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Research Article

Human Face Recognition and Face Detection using Skin Colour Model

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Abstract

As one of the most successful applications of image analysis and understanding, face recognition has recently gained significant attention, especially during the past several years. Human face recognition play important roles in many applications such as video surveillance and face image database management. In this project, we have worked on face recognition techniques and developed algorithms for them. In face recognition the algorithm used is PCA (principal component analysis) using eigen faces in which we recognize an unknown test image by comparing it with the known training images stored in the database as well as display information of the person detected. This algorithms give different rates of accuracy under different conditions as experimentally observed. In face detection, we have developed an algorithm that can detect human faces from an image. We have taken skin colour as a tool for detection. This technique works well for Indian faces which have a specific complexion varying under certain range. We have taken real life examples and simulated the algorithms in MATLAB successfully.

Keywords*: Face recognition, Face Detection, PCA,Ycbcr, Eigen Face, MATLAB.*

1. Introduction

The face is our primary focus of attention in social life playing an important role in conveying identity and emotions. Computational models of face recognition are interesting because they can contribute to theoretical knowledge as well as to practical applications. Computers that recognize faces could be applied to a number of tasks including image and film processing, criminal identification, security system, identity verification, tagging purposes and human-computer interaction. Unfortunately, developing a computational model of face recognition is quite difficult because faces are complex, multidimensional and meaningful visual stimuli.

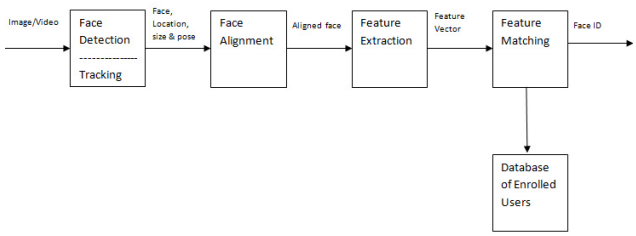

Fig.1 Face Recognition Processing Flow

Face detection is used in many places now a days especially the websites hosting images like picassa, photobucket and facebook. The automatically tagging feature adds a new dimension to sharing pictures among the people who are in the picture and also gives the idea to other people about who the person is in the image. In our project, we have studied and implemented a pretty simple but very effective face detection algorithm which takes human skin colour into account.

Our aim, which we believe we have reached, was to develop a method of face recognition that is fast, robust, reasonably simple and accurate with a relatively simple and easy to understand algorithms and techniques (Pallabi Saikia *et al*,2012; E.Prathibha *et al*,2012; Rabia Jafri *et al*,2009; Faizan Ahmad *et al*,2012).

2. Face Recognition

A **face recognition system** is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected image from the image in a database(Rabia Jafri *et al*,2009). The face recognition algorithm used here are Principal Component Analysis(PCA) using Eigen Faces (Faizan Ahmad *et al*,2012; Jawad Nagi *et al*,2008).PCA is the most simple and fast algorithm. **Principal component analysis** (**PCA**) is used to convert a set of observations of possibly correlated variables into a number of uncorrelated variables called principal components. PCA is mainly concerned with identifying correlations in the data. Correlation measures the simultaneous change in the values of two or more variables. The linear correlation is used here.

2.1 Mathematical approach

Let Γ1, Γ2, …, Γm be the set of train images.

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Average face of set can be defined as $\Psi=(1/M)\sum^{M}_{n=1}(\Gamma_n)$
Each face differs from the average by the vector $\Phi i = \Gamma i - \Psi$
when subjected to PCA, this large set of vectors seeks a set of M orthogonal vectors **Un**, which best describes the distribution of data.
The *k*th vector **Uk** is chosen such that
$\lambda k= (1/M) \sum^{M}_{n=1}[(U_k)^T * \Phi n]^2$
is maximum, subject to
$(U_l)^T U_k = \delta_{lk} = \{1, if\ l=k \quad 0, otherwise$

Consider a dataset where n parametric variables (x_1,x_2,..,x_n) were collected from m observations. The aim of PCA, hence, is to identify k < n (usually k = 2 or 3) new variables (that will turn out to be the principal components) that determine a large portion of the information stored in the data, by accounting for the highest covariations possible in it.
For simplicity, we will consider n = 3 variables, collected from m = 20 observations, so we can visualize the process of representing the initial variables and the procedure of identifying and visualizing the principal components. Table 1 presents the dataset in what is termed the score matrix.

Table 1 Example dataset, 3 parametric variables obtained for 20 observations.

Observation	V1	V2	V3
A	100	8	2
B	220	20	5
C	345	32	10
D	445	43	3
E	532	56	14
F	628	68	16
G	712	79	20
H	823	82	19
I	903	98	24
J	1023	112	31

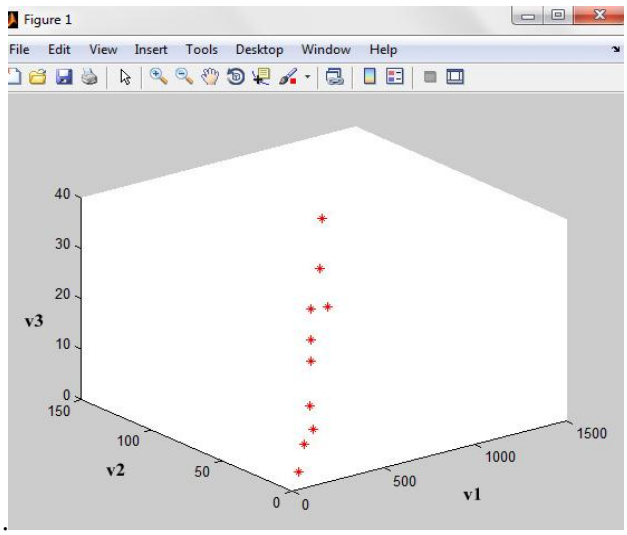

Fig. 2 Scatter plot of the example dataset. The X-axis is defined by V_1, the Y-axis is defined by V_2, and the Z-axis is defined by V_3

2.2 Testing and Evaluation

Fig. 3 Test Image

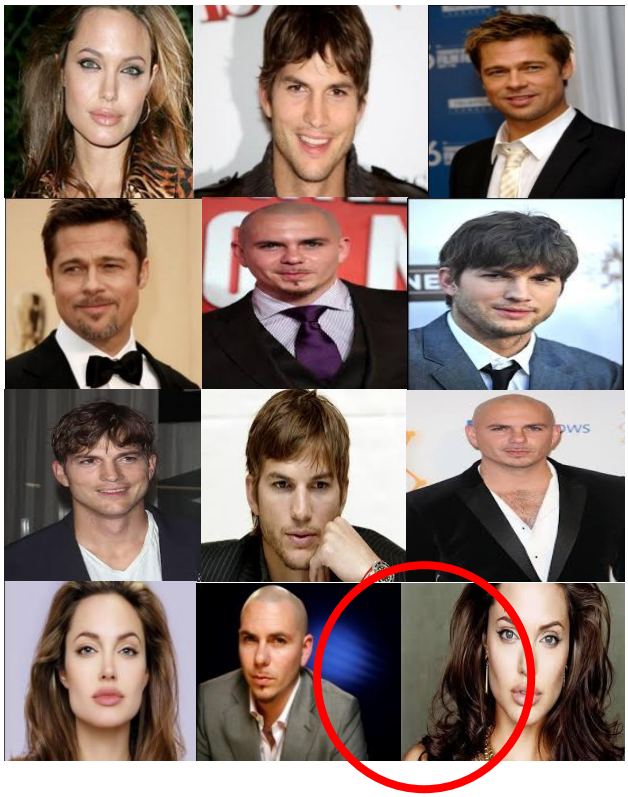

Fig. 4 Database Images

Fig.5 Test Image Equivalent Image

3. Face Detection

Face detection is one of the challenging problems in Computer Applications. The main part is to detect the face portion from the entire image. In this paper, we used YCbCr to detect the skin color of humans by setting appropriate thresholds. The reason for using this color model is to remove the illumination component, Y. We have proposed and implemented a method to locate the face portion of human by determining the number of holes in the skin region using Euler's method and also by taking eye distance.

Using the colour space of YCbCr, different algorithms for skin color detection have been proposed. Researchers mainly focus on the transformation of RGB color space to the small color space of YCbCr.The proposed model for face detection using skin color filter is shown in the figure 5(Pallabi Saikia *et al*,2012). The input RGB image is taken as input for the detection process. To detect the human face, the first and the foremost process is to detect the skin color. The pixel value of our skin color is unique. That's why using appropriate color filtering, proper skin detection can be done efficiently.

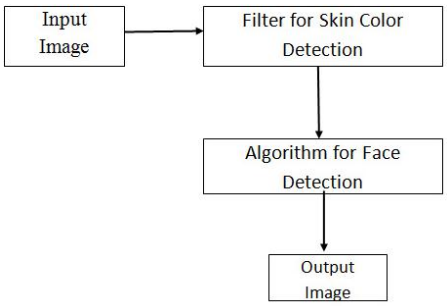

Fig 5 Face Detection Mode

YCbCr is a family of color spaces used as a part of the color image pipeline in video and digital photography systems. Y is the luma component and CBand CR are the blue-difference and red- difference chroma components. Y (with prime) is distinguished from Y which is luminance, meaning that light intensity is non-linearly encoded using gamma correction. The Y in YCbCr denotes the luminance component,and Cb and Cr represent the chrominance factors. InYCbCr, the Y is the brightness (luma), Cb is blue1minus luma (B _ Y) and Cr is red minus luma(R _ Y)(Pallabi Saikia *et al*,2012; E.Prathibha *et al*,2012).

The conversion of RGB to YCbCr is done by the equation given as :

$Y = 0.299R + 0.587G + 0.114B$

$Cb = B - Y$

$Cr = R - Y$

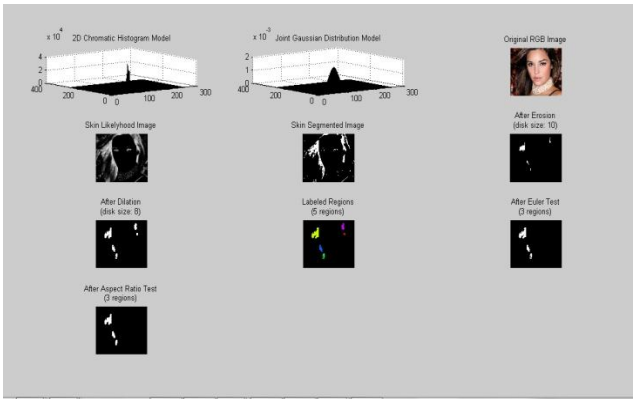

Fig 6 RGB color space to Ycbcr color space conversion

3.1 Result

In this section, a brief description about the experimental results is done. The programming environment used is Matlab2013a. First, the experiment is performed to detect the color of skin using skin color detection,Ycbcr model. We have performed the experiment for both single and many persons and achieved a satisfied result as shown in the two tables below.

Table 2 Accuracy of the system for single person

No. of Images	Positive Detections	Accuracy
100	96	96%
200	193	96.5%

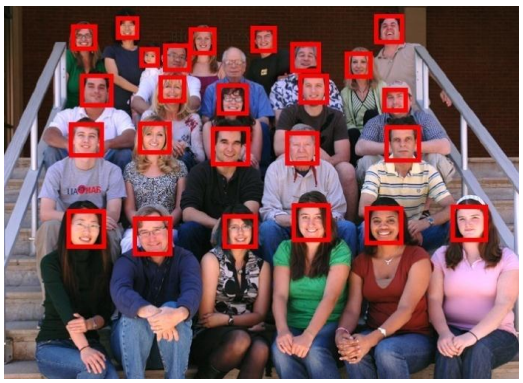

Fig. 7 Face Detection of more than one person

Table 3 Accuracy of the system for more than 1 person

No. of Images	Positive Detection	Accuracy
25	24	96%

Conclusion and Future Scope

The face recognition and detection algorithms were thoroughly studied taking a number of test images and varying the conditions and variables. The PCA for face recognition and Ycbcr for face detection are used and has shown effective results. The success rate was different for different images depending on the external factors. The overall success rate was 95%. This work can be used in future to enhance the accuracy of the system,like eliminating the factors affecting the system namely illumination and pose.

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