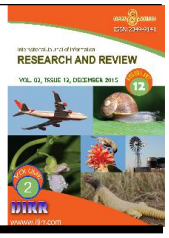
IJIRR

International Journal of Information Research and Review
Vol. 02, Issue, 12, pp. 1467-1471 December, 2015



Review Article

FACE RECOGNITION USING 3D MODELING

***Aaina Arora, Sameer Sharma and Dharmveer Singh Rajpoot**

Department of Computer Science Engineering, Jaypee Institute of Information Technology, Noida, India

ARTICLE INFO

Article History:

Received 12th, September 2015
Received in revised form
19th, October 2015
Accepted 03th, November 2015
Published online 30th, December 2015

Keywords:
Classification Algorithms,
Face Recognition,
3D Model,
Smoothing,
Feature Extraction.

ABSTRACT

In this paper, we did a review on some of the existing methods for classification and recognition of human faces. We have had a small discussion on a few algorithms like PCA, support vector machine, ID3, etc. and we have also discussed about some of the existing work done by my fellow researchers. We have also proposed a method for face detection using 3D modeling of image. We will produce a 3D face model then we do the refinement of 3D face we receive by editing of points and finally we perform a smoothing process. Smoothing of image is a performed to get the more realistic 3D face model for the person.

INTRODUCTION

Classification is a machine learning technology that maps data instances into predefined class labels which are used to estimate the data according to those Classes. A supervised learning algorithm examines the training data and constructs an inferred function, which can be used for depicting new examples. An ideal scenario will allow the function to accurately determine the class labels for new data. It will deduce to which a set of categories (sub-populations) a new instance belongs, based on training set of data containing observations (or instances) whose classes are known. The aim of classification is to precisely predict the target class for each sample in the data. For example: A classification model can be used to classify size of clothes as small, medium and large.

The new input samples are scrutinized into a set of calculable properties, known as explanatory variables or features. These properties can be categorical (e.g. igneous, sedimentary and metamorphic as types of rocks), ordinal (e.g. "high", "medium" or "low" credit risks in case of loan application), integer-valued (e.g. Counts the number of times a part of word in a file appears) or real-valued (e.g. a measurement temperature). Other classification models task is to compare current observations with previous observations by using a distance or similarity function. An algorithm that performs classification is called as a classifier.

Corresponding author: Aaina Arora,
Department of Computer Science Engineering, Jaypee Institute of Information Technology, Noida, India.

The term "classifier" is interchangeably refers to the mathematical function, constructed by a classification algorithm, that plot input data to a class. Some of the applications of classification algorithms are:

- Face Detection: Differentiating human faces from non-faces.
- Signature Recognition: Recognize signatures by structural resemblance which is difficult to evaluate.
- Customer Discovery: Speculate whether a buyer is likely to purchase certain items on the basis of the database of consumer profiles and their history of purchasing activities.
- Character Recognition: Determine handwritten characters, classify every picture of character in one of 10 labels '0', '1', '2' etc.
- Music Information Retrieval: It deals with the problem of enquiring and receiving some types of music from a huge music data set.
- Hand based gestures.

This paper is about Face Detection and we compared different approaches for face detection. Face detection is used to identify and locate the human faces in the picture or video under different pose, illumination, in-plane rotation, orientation and position.

Since face is the most important attribute in images and videos, it is used in various areas such as retrieval, video compression, security and recognition technology.

Classıfıctıon Algorıthms

- Linear Discriminant analysis: LDA (Linear Discriminant analysis) is an abstraction of **Fisher's linear Discriminant (FLD)**, an approach used in pattern recognition, machine and statistics to identify a linear combination of attributes that characterizes or isolate two or more classes of events.
- KNN: K nearest neighbors is a simple algorithm that saves all available cases and identifies new cases on the basis of a similarity measure.
- SVM: Given labeled training data under ***supervised learning***, the algorithm yields an optimal hyper plane which divides new examples.
- C4.5 : This algorithm develops a decision tree. The decision trees developed by C4.5 is used for classification, and this is why C4.5 is often known as a statistical classifier.

Motivation and Problem Statement

There are two major problems that we have explored under this topic.

- The illumination problem: Illumination problem is when a same face appears differently because of change in lighting conditions. This causes system to classify improperly the identity of the input image.The changing direction and energy division of the illumination, in conjunction with the 3D composition of the human face, can become one of the major difference in the shadows and shading on the face. These types of variations in the face impression can be enormous than the variation produced by personal identity.
- The pose problem: The pose problem comes into picture when the same face appears differently because of changes in viewing conditions. Normally, we use the frontal view face images of individuals in face recognition systems. Frontal view images carry more precise data of a face than other pose angle images. The issue arises when the software has to identify a rotated face from frontal view learning data. Multiple glimpse of an individual is needed in a face database to correctly recognize his identity. Furthermore, when illumination variation also comes into the picture, the business of face recognition gets even more challenging.

Literature Survey

Face Expression recognition is done in three steps face detection, feature extraction and expression classification. Face detection starts with preprocessing. The reason is to abstract a pure facial images with reduced intensity, normalized shape and size. The steps taken in modifying an image into a cropped pure facial image for feature abstraction is distinguishing feature points, locating and cropping the face(skin) region with the help of a rectangle. Identifying faces in a single image deals with four methods: Facial invariant, Knowledge based, Appearance basedand Template matching.

Detecting faces in images containing single face: Detecting the regions in pictures where faces can be present is the first step of face preprocessing. Face detection from an image containing only a single face is a very complicated task because of inconstancy in location,scale, pose, Facial expression, orientation, occlusion, and lighting surroundings temper the overall appearance of the face.The difficulties related to face detection occur due to the following major factors:

Figure 1. Steps in Face Detection

Existence of structural components: Face attributes like mustaches, beards and spectacles can or cannot be present in the image and moreover there exists a million of variability among these above defined components inclusive of shape, color, and size.

Posture: Because of the corresponding camera face posture (front view, side view, 45 degree), and many face attributes such the nose orthe eye might come partially or fully occluded.
Occlusion: Face could be partially hidden or occluded by another object.

Image orientation: Face pictures vary for varying rotations about the optical axis of the camera.

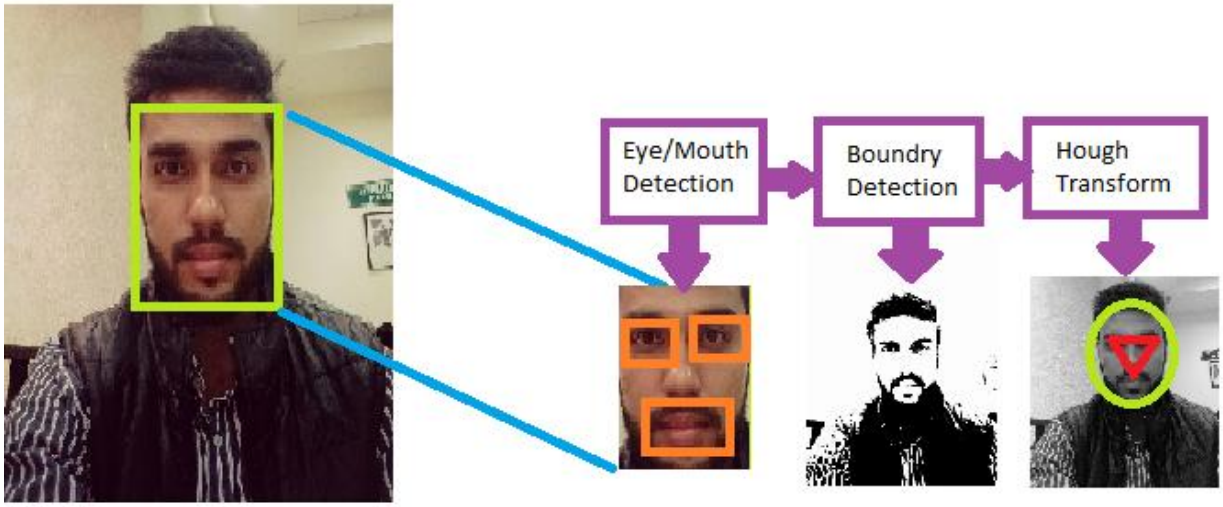
Localization of faces intent to finding the position of image in a single face. The aim of facial attributes detection is to discover the existence and location of features like nose, eyes,nostrils, eyebrow, lips, and ears.Face identification correlate an input picture with a database or gallery and address a match, if exists. Face expression identification identifies the intuitive states (happy, sad etc.) of individuals. Evidently, face detection is the former step in any computerized system which eliminates the above mentioned problems.

Face detection based on skin: When we build a skin color based model, we encounter three different issues: the first problem is to select the color space for modeling; the second issues is the environment illumination and calibration of the camera; the third and the last problem is the adoption of a mathematical model. All of these issues agitatethe optimality and the effectiveness of the skin color as cue. Skin color could be the easiest cue for detecting objects. It gives a fault tolerance way against the geometrical variation under a balanced and equally distributed illumination field. We can shorten the search just by preprocessing the input data and choosing only skin color like area. Performing Gamma encoding of image helps us to reduce the complexity of the image. It optimize the utilization of the bits when we transform the image.

Cho *et al*. (2001), who presented an adaptive skin color filter. The idea is to find the skinregions based on the wide range of skin color and thenfilter it to locate the face. Initially the range of colors weredecided from some sample images. For selecting the color we use HSV color space. Initially we take an upper and lower threshold values for all the color components manually by detecting the skin color distribution of many testing sample images. These values creates a 3D box called as threshold box. The color vectors inside this box act as a standard color vectors for skin color. This box is huge enough to contain all the skin color.This approach may fail if the face isn't the major skin-colored area on the image.

Face Detection in Colored Images

Color based face recognizing and detecting approach have an edge over other techniques in detecting faces in poor quality images.



But unfortunately they faces issues in skin color detection when the image have a complex background and uneven lightning effects. Rein-Lien Hsu, MohamedAbdel-Mottaleb and Anil K. Jain (2002) have proposed a method that is capable of dealing with wide variety of static colored images, having a nonlinear color transformation and lighting compensation technique. They first filter the color image using lighting compensation, then color space transformation, then skin color detection, then variance based transformation and finally connected component and grouping. And the second phase rejects the face candidates that do not have facial features like mouth, eyes and face boundaries. A detected face enclosed in an eclipse with an eye-mouth triangle is shown in figure.

3D Face recognition technology: The issue regarding face recognition is such as: Given static pictures or video, determining one or more people in the images by the use of a collected database consisting of faces Chellappa *et al*. (1995). The issue is substantially a problem of classification. The face detection system is trained with images of known individuals and then allot the unseen test data (pictures) to one of the classes.The issue of AFR (automatic face recognition) is a complex work which involves detecting faces even from a messy or crowded background, extracting out facial features, and face identification or recognition.

3D models of the face capture more data about the face such as surface information. Pose invariant detection is one of the major advantage of 3D modeling. Chua *et al*. (1997, 2000) popularized point signatures for characterizing the 3D landmark. He uses point signatures to depict the eyes, nose and forehead. When tested on a dataset having 6 subjects, his approach reached 100% recognition rate. Wang *et al*. uses point signatures for defining local points over a face. He implemented his approach over a dataset consisting of 50 subjects and his results proved that point signatures alone hit 85% recognition rate .However, if we combine both 2D and 3D landmarks, a recognition rate of 89% can be achieved.

Multiple face detection in color images

Techniques for face detection are basically divided into four broad categories namely template based (Ming-Hsuan Yang, 2002), knowledge based (Ming-Hsuan Yang, 2002) (Hemalatha and Sumathi, 2014), feature based (Ming-Hsuan Yang, 2002) (Hemalatha and Sumathi, 2014) (Rowley *et al*., 1998) and appearance based (Ming-Hsuan Yang, 2002) (Hemalatha and Sumathi, 2014) (Leung *et al*., 1998). Each algorithm have his pros and corns in terms of complexity, accuracy, efficiency, speed etc.

This paper works on feature based approach that segments image based on skin colored area having skin like color. Color based detection have advantages over other approaches when dealing with change in alignment/appearance of face, size of face in the image, etc. We have many different color models like RGB, HSV, YCbCr, YIQ (Chitra and Balakrishnan, 2012), etc. In this paper they have converted RGB into HSV for single face image and from HSV image hue plane is extracted. And for Multiple face image, RGB is transformed into YCbCr color space for separating the skin color region from non skin color portion. RGB has some disadvantages over other color model in clearly isolating the color and intensity. After conversion background separation, thresholding, Morphological operations (Mariusz Jankowski, 2006), Filtering, and finally Particle analysis is done over the image.

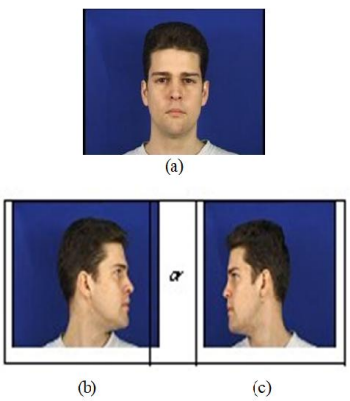
Face Detection by using PCA

Principal component analysis for face detection depend on the information theory method. It extracts the relative data from a face image and encode it efficiently. It then determinesthe subspace from the image space covered by the learned data of the face images and then extracts the pixel values. The advantage of PCA is applying it in Eigenface approach which reduces the size of the database for detection of test image. The image is saved as its feature vector in the database which is found to be projecting every learned image to the set of obtained Eigen face. For reducing the dimensionality of a big data set, PCA is applied on Eigen face method.

Proposed Method

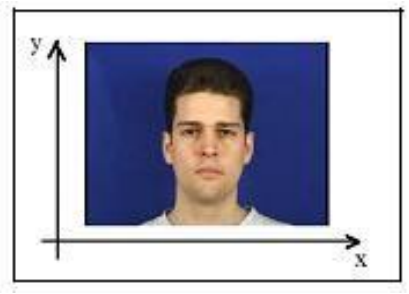
3D face recognition technology has the ability to produce better accuracy than its former techniques because it measures geometry of rigid attributes over the face. This reduces drawbacks of 2D face detection technology such as illumination issues, head orientation, make-up and different facial expressions. Our approach is to use the 3D modeling technique for enhancing accuracy of traditional image recognition system.Our algorithm has the ability to automatically or partially-automatically compose the 3D face model from front and side view of the face. Our algorithm comprises of the following steps:

Frontal View and Profile View: These two views of face are acquired in such a way that the horizontal distance of the side view and the front view is same (i.e.same pixel size). While taking the side view of the face, we should be cautious that side view is perpendicular to front view. Use pictures in an optional resolution (512x512 and higher).

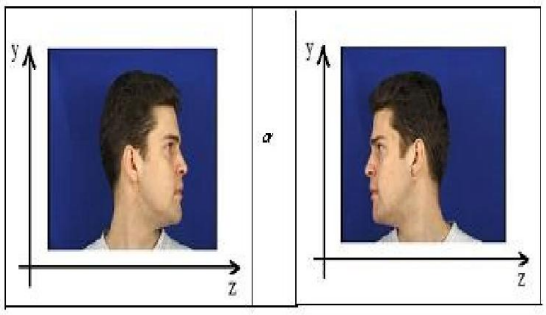


Face Extraction: Face is selected from the front view in a way that the vertical dimension by the side view and front view have to be same plus horizontal measurement of the side view should wrap the entire face. The face and its feature detection is to be performed in isolation for both images. Steps carried out to perform face extraction are:

Getting Coordinate across Projection of Frontal View (x, y): Bytaking the reference of left and right border of the image, x coordinates of the front view are taken from the extracted image and y coordinates are fetched from the bottom border. Every pixel of the front view is determined by the set of x and y coordinates.



Getting Coordinates across Projection of Side View (y, z): By taking the reference of right border of the picture, z coordinates are drawn out from the extracted picture of side view and y coordinates are captured from the bottom border. Every pixel of the side view is determined by the set of y and z coordinates. In order to identify the parameters from the side view of the image we used a median filter for smoothing out the segmentation result and for the reduction of the noise.



3D Model Creation (x, y, z): 3D coordinates captured from the above approach now represented in the3D spaces. This 3D plotting of x, y and z coordinates will represent the 3D face model. The important thing here is that the coordinate of both y_{side} and y_{Front} are the same. 3D face geometry construction is performed by transforming the predefined model on the basis of the parameters identified in this step and normal map texture creation and mapping and color texture.

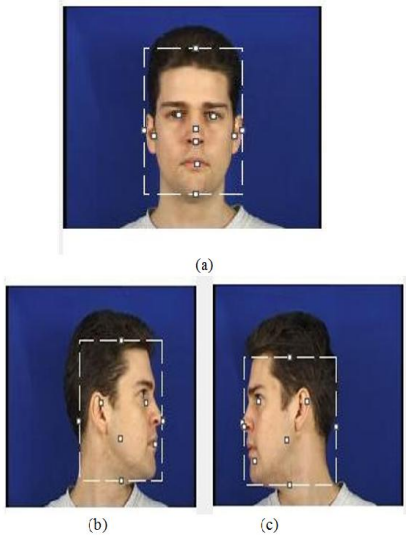
Construction of texture by YCbCr color space

Normal mapping

3D model Smoothing

After producing 3D model from the previous step image is cleaned and for a selected pixel and all its neighboring pixels are matched from 3D previous image. The amount of difference among pixels is accounted for smoothening of image. The image is transformed into YCbCr color model and for all the pixels Cb and Cr are calculated.

$Y = 0.299R+0.587G+0.114B$
$Cr = R-Y$
$Cb = B-Y$



Correction of points

X and Y coordinate deviations are taken into consideration as derivatives of the image function in corresponding directions respectively. Directional vectors are created from these derivatives and then computes image function normal as their cross product.

After then we normalize obtained normal and converts its coordinates into the RGB color space for saving it in the normal map texture. Finally, this will provide the 3D face model.

DataSets Used

Set of images containing faces in different illuminations and different orientations of head postures.

Conclusion

We concluded that 3D face detection rectifies the issues that occurred in the case of 2D face detection i.e. the illumination and the pose problem.
The 3D face recognition techniques are tested over a very small dataset. However, the datasets are increasing day by day since improvedacquisition stuff become available.

REFERENCES

Chitra, S. and Balakrishnan, G. 2012. "Comparative Study for Two Color Spaces HSCbCr and YCbCr in Skin Color Detection", published in Applied Mathematical Sciences, Vol. 6, no. 85, 4229 - 4238 .

Cho, K. M., Jang, J. H. and Hong, K. S. 2001. "Adaptive Skin-color Filter," Pattern Recognition, vol. 34, pp. 1067–1073.

Hemalatha, G. and Sumathi, C.P. April 2014" A Study of Techniques for Facial Detection and Expression Classification", published in International Journal of Computer Science & Engineering Survey (IJCSES) Vol.5, No.2.

Hsu, R. L., Abdel-Mottaleb, M. and Jain, A. K. 2002. "Face Detection in Color Images," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, pp. 696–706.

Leung, T.K., Burl, M.C. and Perona, P. 1998. "Probabilistic affine invariants for recognition," in Proc. IEEE Comput. Soc. Conf. Comput. Vision and Pattern Recogn, pp.678–684.

Mariusz Jankowski, June 2006. "Erosion, dilation and related operators ", published in 8th International Mathematica Symposium Avignon.

Ming-Hsuan Yang *et al*. 2002. "Detecting faces in Images: a survey", IEEE transaction on Pattern analysis and machine intelligene, vol. 24, no.1.

Rowley, H.A., Baluja, S. and Kanade, T. 1998. "Neural network-based face detection," IEEE Transactions On Pattern Analysis and Machine intelligence , vol. 20, pp. 23–38.

****