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# Face Recognition and Detection using Viola-Jones and Cross Correlation Method

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**Abstract:** ***The face detection is process of detecting region of face from a picture of one or multiple persons together. The detected face is extracted in the proposed using the viola-Jones algorithm. The viola-Jones algorithm is considered effective in order to mark and extract the face features. The proposed model is using the correlation model for the purpose of the face recognition. The face recognition process can detect the person among the database of faces without knowing any other details about the person specific. The proposed face detection and recognition model can be deployed anywhere it is required. The results have shown the effectiveness of the proposed model.***

**Keywords:** Viola Jones, correlation, face detection, face recognition

## 1. Introduction

Face detection is a technique what refer to the detection of the face automatically by digital camera. Face Recognition is a term used for recognition of a person automatically by computerized systems by taking a look at his/her face. Face detection is a popular feature used in biometrics, digital cameras and social tagging. Face detection and recognition has gained more research attentions in last some years. There are many good uses of this face detection and recognition feature. It can be used as biometric authentication. It can be used in digital camera for best picture contrast. It can be used for social tagging. Biometric systems are the automatic methods of recognizing a person based on a physiological or behavioral characteristic. Major authentication methods used are as following: Like passwords, PIN, smart card, token or card key, finger print, finger vein. Face detection is an almost unique biometric identity. There are very few chances of having two similar faces. So it can be used in the biometric identity based authentications systems. For security hardening it can used in combination with smart card or key card. Face detection is very important feature in digital cameras and social tagging. In digital cameras, Face detection is used because it controls the contrast on face in the clicked picture and can also help to view the clearer face than the click without face detection. In social tagging, face tagging is used to tag the people in the picture or post.

In existing face detection algorithms, various face detection algorithm methods use various face detection methods like knowledge-based method, feature invariant approaches, template matching method and appearance based methods. In this proposed algorithm we are using template matching face detection method. Knowledge based methods uses the already programmed characteristics to detection the face, whereas appearance based method learn the face shapes by reading various training templates. Feature invariant method uses the object features for the feature detection in an image. Template based method uses the active template comparison, which provide the most accurate results in case of face detection.

Face recognition is used in many applications such as security systems, credit card verification and criminal identification. Due to numerous potential applications face recognition has become a very active research area. In surveillance system if an unknown face appears more than one time then it is stored in database for further recognition. In general, face recognition techniques can be divided into two groups based on the face representation they use appearance-based, which uses holistic texture features and is applied to either whole-face or specific regions in a face image and feature-based, which uses geometric facial features (mouth, eyes, brows, cheeks etc), and geometric relationships between them. Face recognition is the art that compares the similarities of a face under test and the database image based on biometric features that are constant throughout the life of an individual irrespective of age and environmental conditions.

In signal processing or image processing, there are a number of methods for template matching are used for various purposes. In example of Google image search, the algorithm used is a image template matching algorithm. In speaker detection application, there are various voice template matching algorithms are used for various properties of voice. All of these template matching techniques consist of various small feature code segments. These feature code segments may offer noise reduction, light normalization, computer vision anti blurring, feature extraction, feature analysis or feature detection. Out of these all template matching features, the popular among all is cross correlation and there are various cross correlation algorithms used for the template matching. There are normalized cross-correlation and generalized cross-correlation. Normalized cross-correlation for image-processing applications in which the brightness of the image and template can vary due to lighting and exposure conditions, the images can be first normalized. This is typically done at every step by subtracting the mean and dividing by the standard deviation. Image cross-correlation compares two image matrices based on various mathematical techniques. Cross correlation in images can be based upon various image characteristics like color patterns, color pixels, matrix coordinates, etc.

## 2. Literature Review

C. Saravanan have worked upon an algorithm for Face Matching using the Cross Correlation with normalization features. This paper proposes a face matching algorithm that allows a template called extracted face of person which is the Region of Interest from one image and start search for matching with the different image of same person taken at different times, from different viewpoints, or by different sensors using Normalized Cross-Correlation (NCC). Zhiwei Zhang and Dong Yi have worked on regularizing the transfer boosting for face detection across spectrum. In this research, authors have proposed a face detection technique to tackle the issue of multispectral face detection by proposing a combination of existing large scale visible face images and a few multispectral face images. They have cast the problem of face detection across spectrum into the transfer learning framework and try to learn the robust multispectral face detector by exploring relevant knowledge from visible data domain. Xinjun Ma et. al. have developed a face detection algorithm based on modified skin-color model. In this paper, Authors have proposed an improvement in the traditional skin-color model by experiments and apply the proposed model to design a fast eye location algorithm on frontal view face. Additionally, authors have used the limited distance of face and the camera and finally realized passive face detection related to the distribution of skin-color and the distance of two eyes. Different from the conventional methods, this algorithm makes full use of the relationship between the distance of two eyes and the distance between face and camera to assist in face detection, it devises a feasible way to promote efficiency in lip-reading and other non-specific face recognition applications.

Zakaria Z. and Sunandi S.A. have worked upon the face detection using combination of Neural Network and Adaboost. This paper presents a combination of two well known algorithms, Adaboost and Neural Network, to detect face in static images which is able to reduce the false-positives drastically. This method utilizes Haar-like features to extract the face rapidly using integral image. A cascade Adaboost classifier is used to increase the face detection speed. Due to using only this cascade Adaboost produces high false-positives, neural network is used as the final classifier to verify face or non-face. For a faster processing time, hierarchical Neural Network is used to increase the face detection rate. El-Bakry H.M. and Hamada M. have developed a fast principle component analysis for face detection using cross-correlation and image decomposition. This approach is developed to reduce the computation steps required by fast PCA. The principle of divide and conquer strategy is applied through image decomposition. Each image is divided into small in size sub-images and then each one is tested separately by using a single fast PCA processor. In contrast to using only fast PCA, the speed up ratio is increased with the size of the input image when using fast PCA and image decomposition. Simulation results demonstrate that our proposal is faster than the conventional and fast PCA.

## 3. Experimental Design

The system begins with the image acquisition process in which the image is loaded in the MATLAB, which has to be used with the new algorithm. The face detection method is used to detect and extract the face from the image to perform the further computations. The ROI has to be perfectly fetched out of the loaded image to get the better results. The next step is to detect the person after the face region extraction from the original image. The face recognition is the process used to identify the people by analyzing their face properties automatically using computer driven algorithms. The cross correlation mechanism will be used for the face recognition process. The face recognition technique will produce the results by matching the face features (low-level, color based and shape based features) with the template database.

## 4. Simulation Environment

The details of implementation of the proposed model have been discussed under this chapter. Firstly, the proposed model has been developed using the MATLAB simulator. The results have been obtained from various aspects.

| | |
|---|---|
| CPU | Intel Dual Core 1.7 GHz |
| RAM | 2 GB |
| HDD | 80 GB |
| Operating Systems | Microsoft Windows 7 |
| Software | MATLAB v11 onwards |
| Programming Language | Traditional MATLAB Programming |

**Algorithm 1: Voila Jones for Face Detection**

1. For the first stage in the cascade Viola-Jones advices constructing a simple pre-screening filter containing template features.
2. Encode the most fundamental differences between the faces based on the Template features
3. Match the training set and the testing set used for training/demonstration
4. Draw final decision regarding primarily the positive training set and secondly also the negative training set.

The following is the face matching algorithm for matching the extracted face with the different images of same person, which are taken at different times, from different viewpoints, or by different sensors.

**Algorithm 2: The face recognition system**

1) Read the source image, and Extract the ROI from the source face image. ROI will be the sub image, and must be smaller than the Target image.
2) Do Normalized Cross-Correlation and find Coordinates of Peak with the ROI and Target images. Calculate the normalized cross-correlation and display it as a surface plot. The peak of the cross-correlation matrix occurs where the sub images are best correlated.
3) Find the total offset between the images. The total offset or translation between images depends on the location of the peak in the cross correlation matrix, and on the size and position of the sub images.
4) Check if the face is extracted from the target Image. Figure out where face exactly matches inside of target image.

5) Pad the face image to the size of the target image using the offset determined in step 3.
6) Use Alpha blending to show images together. Display one plane of the face image with the target image using alpha blending.

## 5. Result Analysis

The following systems were implemented using MATLAB 2012a and tested on an Intel Core i3 with 4GB of RAM running Windows 7. This platform should be considered as the minimum hardware requirement since the face detection and recognition algorithms could have been modified for increased accuracy on a more powerful testing platform. Automated face recognition has become the holy grail of computer vision artificial intelligence. It is probably the most challenging and ambitious of the computer vision projects that are being studied and is not just a fascinating theoretical problem, but there is a real-world need for such a system. This section of thesis represents some computational results of our proposed program. In Experimental result-image 1 and Experimental result- image 2, both test image and equivalent image which is stored in database have same pose. But test image and equivalent image have different in pose which are shown in Experimental result-image 3 and Experimental result- image 4.

**Figure 1:** Testing Images from the proposed face recognition model

400 images from 20 test subjects were obtained to test the above systems. The data for testing the fully automated face detection system, manual face detection and automated face recognition system and the fully automated face detection and recognition consists of mulitple frontal view images per test subject. The first image was taken under 'good' conditions with relatively constant lighting conditions on a white background. This would be used as the known frontal view face image in the face recognition system. The environment condition of the image was categorised by the researcher as 'A'. The other frontal view images were taken under worsening conditions with adverse lighting conditions and sometimes with a black background. These would be used as test images for the frontal view face recognition system. An effort was made to vary the lighting as much a possible in the environment which the images were gathered to test the systems' robustness. The environment condition of the image was categorized as 'B'. Data for the pose invariant face recognition was gathered as follows. Nine known images from each individual were collected and three (unknown) images taken when the subject was posing in intermediate angles between the nine known images. The nine known images were taken with the test subject posing as in figure 1, 2 and 3. Since pose invariant face recognition is not as robust as frontal view face recognition this data was gathered under very controlled conditions The images from test subjects had to be rejected since many of these had been very adversely affected by the automatic exposure of the digital camera used to obtain the face images. A subset of the face database can be found on the compact disk accompanying this thesis.

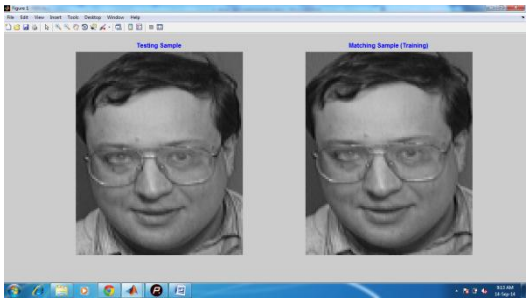


**Figure 2:** Results of the simulation of proposed model

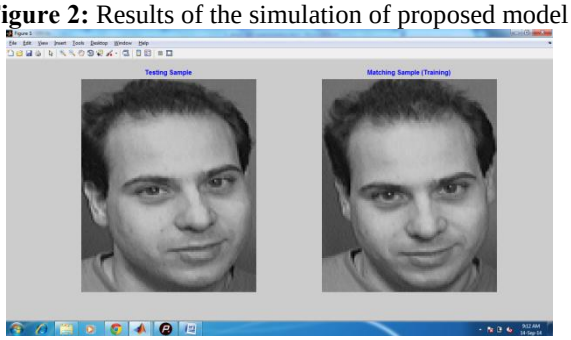


**Figure 3:** Results obtained from the proposed model.

Here correlation with the average face is used to verify the potential face locations proposed by the fully automated face detection system. Condition A and B images are as with the previous test. Condition of images Total tested Successful detection Failures

**Table 1:** Table of experimental Results in the mainstream application of proposed Hybrid approach using Cross correlation and Voila Jones (Face detection and recognition) for the routine face recognition practices

| Condition of Image | Total tested | Successful detection | Failures | Accuracy (in percentage) |
|---|---|---|---|---|
| A | 38 | 37 | 1 | 97.37 % |
| B | 95 | 92 | 3 | 96.84 % |

**Table 2:** Table of experimental Results of proposed Hybrid approach using Cross correlation and Voila Jones (Face detection and recognition) tested with the random samples in variable ranges

| No. of Person | No. of Photos Per Person | Total no. of Test faces | Total no. of Face Images with angle Taken for experiment | Success Rate For Hybrid approach using Cross Correlation and Voila Jones Approach |
|---|---|---|---|---|
| 5 | 4 | 20 | 5 | 91% |
| 5 | 4 | 20 | 10 | 96% |

| | | | | |
|---|---|---|---|---|
| 5 | 4 | 20 | 15 | 94% |
| 5 | 4 | 20 | 20 | 96% |
| 10 | 4 | 40 | 5 | 95% |
| 10 | 4 | 40 | 10 | 95% |
| 10 | 4 | 40 | 15 | 93% |
| 10 | 4 | 40 | 20 | 95% |

## 6. Conclusion

The computational models, which were implemented in this project, were chosen after extensive research, and the successful testing results confirm that the choices made by the researcher were reliable. The system with manual face detection and automatic face recognition have proved to be with recognition accuracy over 95% even after a wider number of face images that were used for the training purposes. This system was tested under very robust conditions in this experimental study and it is envisaged that real-world performance will be far more accurate.

The fully automated frontal view face detection system displayed virtually perfect accuracy and in the researcher's opinion further work need not be conducted in this area. The fully automated face detection and recognition system was not robust enough to achieve a high recognition accuracy. The only reason for this was the face recognition subsystem did not display even a slight degree of invariance to scale, rotation or shift errors of the segmented face image. This was one of the system requirements identified in section
The implemented fully automated face detection and recognition system could be used for simple surveillance applications such as ATM user security, while the implemented manual face detection. The frontal view face recognition scheme should display a recognition accuracy far better than the results, which were obtained in this study, which was conducted under adverse condition

## 7. Future Work

In this research, we worked with some still pictures but we will try to develop a system using video camera that will work with real time face recognition. Here we have used 400 face images of 20 random persons, but in future one may like to work with huge database than the one tested under this research project. A effort can be made to overcome the problem of different size face image recognition. Also a comparison for the performance analysis of the proposed model with other face recognition techniques like, the PCA based method or others existing face recognition methods.

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