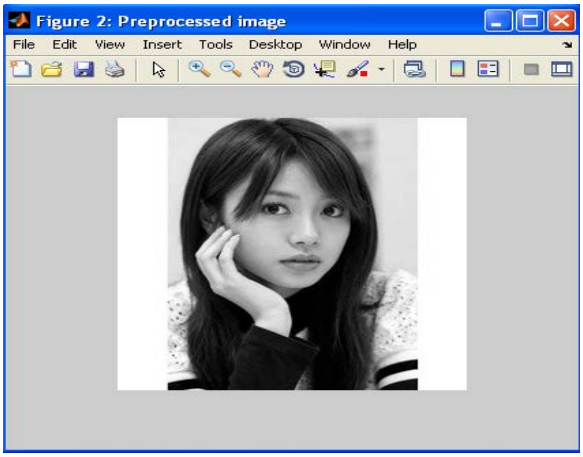


Fig 2 Preprocessed image

The first stage of recognition starts with face detection module will be used to obtain face images, which have normalized intensity, are uniform in size and shape and depict only the face region. Here granular computing and face features will be presented to match face images in various illumination changes. The Gaussian operator generates a sequence of low pass filtered images by iteratively convolving each of the constituent images with a 2-D Gaussian kernel. Then, DOG pyramid will be formed from successive iterations of Gaussian images. By this granulation, facial features are segregated at different resolutions to provide edge information, noise, smoothness and blurriness present in a face image. In feature extraction stage, DRLBP is used to extract to local texture features. This method is efficient to face recognition since it is less sensitive to illumination and scaling.

A) Pre Processing

Preprocessing methods use a small neighborhood of a pixel in an input image to get a new brightness value in the output image. Such preprocessing operations are called filtration. Median filter is used to extract the hybrid features and eliminates the noise and it detects the edges shown in fig 2. The hybrid features includes both the local features and global features.

B) Face Granulation

Having extracted the hybrid features in the feature extraction step, the Face granulation is done to produce out the Difference of Gaussian (DoG) pyramid formation. The DoG pyramids are produced to analyze the Euclidean distance to discern the face images valiantly.

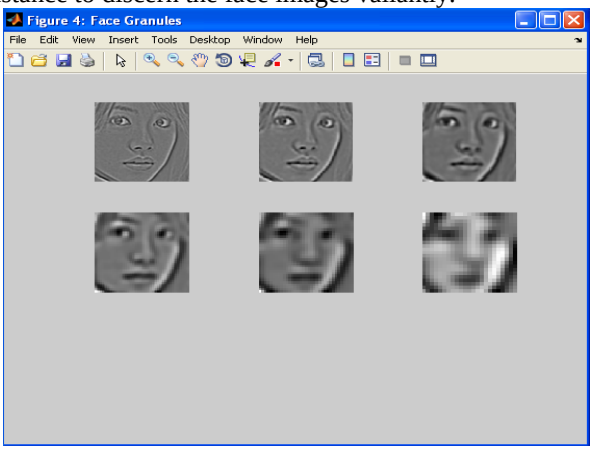


Fig 3 Face Granulation Values

Each and every face image is granulated shown in figure 3 is based on giving some pyramid granules. The performance is to be measured based on the comparison with the normal input image and the classified granules computed image.

4. ALGORITHMS

A) Algorithm for Difference of Gaussian (DoG)

Difference of Gaussians is a feature enhancement algorithm that involves the subtraction of one blurred

version of an original image from another, less blurred version of the original. In the simple case of grayscale images, the blurred images are obtained by convolving the original grayscale images with Gaussian kernels having differing standard deviations. Blurring an image using a Gaussian kernel suppresses only high-frequency spatial information. Subtracting one image from the other preserves spatial information that lies between the ranges of frequencies that are preserved in the two blurred images. Thus, the difference of Gaussians is a band-pass filter that discards all but a handful of spatial frequencies that are present in the original gray scale image.

i)Mathematics of Difference of Gaussians

Given a m-channels, n-dimensional image

$$I : \{\mathbb{X} \subseteq \mathbb{R}^n\} \rightarrow \{\mathbb{Y} \subseteq \mathbb{R}^m\} \quad \text{----------(1)}$$

The difference of Gaussians (DoG) of the image I is the function

$$\Gamma_{\sigma 1,\sigma 2} : \{\mathbb{X} \subseteq \mathbb{R}^n\} \rightarrow \{\mathbb{Z} \subseteq \mathbb{R}\} \quad \text{--------(2)}$$

Obtained by subtracting the image I convolved with the Gaussian of variance σ_2^2 from the image I convolved with a Gaussian of narrower variance σ_1^2, with $\sigma_2 > \sigma_1$. In one dimension, Γ is defined as:

$$\Gamma_{\sigma 1,\sigma 2}(x) = I * \frac{1}{\sigma_1\sqrt{2\pi}} e^{-(x^2)/(2\sigma_1^2)} - I * \frac{1}{\sigma_2\sqrt{2\pi}} e^{-(x^2)/(2\sigma_2^2)} \quad \text{---------- (3)}$$

and for the centered two-dimensional case :

$$\Gamma_{\sigma,K\sigma}(x,y) = I * \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/(2\sigma^2)} - I * \frac{1}{2\pi K^2\sigma^2} e^{-(x^2+y^2)/(2K^2\sigma^2)} \quad \text{---------- (4)}$$

Which is formally equivalent to:

$$\Gamma_{\sigma,K\sigma}(x,y) = I * \frac{1}{2\pi\sigma^2} e^{-(x^2+y^2)/(2\sigma^2)} - \frac{1}{2\pi K^2\sigma^2} e^{-(x^2+y^2)/(2K^2\sigma^2)} \quad \text{---------- (5)}$$

Which represents an image convoluted to the difference of two Gaussians, which approximates a Mexican Hat function.

As a feature enhancement algorithm, the difference of Gaussians can be utilized to increase the visibility of edges and other detail present in a digital image.

The difference of Gaussians algorithm removes high frequency detail that often includes random noise, rendering this approach one of the most suitable for processing images with a high degree of noise. Differences of Gaussians have also been used for blob detection in the scale-invariant feature transform.

In fact, the DoG [11] as the difference of two Multivariate normal distribution has always a total null sum and convolving it with a uniform signal generates no response. It approximates well a second derivate of Gaussian (Laplacian of Gaussian) with K~1.6 and the receptive fields of ganglion cells in the retina with K~5. It may easily be used in recursive schemes and is used as an operator in real-time algorithms for blob detection and automatic scale selection.

B. Discriminative Robust local binary pattern

Normally Discriminative Robust Local Binary Pattern (DRLBP) is used to extract representative features from each facial image. DRLBP approach generates LBP for each pixel, which describes the face image. In this method it is only essential to generate LBP for particular pixel of face image. For this purpose we are using Gabor filter first and then we are going for DRLBP. Gabor filter extracts the local image features efficiently. On basis of these features binary face template is produced.

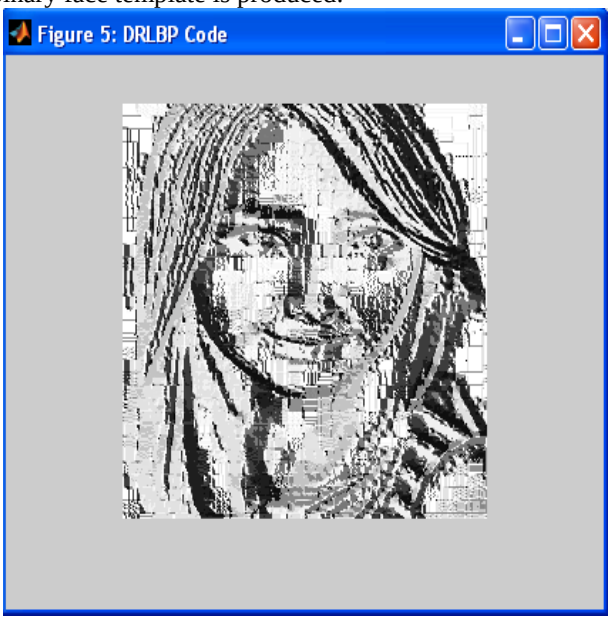
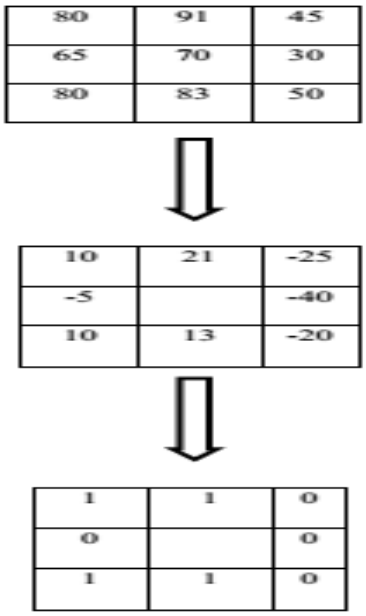


Fig 4 DRLBP face Recognition

Only for this reason we have used Gabor filter prior to the local binary pattern This approach generates adaptive LBP only for pixel I(X, Y), which has a value corresponded to BFT(X, Y).Due to this we reduce the number of patterns. It gives more unique information about face. Since there is

no variation in performance due to missing pixel. We get good matching score. This is a straight forward process and there is no need of training. The main advantage of using LBP is it is less sensitive to illumination variation, scaling and rotation. The LBP operator is generalized by allowing larger neighborhood radii r and different number of sampling points s. These parameters are indicated by the notation LBP (s,r).



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5. Experimental Results

In this section we have evaluated the performance of Difference of Gaussian and feature extraction based on Discriminative Robust Local Binary Pattern. Here we test the proposed approach using FERET dataset for face recognition. The image is cropped and made into 64X64 from middle of location of eyes. Here we have considered the local features such as eyes, nose, mouth and chin and also detects properties of relations (e.g. areas, distances, angles) between the features are used as descriptors for face recognition.

The results shows that the selective local texture features reduces the number of Discriminative Robust LBP into half compared to the existing LBP method. Due to this reduction the proposed method reduces the computation time considerably.

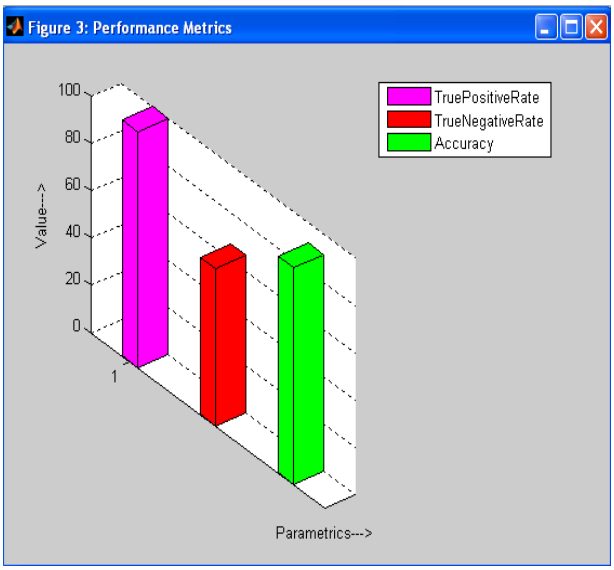

Fig 5 Performance of the Proposed System

We have considered 1sample per person for each individual person. Here we will store each person's image in the FERET database and later which can be used for matching. FERET database is a standard database which is used for storing images. And the resolution of image is 128X128.The results shows that the combined features are useful to distinguish the maximum number of samples accurately and it is matched with already stored original face samples for identification. The results produced by using this method provide better discriminatory power for recognizing different facial appearance with accurate results.

6. Conclusion and Future Enhancement

In this paper, we used local matching method for Face recognition using Difference of Gaussian, Discriminative Robust Local Binary Pattern .Here first the facial features are features are segregated at different resolutions to provide edge information, noise, smoothness and blurriness present in a face image using Difference of Gaussian and Discriminative Robust Local Binary Pattern is used to extract the features describes texture and edges with better discrimination This feature is useful to distinguish the maximum number of samples accurately and it is matched with already stored original face samples for identification. Since we are using single sample, the space and time complexity is reduced and performance has improved. In future it lies in how to exploit the proposed descriptor for the domain of face recognition of identical twins and to improve the recognition performance with less computation time for the Single Sample per Person Problem.

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