International Journal of Emerging Science and Engineering (IJESE)
ISSN: 2319–6378, Volume-1 Issue-5, March 2013

An FPGA-Based Real-Time Face Detection & Recognition System across Illumination

K. Veeramanikandan, R.Ezhilarasi, R. Brindha

Abstract— Automated face recognition is an interesting computer vision problem with many commercial and law enforcement applications. Mug shot matching, user verification and user access control, crowd surveillance, enhanced human computer interaction all become possible if an effective face recognition system can be implemented. This paper presents a complete real-time face recognition system consisting of face detection, recognition and a down sampling module using an FPGA. The focus is on subspace techniques, investigating the use of image Pre-processing applied as a preliminary step in order to reduce error rates. Our method is simple and fast, which makes it useful for real-time applications, embedded systems, or mobile devices with limited resources.

Index Terms— Ada Boost, Face recognition, face detection, Mug shot matching.

I. INTRODUCTION

Face recognition is the ability to recognize people by their facial characteristics. Just like human beings, computer algorithms to perform face analysis are also divided into detection, recognition and expression understanding. LIGHTING variation is one of the most challenging problems in vision applications. For face recognition, it has been observed that the variations among images of the same face due to illumination.

The proposed face detection framework based on the AdaBoost learning algorithm using Haar features with varying illumination is considered one of the most difficult tasks for face detection. Variation caused by illumination is highly non linear and makes task extremely complex. Well known contrast enhancement algorithm, histogram equalization is applied for compensating the illumination conditions. In this research, a method is proposed to enhance the accuracy of recognizing faces of people. An ideal face recognition system should first have a face detection subsystem which is necessary for finding a face in an arbitrary frame, and also a face recognition subsystem which identifies the unknown face image. We define the *complete face recognition system* as a system which interfaces with a video source, detects all face(s) images in each frame, and sends only the detected face images to the face recognition subsystem which in turn identifies the face images.

Manuscript received on March , 2013

K. Veeramanikandan, Department of CSE, V.R.S. College of Engineering & Technology,Villupuram,Tamil Nadu,India.

R.Ezhilarasi, Department of CSE, V.R.S. College of Engineering & Technology,Villupuram,Tamil Nadu,India.

R.Brindha,Department of CSE, V.R.S. College of Engineering & Technology,Villupuram,Tamil Nadu,India.

II. FACE RECOGNITION USING SUBSPACES TECHNIQUES

A face recognition system is supposed to recognize faces under different illumination and lighting conditions present in the images. An efficient system to recognize human faces can be approached through the integration of different techniques viz., Normalization, Feature extraction and Classification under subspace techniques. Fig.2. represents the conceptual diagram on how the face can be recognized under different illumination and lighting conditions by this method for the viewer-cantered images. The input image is given to the image pre-processing to remove the illuminations, shades, lighting effects by using the illumination normalization technique without affecting to the face features which are needed for further processes. Then the features from the normalized image are extracted using a proposed subspace framework. Then the extracted features are trained using subspace classifier to get the identified image.

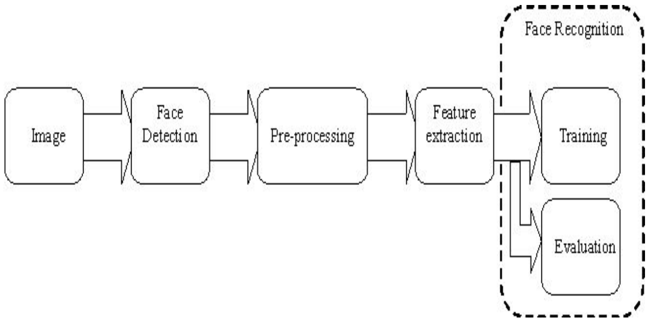

Figure1. Face recognition steps

III.FACE DETECTION

AdaBoost, short for Adaptive Boosting, is a machine learning algorithm, formulated by Yoav Freund and Robert Schapire. The adaboost algorithm is based on the idea that a strong classifier can be created by linearly combining a number of weak classifiers. A weak classifier consists of a feature (j), a threshold (0), and a polarity (P) indicates the direction of the inequality:

$$h(x,f,p,\theta) = \begin{cases} 1 & \text{if } pf(x) < p\theta \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

In the boosting algorithm T hypotheses are constructed each using a single feature. The final hypothesis is a weighted linear combination of the T hypotheses where the weights are inversely proportional to the training errors. Each iteration t, it will train a best weak classifier which can minimizes the training errors. After T iteration, we can obtain a strong classifier which is the linear combination of the T best weak classifiers multiplied by the weight values.

The AdaBoost algorithm is used to select a set of features and train a classifier. Locating such features is an important stage in many facial image interpretation tasks (such as face verification, face tracking or face expression recognition). We adopt the fast and efficient face finder recently described by Viola and Jones to locate the approximate position of each face in an image. A detector is used to cascade the structure to reduce the number of features considered for each sub-window. We then use the same method, trained on regions around facial feature points, to locate interior points on the face.

IV.PREPROCESSING

A pre-processing method which reduces the effect of various illumination conditions in the image is used. In Normalization, the pre-processing chain mainly categorized under five steps viz., RGB Image to Gray Scale Image, Gamma Correction, Difference of Gaussian, Masking and Equalization of Normalization. The pre-processing is an efficient method through which the darkness from the image is removed, still preserving the necessary information from the input image for further processing of feature extraction. Fig.1. shows the sequential steps of the effective preprocessing chain used in this paper as it is the first step in eliminating the noise or darkness from the input face image.

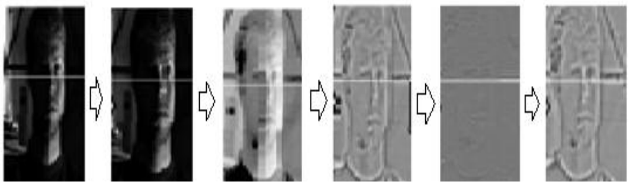

Figure2. Sequence of Image Pre-processing Chain

A. Input image

The Input Images in Image Pre-processing Chain has the dimension of 150 x 130 which has been taken from the Yale–B database which is subjected to different variations. One input face image is projected to ten different illumination variations. Apart from the Yale–B dataset, the other test images which are RGB images are also considered for testing so that the image should be recognized even if the produced image is a RGB image.

B. RGB Image to Grayscale

The true color RGB image is converted to gray scale intensity level so that the pixels can be set to 0 and 1 instead of 0 to 255 colors. The reason for not considering the image as RGB image itself is that it becomes a hectic process for identifying the location of a pixel. This conversion also helps in eliminating the hue and saturation information still retaining the luminance.

C. Gamma Correction

Gamma correction is nonlinear gray-level transformation used to correct the power-law transformation phenomena which perform the transformation of an input image to its original appearance. This transformed gamma-corrected image is free from the darkness by compressing all the dark regions into bright regions. It replaces the original gray-level I with $I\gamma$ by considering $\gamma > 0$, but lies between 0 and 1 (i.e., $\gamma \in [0, 1]$). The underlying principle behind the gamma correction is that the intensity of the light reflected from an object is the product of the incoming illumination and the local surface reflectance. Here, the obtained image after gamma correction should be an illumination free image. The gamma value from 0 to 1 is considered to be a full log transformation which is very strong to convert the dark regions. Hence the value of γ can be range from [0, 0.5] and by default the value of $\gamma = 0.2$ is to be considered. Fig.3 shows the image and a histogram after gamma correction.

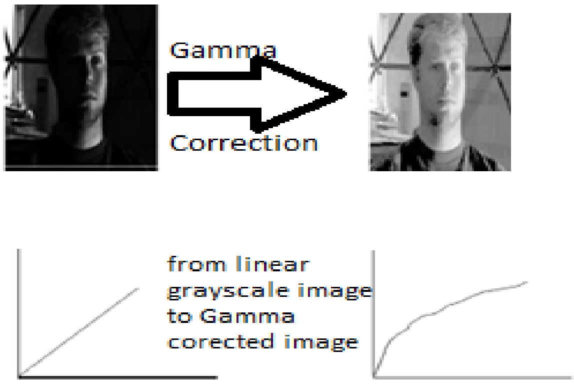

Figure3. Gamma Corrected Image and its corresponding histogram

D. Difference of Gaussian

Gamma Correction does not remove the complete darkness, but, the local shadings can be removed by applying the high-pass filtering thus by simplifying the recognition problem. The high-pass filter attenuates low frequencies while passing high frequencies so that the edges of the image become sharper. Hence by implementing the filters using explicit convolution, boundary effects can be minimized. The process of convolution creates the mask from pixel to pixel in an image and thus computes the predefined quantity at each pixel. In order to significantly reduce the performance of the boundary conditions, Forward Fourier Transform (FFT) is utilized. Thus by establishing this filters, obviously produces a good result for the recognition of the features. Gaussian filters are the special analysis tools which are easy to manipulate.

Utilizing the characteristics of Gaussian function, the gamma corrected image generates the informative image using the difference between the two Gaussian filters according to the local contrast information of the images. The two Gaussian filters with the variances $\sigma 1 = 1.0$ and $\sigma 2 = 2.0$ by default (always $\sigma 1 < \sigma 2$) can be considered. Though gamma correction produces an informative image, still without DoG filtering, the resulting images suffer from reduced local contrast in shadowed regions.

E. Equalization of Normalization

The last step of the pre-processing chain is the equalization of normalization which rescales the image intensity, thus highlights the most of the information by preserving the essential elements of visual appearance.

F. Histogram and Computation Time

The difference between the input face image's histogram before and after the proposed pre-processing stage is shown in the Fig. 4. This illustrates clearly how important the preprocessing to be done in order to reduce the unwanted noise or the highly variable lighting differences from the images to get the fruitful information for extracting of the features for the agent.

Run time is considered to be very important. The computational time taken by the Matlab 7.4 is only about 60ms for 150 x 130 dimension image.

V.SUBSPACE FEATURE EXTRACTOR

A.BDPCA+LDA

This section proposes a fast feature extraction technique, Bi-Directional PCA plus LDA (BDPCA+LDA), which performs LDA in the BDPCA subspace. Compared to any subspace feature extraction method, BDPCA+LDA requires less computational and memory needs and can achieve competitive recognition accuracy. Apart from the various challenges that already addressed in preprocessing, this framework addresses singularity, over fitting and robustness.

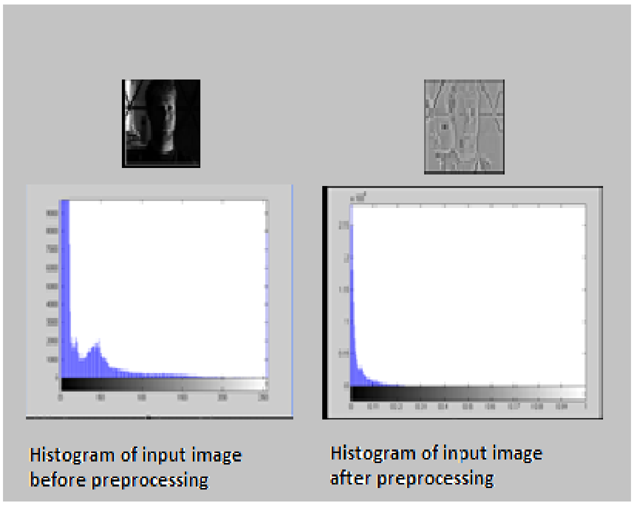

Fig.4. Difference between the histograms before and after preprocessing of the image under dim light condition

B. The Classifier

The classifier considered in this paper is a subspace classifier, the most existing method – Fisher Liner Discriminate (FLD) that classifies unlabeled features based on their similarity with features in their training sets. Fisher's linear discriminate is a classification method that projects high-dimensional data onto a line and performs classification in this one-dimensional space. The projection maximizes the distance between the means of the two classes while minimizing the variance within each class. This defines the Fisher criterion, which is maximized over all linear projections, *w*: where *m* represents a mean, *s*2 represents a variance, and the subscripts denote the two classes. In signal theory, this criterion is also known as the signal-to-interference ratio. Maximizing this criterion yields a closed form solution that involves the inverse of a covariance-like matrix. This method has strong parallels to linear perceptrons that significantly improves the results.

VI.CONCLUSION

The main technical contribution of this research is improving the recognition rate with less complexity and faster time-process. The approach in this work is primarily to reduce the error rates by using preprocessing techniques and recognizing using subspace methods. A new subspace framework is used in this paper for better recognition. The subspace framework applied to this work would give significant results. This proposed approach would reduce the ERR of the subspace methods.

FUTURE WORK AND EXTENSIONS

Much research attempt around the world is being practical to increasing the accuracy and ability of recognition domain. The recognition technique helps us to recognize the human faces, which is helpful to increase security. Face detection done in real time. The face of the person is being recognized at various poses, illumination and the expression of person. The face database should be able to store around 3000 – 5000 faces. The accuracy in case of face recognition is always the question mark. In a future work we will try to boost percentage of correctly recognition for real time frame moving face discovering and identifying automation system. We also amplify the performance for the larger databases to recognize the human faces. In future we can also develop Mobile authentication (application which can work on mobile phones), IR-based technology can be used to achieve superb accuracy.

REFERENCES

1. Janarbek Matai, Ali Irturk and Ryan Kastner, "Design and Implementation of an FPGA-based Real-Time Face Recognition System", IEEE International Symposium on Field-Programmable Custom Computing Machines 2011.
2. Mohammad Said El-Bashir, "Face Recognition Using Multi-Classifier" Applied Mathematical Sciences, Vol. 6, 2012, no. 45, 2235 – 2244.
3. K.Padmaja and Dr.T.N.Prabakar M.Tech., Ph.D "FPGA Based Real Time Face Detection using Adaboost and Histogram Equalization" IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM -2012) March 30, 31, 2012.

AUTHORS PROFILE

K. Veeramanikandan is Assistant Professor at V.R.S. College of Engineering & Technology, Villupuram .His Qualification is M.E, MBA. His research area is Image Processing & Bio-Medical.

R. Ezhilarasi is Assistant Professor at V.R.S. College of Engineering & Technology, Villupuram .Her Qualification is M.E. Her research area is Data Mining. She has published one international journal.

R. Brindha is Assistant Professor at V.R.S. College of Engineering & Technology, Villupuram. Her Qualification is M.Tech. Her research area is Software Engineering.