ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 20, April 2016

# Face Detection Using Gabor Feature Extraction Based On Surveillance Video

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***Abstract*— Face detection and identification is a challenging area of research in the field of security surveillance. A performance of the detection and recognition system depends on many conditions. In this paper, the description of the face detection and recognition on the video is focused. The preprocessing methods such as cropping, resizing, noise removal, histogram equalization, and contrast enhancement are applied to the video. The Gabor feature extraction techniques are used on the preprocessed data and facial regions are extracted for further processing. The proposed work is tested on M2VTS dataset.**

***Keywords*— *Face Detection, Gabor Feature Extraction.***

## I. INTRODUCTION

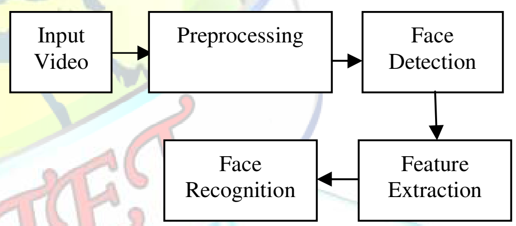
The purpose of face detection is to find out whether or not there are any faces in the image and, if present, return the position and the extent of each face [1]. While face detection is a trivial task for human visualization, it is a challenge for a computer revolution due to the variations in scale, location, orientation, pose, facial expression, light condition, and various glance features.

The facial feature such as nodal position on the face, distance between the eyes, and shape of the cheekbones are some of the key features. Among these features, some may have more selective power than others. The higher number of features may not lead to high recognition rate. Hence, the selection of the best features becomes a primary concern. It decreases the feature size and increases the recognition rate. This method provides the techniques used for face recognition. The qualities of image degradation on lighting, illumination condition, noise and occlusions [2].

In this paper, introduction to moving object detection and feature extraction is discussed in the first section. In the second section, overall the proposed methods are discussed. The preprocessing methods are explained in the third section. The fourth section described the face detection technique. Feature extraction technique is explained in the fifth section. The final section concludes the paper.

## II. PROPOSED WORK

The block diagram of the proposed face detection and feature extraction on video sequence is shown:




From the above figure, select the video sequence as input. The video can be preprocessed by using median filtering and enhance the resultant image using CLAHE. After that, face detection can be done by using Viola Jones technique. Faces are detected and marked by a rectangular box. The Gabor feature technique was used to extract the feature from the facial regions and the features are used for further processing.

## III. PREPROCESSING TECHNIQUES

Face video sequences are pre-processed and enhanced to improve the recognition performance of the system. Based on necessity some of the following pre-processing techniques are used in the proposed face detection technique.

### *A. Noise Removal and grayscale conversion*

In the face detection process, the first step is to convert the RGB video sequence into grayscale.

The median filter is applied in order to produce the blurry effect, because in the later stages face recognition algorithm include the step of face image re-sizing (by using down sampling method) while maintaining the quality of face image. The 5*5 filter is used for this process.

$$R=\frac{1}{25}\sum_{1=1}^{25} Z_i \quad (1)$$

Equation (1) calculates the average value of the pixels, while 'z' is the mask, 'i' are mask elements. The mask is then

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convolved with image to produce a filtering effect, for a 5*5 mask used in the performance, it calculates the average of 25 pixels in that filter mask.

The resultant image after grayscale conversion and median filter is shown in Fig. 1.

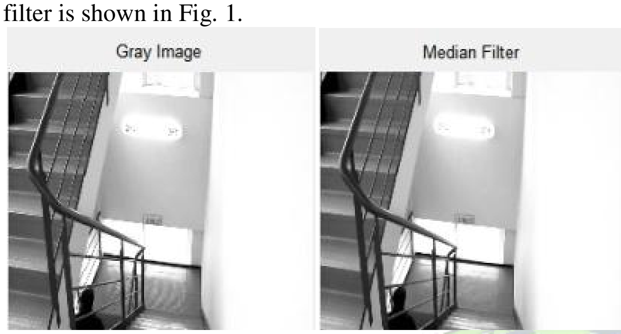


Fig.1. Grayscale and Median Filter

*B. Histogram Equalization*

It is usually done on low contrast images in order to enhance image quality and to improve face recognition performance. It changes the active range (contrast range) of the image and as a result, some important facial features become more observant.

Mathematically histogram equalization can be expressed as:

$$S_k = T(r_k) = \sum_{j=0}^{k} \frac{n_j}{n} \qquad (2)$$

where k=0,1,2,…., L-1 Here in equation (2) 'n' is the total number of pixels in an image, 'nj' is the number of pixels with gray level 'rk' ,and 'L' is the total number of gray levels exist in the face image.

The result after histogram equalization Fig .2.

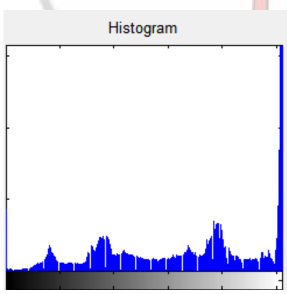


Fig.2. Histogram Equalization

*C. Contrast equalization*

The final stage of the preprocessing chain rescales the image intensities. It is main to use a robust estimator because the signal typically contains excessive values produced by highlights, small dark regions such as nostrils, garbage at the image borders, etc [3].

One could use (for example) the median of the fixed value of the signal for this, but here a simple and rapid approximation is favored based on a two stage process as follows:

$$\left.\begin{aligned} I(x, y) &= \frac{I(x,y)}{mean(\min(\tau, |I(x',y')|)\alpha))^{1/\alpha}} \\ I(x, y) &= \frac{I(x,y)}{mean(\tau, |I(x',y')|)\alpha))^{1/\alpha}} \end{aligned}\right\} \qquad (3)$$

Here, α (3) is a strongly compressive exponent that reduces the influence of large values, τ is a threshold used to shorten large values after the first phase of normalization, and the mean is over the whole (unmasked part of the) image.

The resultant image after contrast enhancement is shown in Fig. 3.

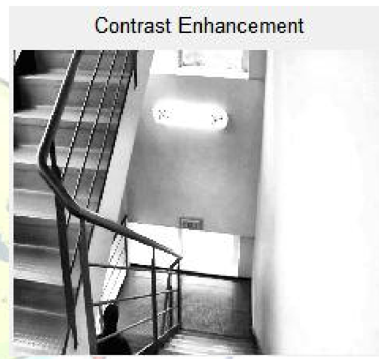


Fig. 3. Image after contrast enhancement

*D. Cropping the face region*

Face cropping is also an important task to achieve high recognition rates. Cropping can be completed using various face detection techniques. When the area of an image has much larger compared to that of a face, the region of the image where the face is located is cut out from the image and only this area is used in the method of face recognition. By using the cropping technique only main face can be extracted.

## IV. Face Detection Technique

Face detection techniques can be categorized into two major groups that are featured based approaches [4], [5] and image based approaches. Image based approaches use linear subspace method, neural networks [6],[7],[8]and statistical approaches for face detection. Feature based approaches can be subdivided into low level analysis, feature analysis and active shape model.

*A. Viola Jones technique*

Viola-Jones technique [9] is based on exploring the input image by means of sub window capable of detecting features. This window is scaled to detect the faces of different sizes in the image. Viola Jones developed a scale invariant detector which runs through the image many times, each time with different size. Being scale invariant, the detector requires the

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Special Issue 20, April 2016

same number of calculations regardless of the size of the image.

The system architecture of Viola Jones is based on a cascade of detectors. The first stages consist of simple detectors which eliminates only those windows which do not contain faces. In the following stages the complexity of detectors is increased to analysis the features in more detail. A face is detected only if it is observed through the entire cascade.

The first step of this algorithm is to convert the input image into an integral image. This is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel. By doing so, the sum of all pixels inside any given rectangle can be calculated using only four values.

Sum of the rectangle ABCD = D - (B + C) + A

The face detector in Viola Jones method analyzes a sub-window using features. These features consist of two or more rectangles. Each feature gives a single resultant value which is calculated by subtracting the sum of the white rectangle(s) from the sum of the black rectangle(s).

Viola and Jones used a simple classifier built from computationally efficient features using AdaBoost [10],[11] for feature selection. AdaBoost is a machine learning boosting algorithm that constructs a strong classifier through a weighted combination of weak classifiers. Mathematical description of weak classifier is, where x is a sub-window, f is the applied feature, p the polarity and θ is a threshold that concludes whether x should be classified as a negative (non-face) or a positive (face).

Viola-Jones face detection algorithm scans the detector several times through the same image –each time with a new size. The detector detects the non face area in an image and discards that area which results in detection of face area. To discard non face area Viola Jones takes advantage of cascading. When a sub window is applied to cascading stages, each stage concludes whether the sub window is a face object or not. Sub windows which contain some percentage of having faces are passed to the next stage and those which are not faces are discarded. The final stage is considered to have a high percentage of face objects.

The face detects results shown in Fig. 4.

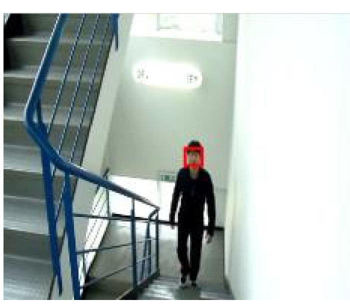


Fig. 4. Face Detection

## V. FEATURE EXTRACTION

The feature extraction techniques are used to extract the feature points. In this paper, a Gabor feature extraction technique is presented.

### A. Gabor feature extraction

The proposed work use a Gabor wavelets based feature extraction technique. The Gabor filter id defined as,

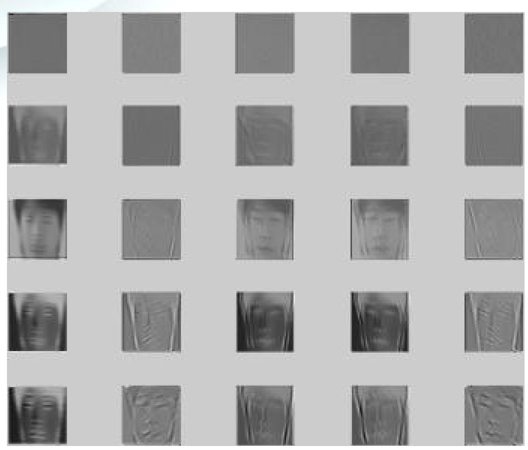
$$\left.\begin{array}{l} W(x, y, \theta, \delta, \varphi, \sigma, \gamma) = \exp\left(-\frac{x^2+\gamma 2 \partial 2}{2\sigma^2}\right) \\ \qquad \cos\left(2\pi \frac{x'}{\partial} + \varphi\right) \\ X' = x\cos(\theta) + y\sin(\theta) \\ Y' = -x\sin(\theta) + y\cos(\theta) \end{array}\right\} \quad 4$$

In equ 4, where (*x*, *y*) specifies the position of a light impulse in the visual field and $\mu$, ϕ, γ, λ, σ are parameters of the wavelet. We have chosen the parameters used by Wiskott [12] which are shown in Table 1.

TABLE I
PARAMETERS OF GABOR

| **Parameter** | **Symbol** | **Values** |
|---|---|---|
| Orientation | Θ | $\{0, \frac{\pi}{8}, \frac{2\pi}{8}, \frac{3\pi}{8}, \frac{4\pi}{8}, \frac{5\pi}{8}, \frac{6\pi}{8}, \frac{7\pi}{8}\}$ |
| Wavelength | Λ | $\{4, 4\sqrt{2}, 8, 8\sqrt{2}, 16\}$ |
| Phase | Φ | $\{0, \frac{\pi}{2},\}$ |
| Gaussian Radius | Σ | $\sigma = \lambda$ |
| Aspect Ratio | Γ | 1 |

A set of Gabor filters is used with 5 spatial frequencies and 5 distinct orientations, this makes 25 different Gabor filters represented in Fig. 5.



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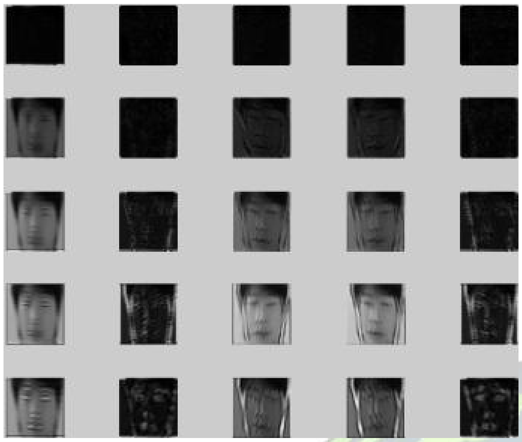
a) Real part of filters



b) Magnitude filters

Fig. 5. Gabor uses real part and magnitude part of filters

When convolving these Gabor filters with a simple face image and obtain the filter responses. It finds out the desirable locality and orientation performance.

In this work, selected 5 sets of Gabor filters with different orientations displayed Table 2.

TABLE 2
SETS OF GABOR FILTERS FOR DIFFERENT ORIENTATIONS

| **Parameters** | **Values** |
|---|---|
| 5 | $\theta = \{0\}$ |
| 10 | $\theta = \{0, \frac{\pi}{5}, \frac{7\pi}{5}\}$ |
| 15 | $\theta = \{0, \frac{2\pi}{5}, \frac{4\pi}{5}\}$ |
| 20 | $\theta = \{0, \frac{2\pi}{5}, \frac{4\pi}{5}, \frac{6\pi}{5}\}$ |
| 25 | $\theta = \{0, \frac{\pi}{5}, \frac{2\pi}{5}, \frac{4\pi}{5}, \frac{6\pi}{5}\}$ |

When Gabor filters are applied to each pixel of the image, the dimension of the filtered vector can be very large (proportional to the image dimension). So, computation and storage cost will lead to expensive.

## VI. CONCLUSION

In this experiment, video sequence can be preprocessed by using median filtering and manipulates process such as cropping, resizing, and histogram equalization and enhance the image using CLAHE technique. From the video sequence, the face can be detected by using Viola Jones method. Using Gabor wavelet, features can be extracted based on real parts and magnitude parts. And, the video sequence Gabor wavelet for feature extraction and Viola Jones for face detection are used. In future work, perform SIFT feature extraction and evaluate the result of the two techniques.

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