Security based Face Recognition by using Space, Scale and Orientation Domains

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Project Guide:

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Introduction

- Face recognition, as one of the primary biometric technologies, became more and more important owing to rapid advances in technologies such as digital cameras, the Internet and mobile devices, and increased demands on security.
- But there are various challenges to be faced like different expressions, poses, occlusions and illuminations and time constraint for processing.
- To extract discriminant features and enlarge the margin among different persons becomes a critical and difficult problem in face recognition.
- In Crime Investigation it is very important to identify the suspect in a very short time.

Introduction

- Holistic features like PCA and LDA are not stable to local changes such as illumination, expression.
- Local appearance features like Gabor and local binary patterns (LBP's) are found to be more stable to such local changes.
- LBP operator describes the neighbouring changes around the central point, is a simple yet effective way to represent faces.
- Gabor filters, exhibit desirable characteristics of spatial locality and orientation selectively and are optimally localized in the space and frequency domains.
- It is invariant to any monotonic grey scale transformation and is, therefore, robust to illumination changes.

Literature Survey

These are the different Methodologies used for Face Recognition:-

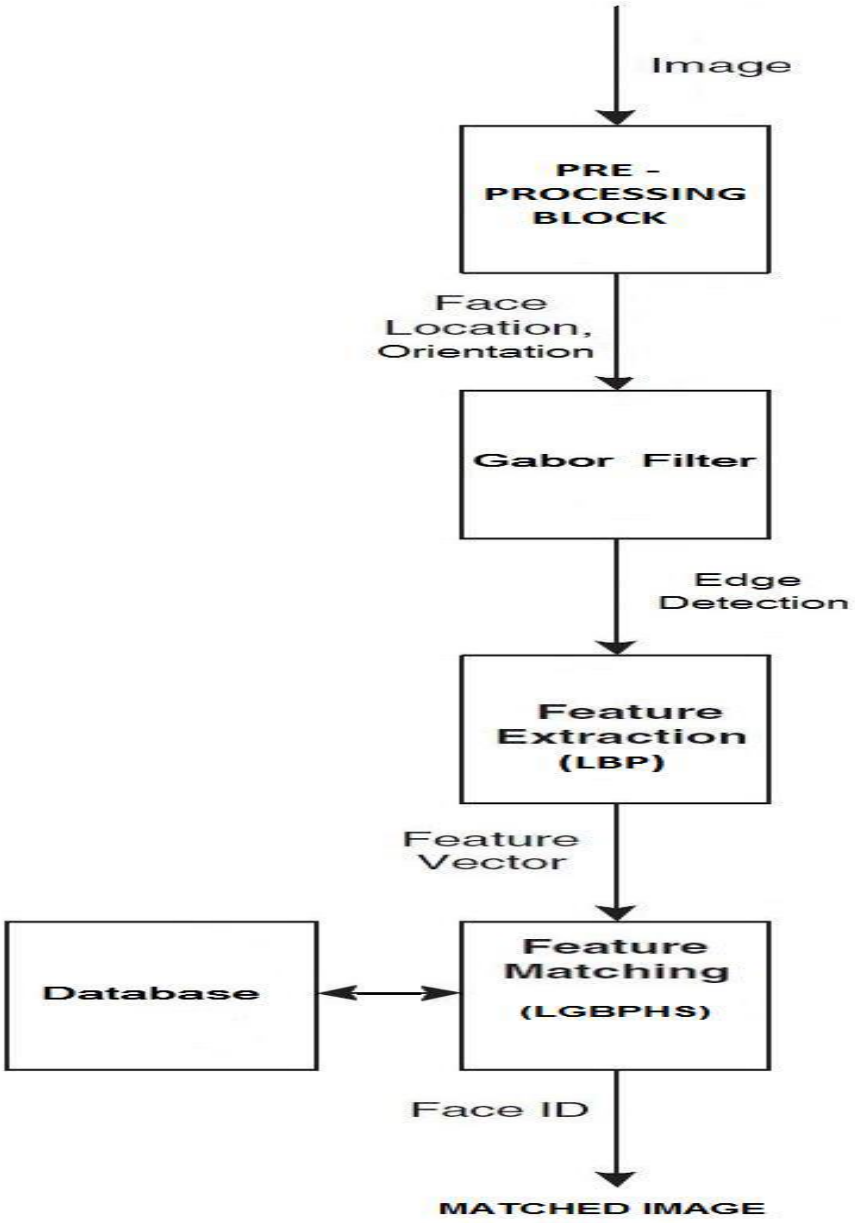
The performance of face recognition systems has improved significantly since the first automatic face recognition system was developed by Kanade in 1973. Furthermore, face detection, facial feature extraction, and recognition can now be performed in “real time” for images captured under favourable situations using various techniques.

Year	Authors	Method
1973	Kanade	First Automated System
1987	Sirvovich & Kirby	Principle Component Analysis
1991	Turk & Pentland	Eigen Faces
1996	Etemad & Chellapa	Fisher face
2007	Naruniec & Skarbek	Gabor Filters

OBJECTIVE

- To propose a novel face representation and recognition approach by exploring information jointly in image space, scale and orientation domains.
- Face image is first decomposed into different scale and orientation responses by convolving multi-scale and multi-orientation Gabor filters.
- Local binary pattern analysis is used to describe the neighbouring relationship not only in image space, but also in different scale and orientation responses.

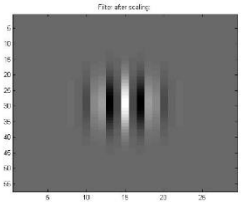
Block Diagram

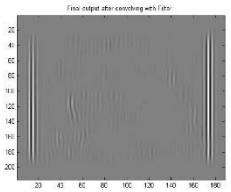


System – Work Flow

Load Face Image

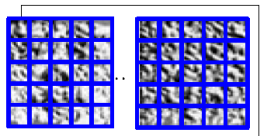
Convolve with Gabor Filter

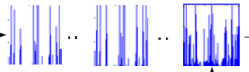




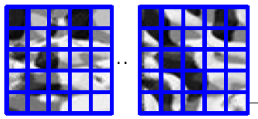
Gabor Magnitude Faces

Gabor Phase Faces





LGBPHS



LGBP Maps

Local Binary Pattern

Effective GV-LBP Formulation

GV-LBP Feature Vector

Methodology

Gabor Filter - LBP

- The main procedure of the proposed joint information extraction is as follows
- First, the multi-scale and multi-orientation representations are derived by convolving the face image with a Gabor filter bank and formulated as a third-order volume.
- Second, LBP operator is applied on the three orthogonal planes of Gabor volume, respectively, named GV-LBP-TOP in short.
- In this way, we encode the neighbouring information not only in image space but also among different scales and orientations of Gabor faces.

GABOR FILTER

- Gabor filters ,exhibit desirable characteristics of spatial locality and orientation selectively and are optimally localized in the space and frequency domains. The Gabor kernels used are defined as follows:

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

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

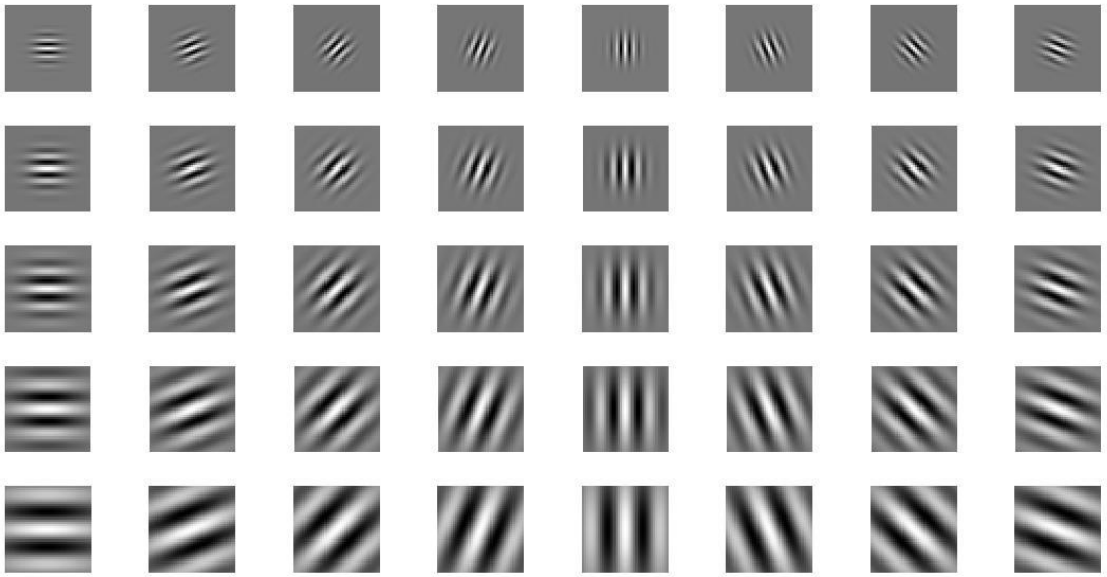
$$k_{u,v} = k_v e$$

σ is the standard deviation.

GABOR FILTER BANK

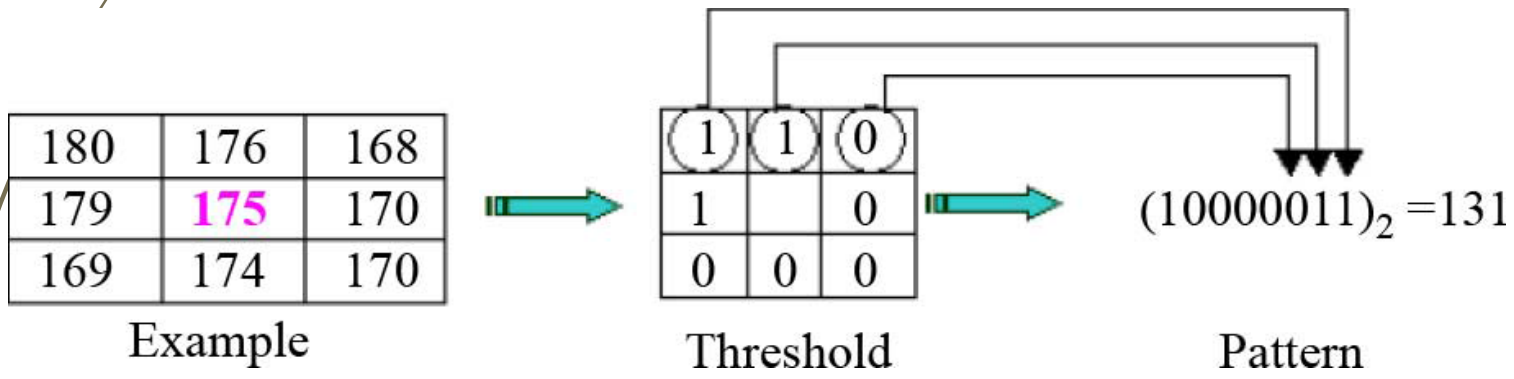
- Gabor kernels have five scales **v € {0,1,2,3,4}** and eight orientations **μ € {0,1,2,3,4,5,6,7}** to derive the Gabor representation by convolving face images with corresponding Gabor kernels.

- For every image pixel we can obtain 40 Gabor magnitude and 40 Gabor phase face from a single input face image.



LBP (Local Binary Pattern):-

- The basic LBP operator labels the pixels of an image by thresholding the 3 X 3 neighbourhood of each pixel with the centre value and considering the result as a binary number (or called LBP codes).



GV - LBP

$$E - GV - LBP = \sum_{p=0}^{7} 2^p S(I_p - I_c)$$

where $S(I_p - I_c)$ is a threshold function defined as

$$S(I_p - I_c) = \begin{cases} 1, & \text{if } I_p - I_c \geq 0 \\ 0, & \text{if } I_p - I_c < 0. \end{cases}$$

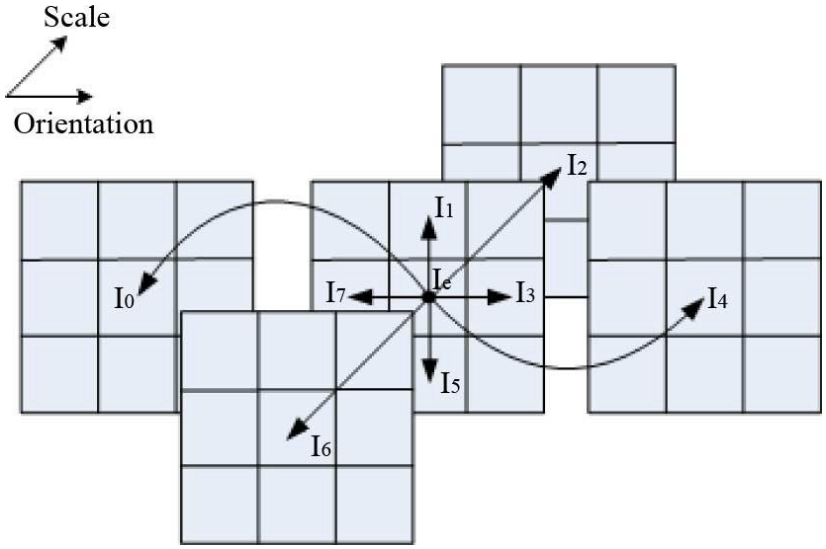


Fig. 4. Formulation of GV - LBP.

There are mainly three advantages for the proposed method :-

1. Gabor feature is applied to the face images to alleviate the variations of facial expression and illumination.
2. The LBP is utilized to model the neighbouring relationship jointly in spatial, frequency and orientation domains.
3. A feature selection and discriminant analysis method is introduced to make the face representation compact and effective for face recognition.

WEIGHTED HISTOGRAM INTERSECTION

- The histogram intersection is used as the dissimilarity to measure different face images.

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

where H1, H2 are two histograms and h_i^1 , h_i^2 denote the bin value.

- In this method the face image is divided into several blocks.
- The local histograms are first obtained from different blocks and then concatenated into a histogram sequence to represent the whole face.
- Thus the face image is depicted successfully at three levels as in local histogram expresses characteristic at regional level which is robust to alignment errors.
- The areas nearby eyes and nose are more important than others. Therefore, it is sensible to assign different weights onto different blocks when measuring the dissimilarity of two images.

Software requirement

MATLAB :

- Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces.

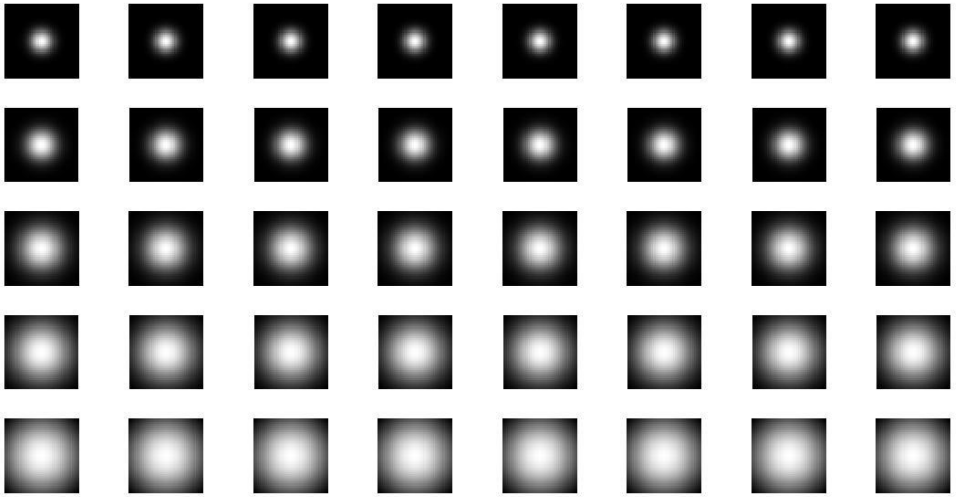
Image Processing Toolbox :

The image processing toolbox allows such manipulations as :

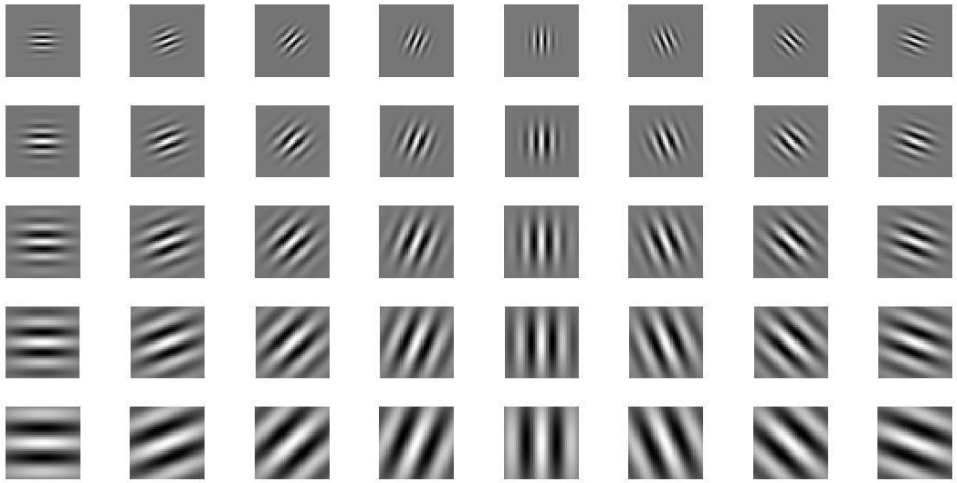
- Direct visualization of images in MATLAB
- Colour space conversions
- Filtering and fast convolution
- Image arithmetic
- Morphological operations

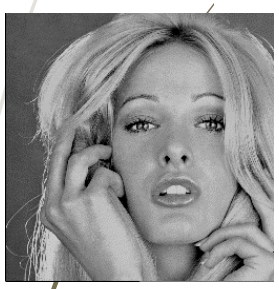
OBSERVATIONS

Magnitude of Gabor Filter

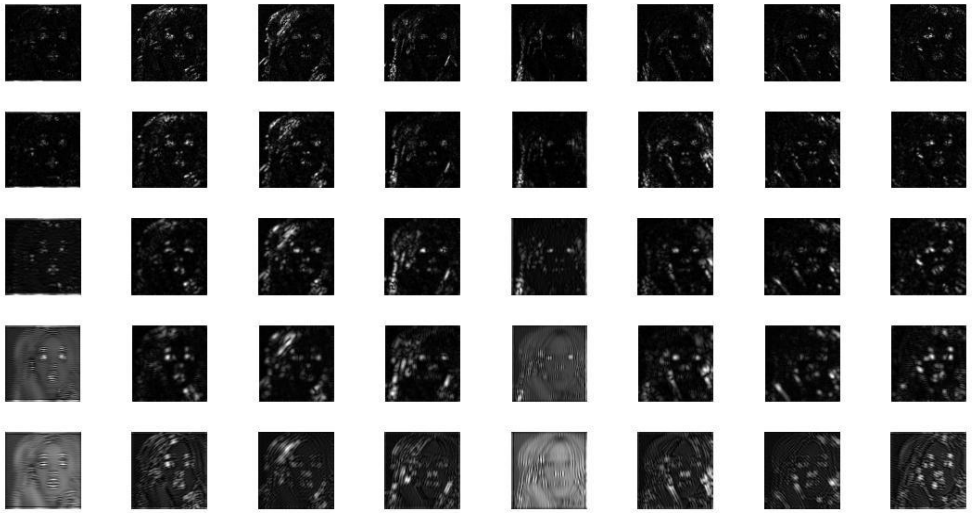


Phase of Gabor Filter

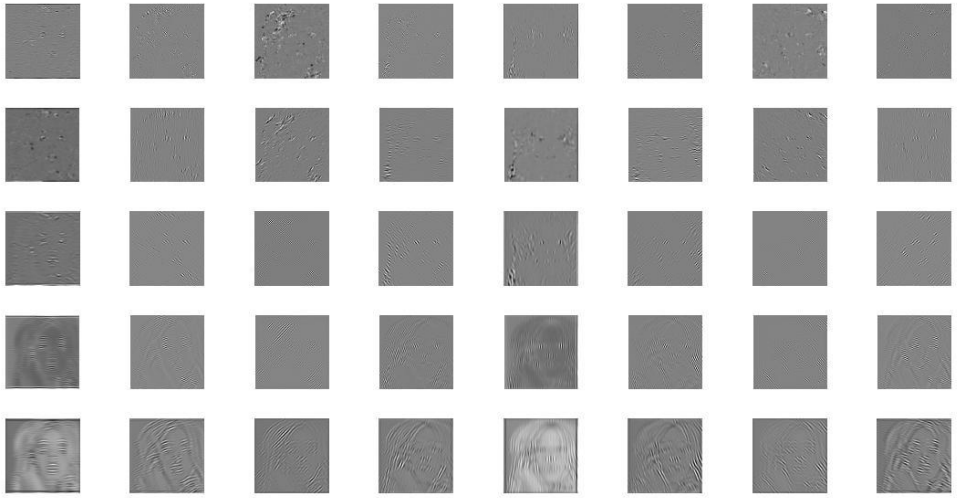




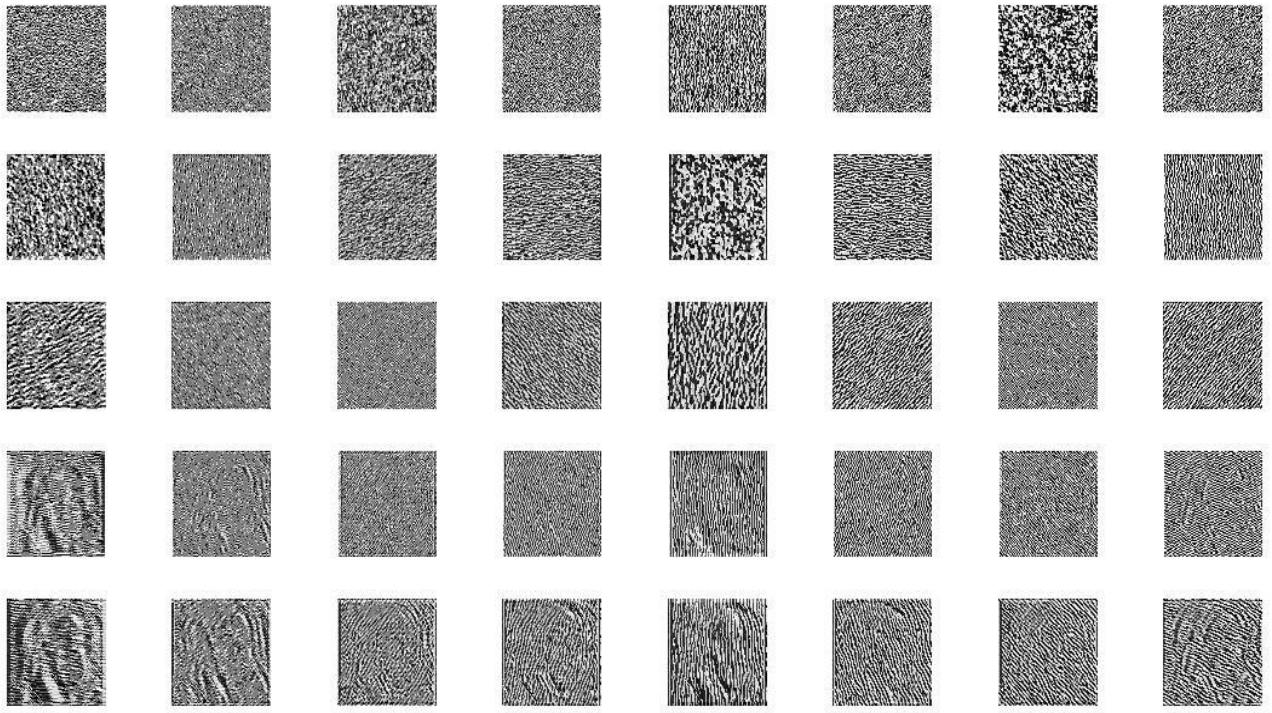
Magnitude of Gabor Feature



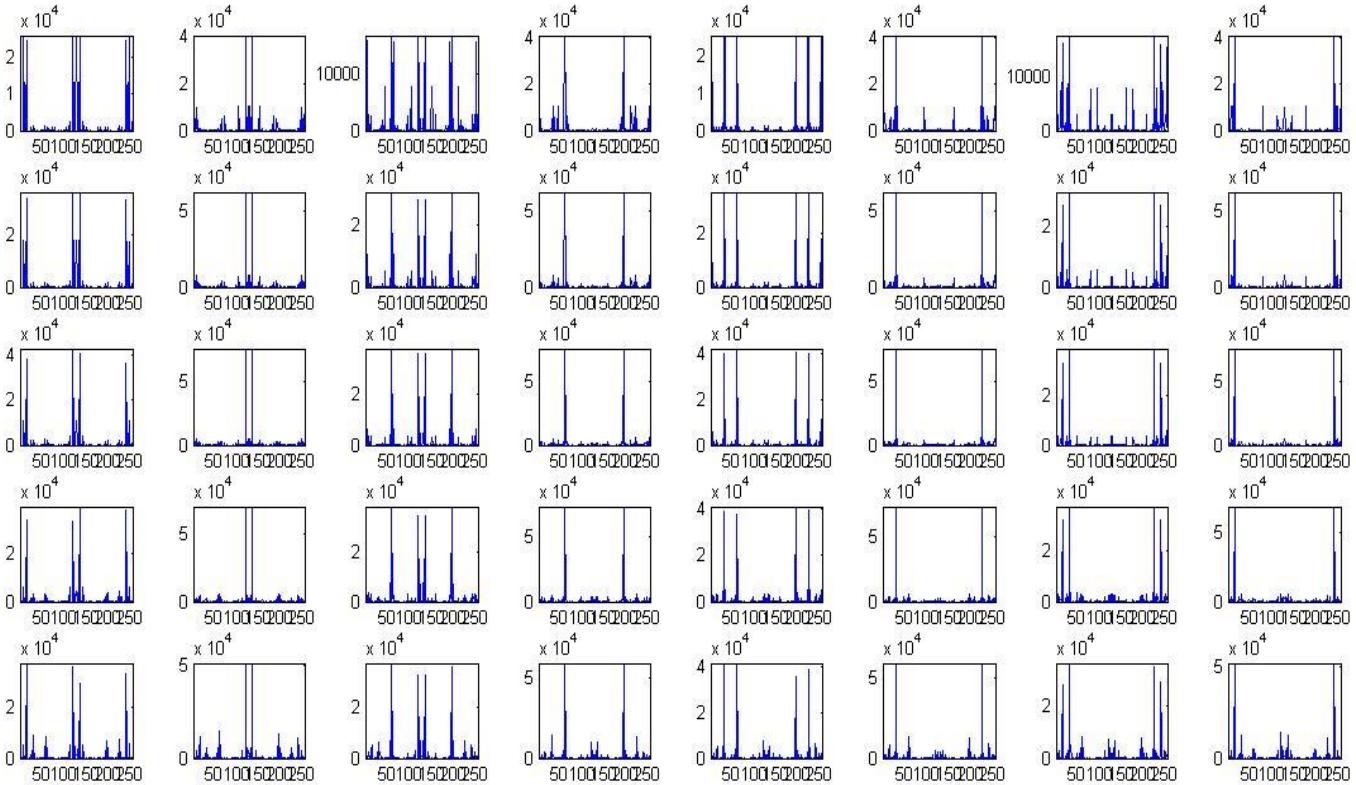
Phase of Gabor Feature

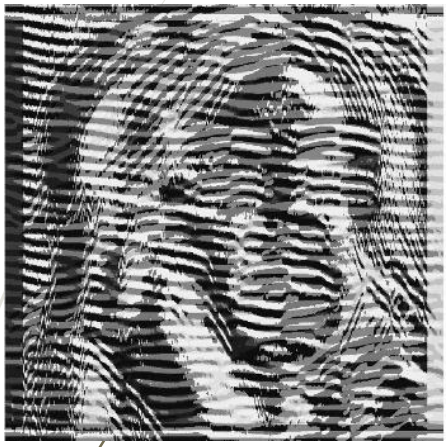


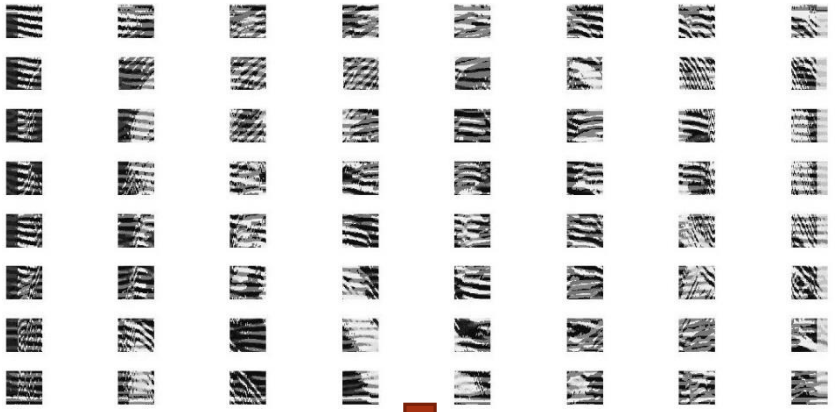
LBP (Local binary Pattern)

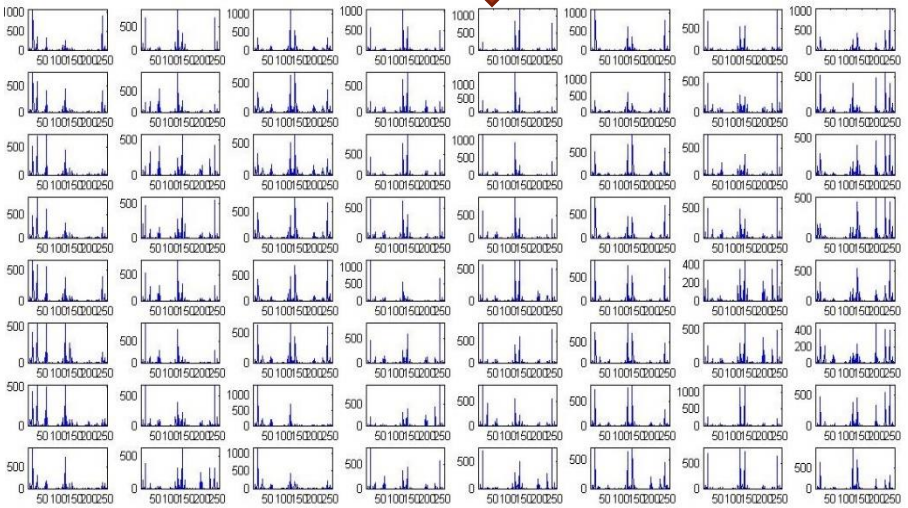


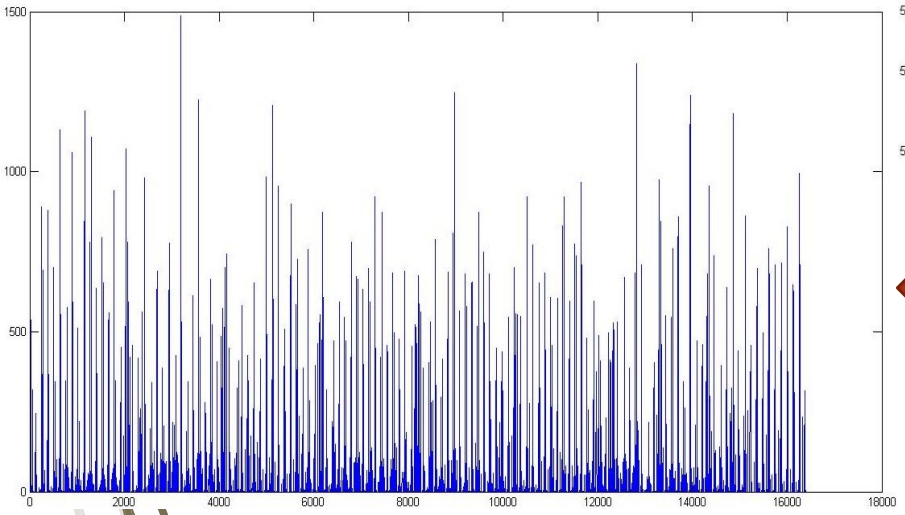
Histogram of LBP



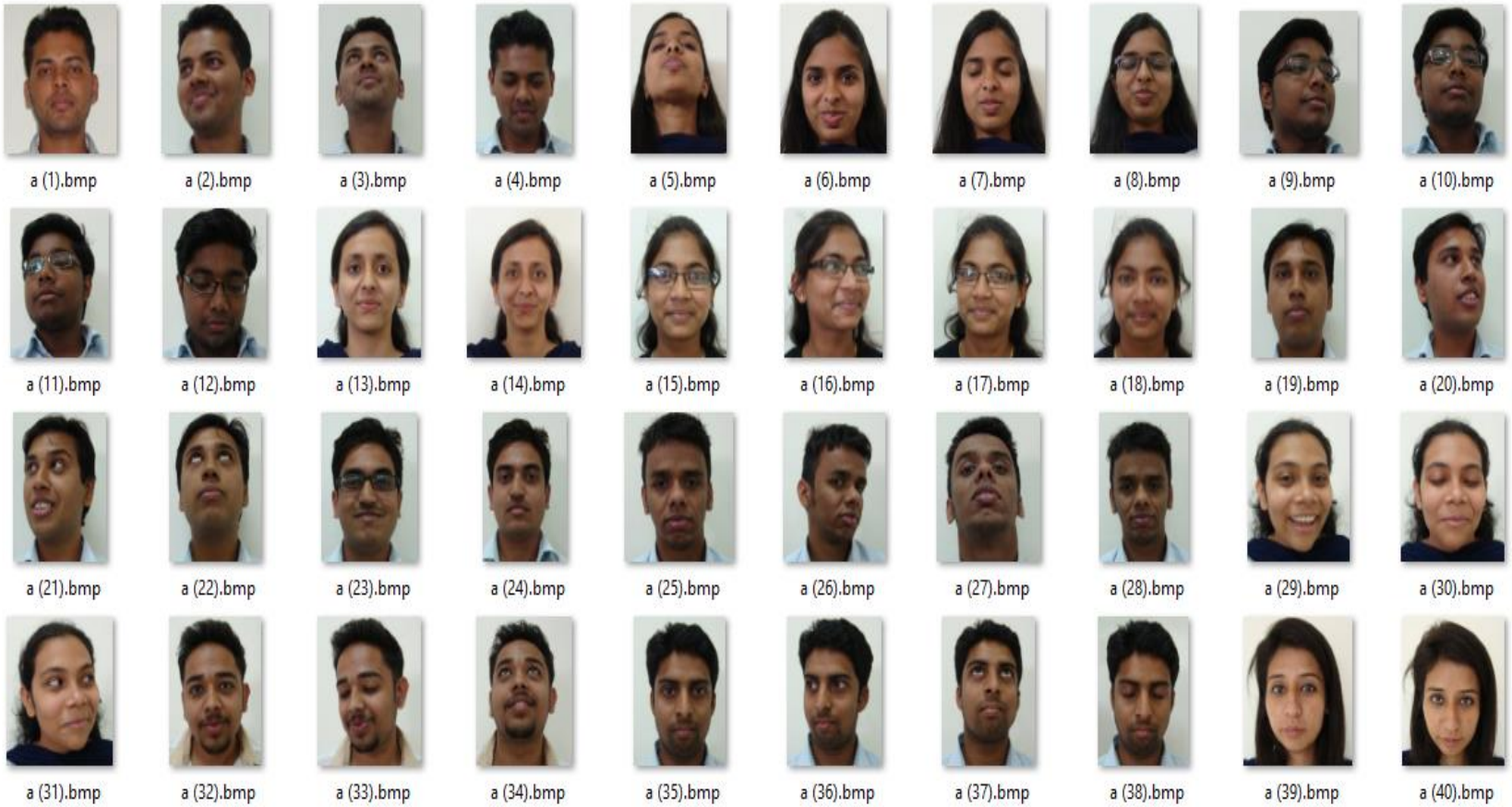







1500
1000
500
0
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

Self Created Database



RESULTS BASED ON SELF-CREATED DATABASE

FOR ORIENTATION

Fig.1: Input Image

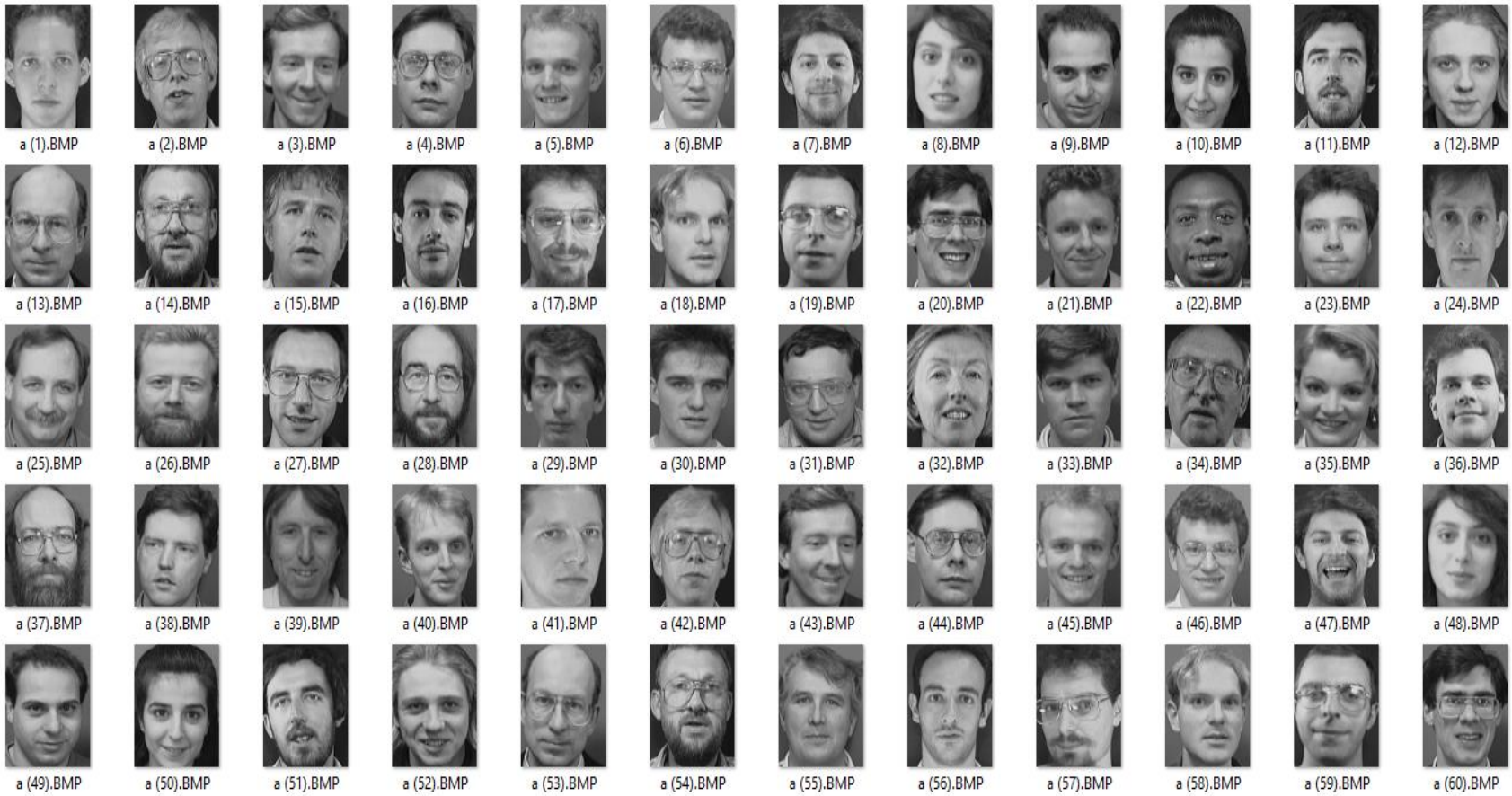
Fig.2 Matched Image

FOR ILLUMINATION

Fig.1: Input Image

Fig.2 Matched Image

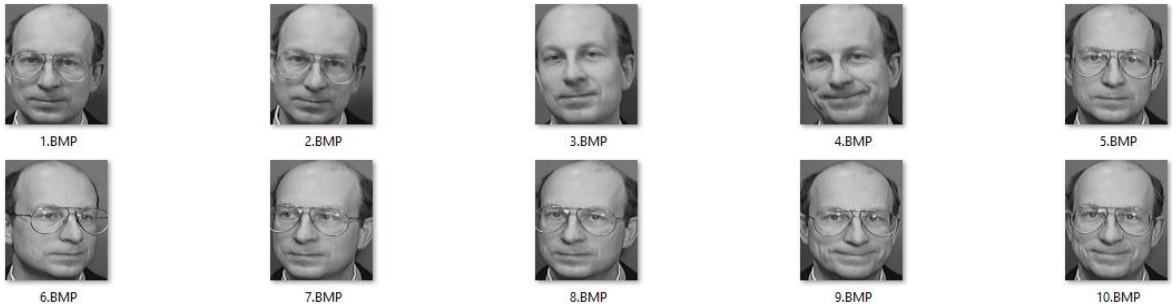
ORL DATABASE



RESULTS BASED ON ORL DATABASE

Input image

Training database



Matched image

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Thank You!