Security based Space, Scale and Orientation invariance for human face detection

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Abstract

Though a lot of work has been done in face recognition, there are some difficulties in recognition of face images with different pose, illumination and expression. Image space, scale and orientation jointly contain large information than the individual domain. In visual perception the position, frequency and orientation selectivity have main role .This paper proposes face recognition approach by exploring information jointly in space, scale and orientation. First the face image is convolved with multi-scale and multi orientation Gabor filters which decompose the image in to different responses with different orientations and scaling. Secondly Local binary pattern is used to describe neighboring relationship in space, scale and orientation domain. This way information from different domains is explored to give more stable results. Finally weighted histogram intersection is used for discriminant classification. Own database is used for checking the results.

Keywords- *Gabor volume based local binary pattern (GV-LBP), Local binary pattern (LBP), linear discriminant analysis (LDA),* and Local Gabor binary pattern histogram sequence (LGBPHS)

1. Introduction

One of the growing tech – tools law enforcement agencies are using to track down suspects during crime investigations is Face recognition (FR) technology. Face Recognition has gained a lot of importance in defense as crime and terrorist activities have plummeted to the peak. But there are many challenges that are been faced in Crime Investigation like delay in recognition of the suspect, improper or difficult lighting conditions, invariant pose and disguised faces. To extract discriminant features and enlarge the margin among different persons becomes a critical and difficult problem in face recognition [1].

Till now, a lot of face recognition algorithms have been introduced which include local appearance features and holistic features. The typical holistic features include the very well – known Linear Discriminant Analysis (LDA), Principal Component Analysis (PCA), Independent Component Analysis (ICA) etc. PCA Principle Component Analysis provides an optimized linear mapping from the original image space to an orthogonal Eigen space [4]. Holistic features like LDA and PCA are not suitable to feature changes like expressions and illumination. Thus Gabor and Local Binary Patterns (LBP's) are found to be more robust to such changes [1].

Gabor filters provides desirable characteristics of orientation selectivity and spatial locality and are optimized for space and frequency domains. It is invariant to any monotonic grey scale transformation and is, therefore, robust to illumination changes.

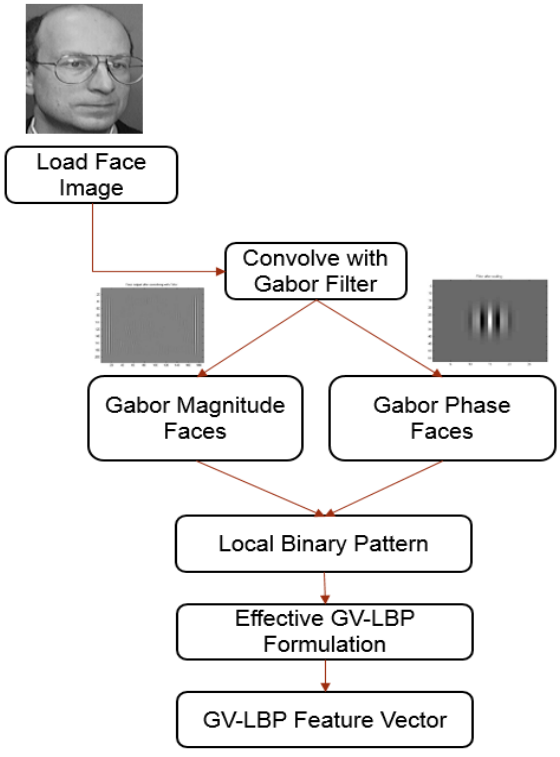

Fig 1: Flow Chart of Face Recognition Process

2. GV-LBP Based Face Representation

A. Gabor Faces

Gabor filters have inbuilt capacity of spatial locality and orientation selectivity [2]. Due to this advantage they are successfully used for face recognition. The Gabor
Kernels we implemented are follows:

$$\varphi_{u,v} = \frac{k_{u,v}^2}{\sigma^2} \exp\left(-\frac{k_{u,v}^2 z^2}{2\sigma^2}\right) X\left[\exp(ik_{u,v} z) - \exp\left(\frac{-\sigma^2}{2}\right)\right]$$

Where u and v represents orientation and scale of the Gabor filter respectively. z= (x, y), and the vector $k_{u,v}$ is defined as:

$$k_{u,v} = k_v e^{i\phi u}$$

σ is the standard deviation.

Where,

$$k_v = k_{max}/f^v \quad , \quad k_{max} = \pi/2 \quad ,$$

$$f = \sqrt{2}\,, \phi_u = \pi u/8.$$

Bank of Gabor filters can be generated using this kernel. By simply scaling and rotating the scaling vector [2]. In this paper we use five scales and eight orientations. For every face image there are total 40 Gabor magnitude and 40 Gabor phase faces.

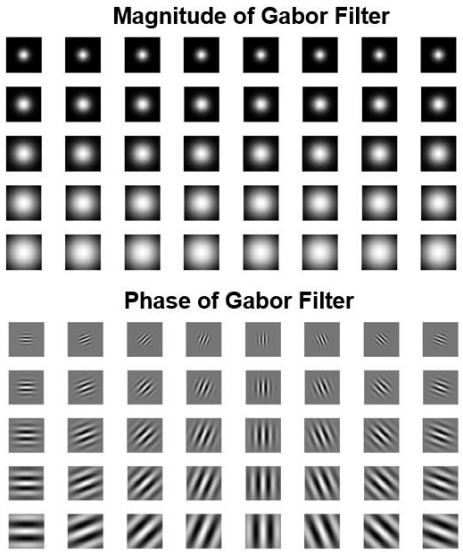

Fig 2: Gabor Filter Bank

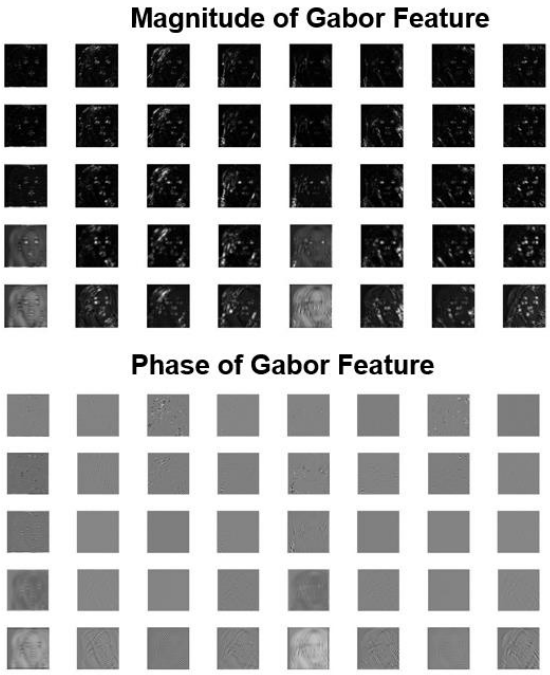

Fig 2: Gabor Features after image convolved with bank

B. Gabor volume based LBP.

LBP is very strong local descriptor which is useful in describing the micro features of an image. In LBP for every pixel we threshold the 3x3 neighborhood with center value [1].and replace the center value with equivalent binary number. The illustration is shown in the figure below.

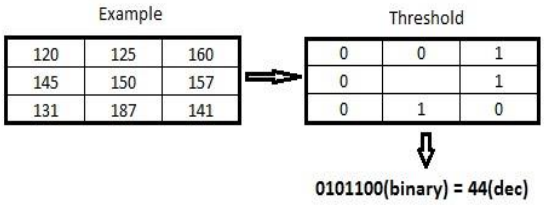

Fig.3: Calculation of LBP code from 3x3 Mask

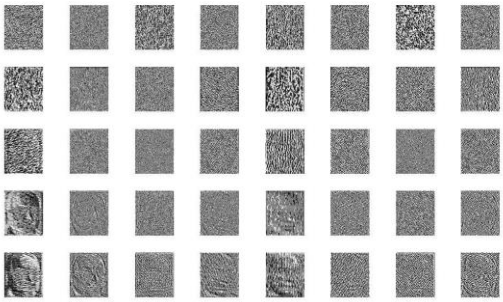

Fig.4: Local Binary Pattern of the Input Image

3. Histogram Intersection Based Face Recognition.

The difference of face images from same type of person could be greater than those of different ones. Thus to extract discriminant features that makes face recognition robust becomes a challenge. To measure dissimilarity between face image, histogram intersection is used as a novel approach [3], [5]. The histogram based on GV-LBP results is used as measure to recognize face image.

$$d(H^1, H^2) = \sum_i \min(h_i^1, h_i^2)$$

Where H^1 and H^2 are two histograms and h_i^1 and h_i^2 denote the bin value corresponding to the histogram. The main intension behind this computation is calculating the common part of the two histograms [6]. The main characteristics of histogram is that they are robust to alignment errors.

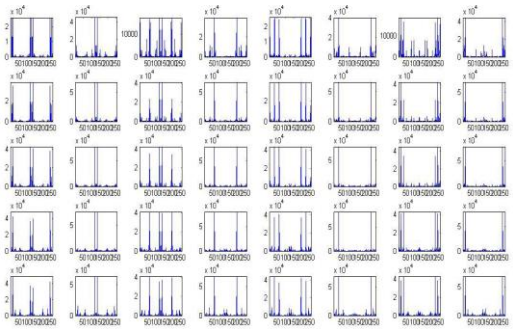

Fig.5: LGBPHS

2. Results

FOR ORIENTATION

Fig.6: Input Image

Fig.7: Matched Image

FOR ILLUMINATION

Fig.8: Input Image

Fig.9: Matched Image

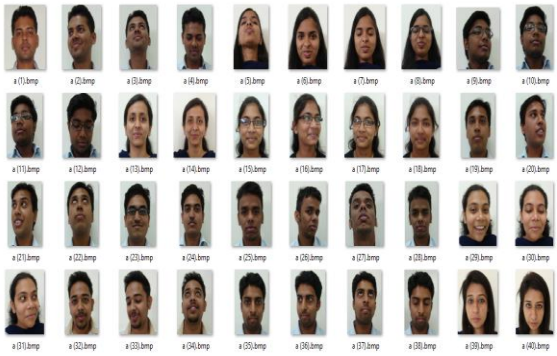

Fig.10: DATABASE

For face recognition, database of 50 images is used. Resolution of 512 X 512 pixels is used. Fig (6) and Fig (8) shows oriented and illuminated image respectively which are taken as an input image. Result in Fig (7) and Fig (9) shows that the face is matched properly even if there are orientation and illumination changes. Thus results show that the GV-LBP and histogram matching algorithm makes system robust as it is invariant to changes in illumination, orientation and occlusion.

5. Conclusion

This paper proposes a novel face representation, which is impressively insensitive to orientation, phase and scale variations. The effectiveness of this approach is due to the robustness of multi resolution and multi orientation Gabor filter, local binary pattern and the histogram intersection algorithm .Experimental evaluations of the proposed approach is done on the ORL and the own database. The results illustrate effectiveness and robustness to the variations of orientation and scaling.

Future efforts will be focused on how to match two images more effectively at the same time we will try to minimize time complexity of the algorithm. .

6. References

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