A Novel Technique to Detect Face Skin Regions using YC_bC_r Color Model

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ABSTRACT

A novel technique to detect face skin regions using YC_bC_r color model is proposed in this paper. Initially Viola Jones algorithm is applied to locate the face region, then image cropping and bounding box methods are used to detect and crop the face region. Finally, YC_bC_r color model is proposed to suppress the background objects like hairs or any scenery and to retain only the face skin region. The proposed method was implemented using MATLAB tool and tested on various real images captured by digital camera and the results are analyzed. It gives good performance on images with complex background and effectively detects the face skin region of different sizes, poses and expressions under different environmental conditions.

Keyword: - *Viola Jones, image cropping, bounding box, YC_bC_r color Model, MATLAB.*

1. INTRODUCTION

Digital Image processing has found a number of applications in various fields such as Biometric Identification, Medical Imaging, Remote Sense, Industrial Assessment and Agricultural Processing etc. Biometric Digital Image Processing refers to technologies for measuring and analyzing a person's physiological or behavioral individuality like Face Detection, Face Recognition, and Fingerprint Recognition, etc.

A biometric system is a pattern recognition system that makes a personal identification by determining the authenticity of a specific user. Generally, an automatic face recognition system is based on extracting a set of features from the user's face, either geometric characteristics or textures and shapes of human face. For a given human image, detecting the face region is the most important step in the face recognition system [1].

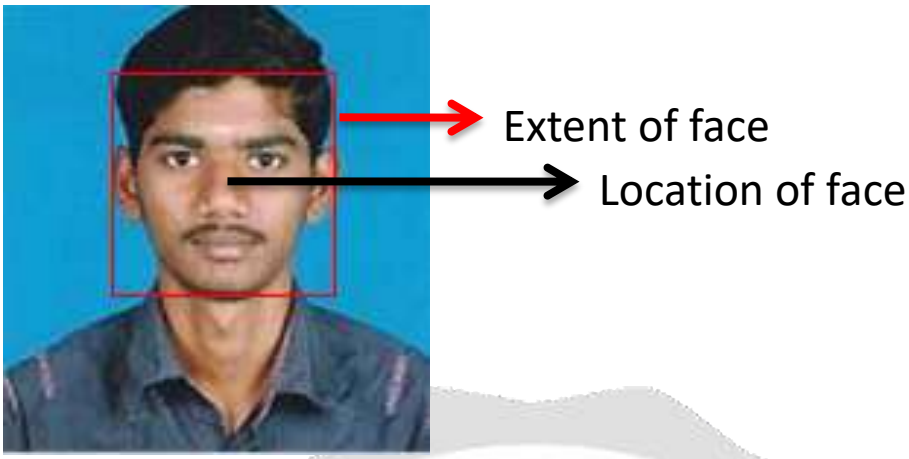


Fig -1: Face Region Detection

Human face detection is an important research area having wide applications in Public security, Electronic commerce, Video conferencing, Smart cards, Law enforcement & surveillance, human machine interface, advertisement industry, content-based image retrieval, gesture recognition, crowd surveillance and face recognition, entertainment services, etc. Face Detection is a challenging task due to the following factors: Textual differences among the faces, Pose, Facial expressions, Orientation, Facial size, Illumination conditions, Cluttering, Occlusion, Gender, skin tones and changes in surroundings, and RST (Rotation, Scaling and Transformation). Scene changes can also be detrimental to face detection since a background can be simple as well as complex [2].

Face detection techniques can be classified into Template Matching Method, Knowledge Based Method, Feature Invariant Approach and Appearance Based Method [4]. Face detection techniques include Detecting faces in the images with mono-color (controlled) background, Detecting faces by color, Hybrid Algorithms, Finding faces by motion, Skin color model for Face Detection and Viola Jones Face Detection [5].

The existing Viola Jones Face Detection algorithm combined with skin color segmentation using YC_bC_r color model is proposed to detect the face regions in this paper. The main purpose of selecting a color model is to eliminate the unwanted regions like background and hairs from the face region.

The paper is organized as follows: In Section II different types of Face detection techniques are reviewed. A novel technique to detect face skin region using YC_bC_r color model is proposed in Section III. The results are analyzed in Section IV. Finally the conclusion and the future direction of work are made in Section V.

2. LITERATURE SURVEY

A literature survey on Digital Image Processing Techniques to detect face regions from the human images is provided below:

RosaliMohanty (2016) et al., proposed face detection technique by using multi-color space based skin segmentation and region properties. First, skin regions are extracted from an image by the application of group of color models RGB, HSV and YC_gC_r and thresholding concept. Then facial features are used to locate the human face based on the knowledge of geometrical properties of human face by testing each segmented skin region [6].

Narayan T.Deshpande (2016) et al., proposed a technique to recognize human face by calculating the features present in the image and identifying the person using these features. Face detection and identification is performed in two stages. In the first stage, attendance of face in a given image is detected using Viola-Jones algorithm and in the next stage, the detected face is identified using Linear Discriminative Analysis (LDA) and Artificial Neural

Network (ANN). The Viola- Jones algorithm with fusion of ANN and LDA provided an identification accuracy of 92%. This method provides better identification accuracy in comparison with the other existing methods [7].

NeetuSaini (2015) et al., presented a multiple face detection algorithms in color images. The First algorithm combines HSI and YC_bC_r color models along with morphological operations. In the second algorithm, RGB color model with Viola-Jones algorithm is used. It is observed that the first algorithm is suitable for simple background and different lightening conditions of images and the second algorithm is suitable for simple as well as complex background of images [8].

Rajeshwari D G (2015) et al., presented Viola Jones classifier method, Background subtraction method and skin color detection on HSV color spaces. The Viola Jones classifier method gives good results for detecting frontal faces but for finding faces in motion, it takes more time to detect and does not give accurate results. Background subtraction method and Skin color detection on HSV color space are more efficient compared to the first method by giving accurate results for detecting faces in motion [2].

Wen-cheng Wang (2015) et al., proposed an approach that realizes the face detection through the combination of skin color segmentation and geometric features. Firstly, some common color models are analyzed, and a huge amount of skin images are used to create an YC_bC_r color model for region segmentation. Then, the morphological processing is executed on the binary image, and the facial regions' filtering is conducted by adopting some geometry constraints such as Euler number, the ratio of width and height, centroid. Finally, the face region is placed and labeled with a rectangle [9].

AnishaAnchit (2014) et al., presented a comparative analysis for face detection in Haar Classifier and Skin color detection method. Using Viola Jones the Haar detection rate for the facial features like nose, eye and mouth is calculated. The efficiency achieved by Haar for face is 89.42% which is higher than 84.61% from skin color model is 84.61%. But the speed of skin color model is faster than that of Haar[10].

Divya (2014) et al.,used different color spaces (RGB, HSV, and YC_bC_r) to identify the color model suitable for human skin detection. YC_bC_r color model gives an efficient output compared to RGB and HSV skin color detection methods. [11].

Mehul K Dabhi (2013) et al., presented Haar feature based Adaboost algorithm to extract the facial region from the image [12].

KamathAashish et al., presented a face detection comparative methods. The methods are Viola-Jones and Kanade-Lucas-Tomasi. Viola-Jones method gives better detection rate compared to kanade-Lucas-Tomasi method in looking front, left, right, up and down portions of the image [13].

From the review of various research works, it has been identified that the Viola Jones algorithm enriched with YC_bC_r skin color segmentation technique can locate and detect the face regions from the human image with higher efficiency.

3. METHODOLOGY AND PROPOSED WORK

Detection of face skin region from the human image contains two main tasks. First, face region is located and detected from a human image. Then suitable color model is applied to segregate the human face skin region. The result of the proposed research work is the extraction of face skin regions from the human image using YC_bC_r color model. The frame work of the proposed research work is shown in Fig -2.

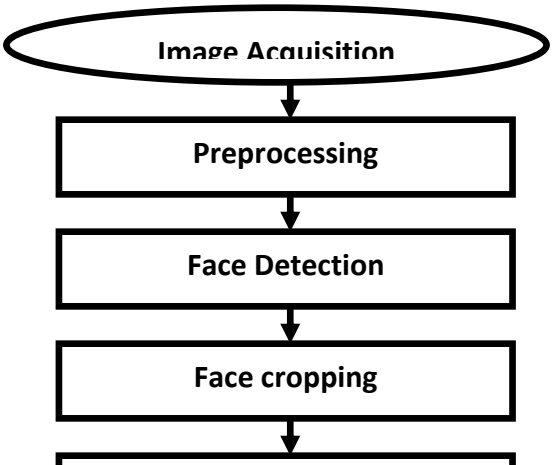


Fig -2: Framework of the Proposed Face Skin Region Detection

3.1 Image Acquisition

The images are obtained by high-quality digital camera. The images captured by the digital camera should have the face of the human being, which should be a single image. The acquired image will be in RGB color model stored in jpg format with different sizes. For computational efficiency, all the images are resized into 400×200.

a) Original Image of Size 259 × 344 b) Resized Image of Size 400×200

Fig -3: Image Acquisition

3.2 Pre-Processing

The aim of pre-processing is to improve the image data by suppressing the unnecessary distortions or to enhance some image features significant for further processing. In Pre processing phase, Median Filter is applied to reduce the noise of an input image. All pixels arranged in an ascending order of intensity values and the intensity value of center pixel is taken as a median value. Then all pixels are replaced with the median value. The preprocessed image is shown in Fig -4.

a) Original Image b) Noise Smoothened Image

Fig -4: Preprocessing

3.3 Face Detection

The input image may have number of objects in its background like human, tree, dog, buildings etc. Paul Viola and Michael Jones presented a fast and robust method to detect faces with 95% accuracy and less computing time. This face detection framework is capable of processing images extremely rapidly while achieving high detection rates.

In MATLAB, the function vision.CascadeObjectDetector() creates a System object called detector to detect items. The cascade object detector is used to distinguish people's faces, noses, eyes, mouth and upper body. By default, the detector is configured to detect faces. The function, BBOX = step (detector, I) displays a bounding box that contains the detected object. This method performs multi scale object detection on the input image. Each row of the BBOX contains four-elements x, y, width and height where (x,y) specifies the co-ordinates of upper-left corner and size of a bounding box is specified by the width and height values. The input image must be a grayscale or true color (RGB) image.

Fig -5: Face Detected From Human Image

3.4 Face Cropping

Once face region is identified by the bounding box, CROP function is used to extract only the face region from the image. i.e., the regions other than face should be removed from the image. Cropping is the removal of unnecessary portions of an image to improve framing, accentuate subject matter or change aspect ratio. In this work, the cropping function imcrop() is used to crop the region covered by the bounding box from the input human image.

Fig -6: Face Cropped From Human Image

3.5 Skin Region

The inspiration to use skin color models for classification of an image into probable face and non-face regions comes from the fact that the color of human skin is different from the color of other natural objects of the world.

The cropped RGB face may have face regions as well as background objects like hairs. To detect only the face skin regions, the cropped image is converted into YC_bC_r color model to recognize the human skin color and texture of the image. YC_bC_r images require low processing time and yields better results and performance under changeable lightening conditions and illumination. YC_bC_r is the vital color space used for digital video encoding, where a color is represented by using brightness and two color difference signals. The YC_bC_r color space contains one luminance component (Y) and two chrominance components (C_b and C_r).

The intensity of the light is represented by 'Y' component. The intensities of the blue and red components relative to the green component are represented by 'C_b' and 'C_r' components respectively.

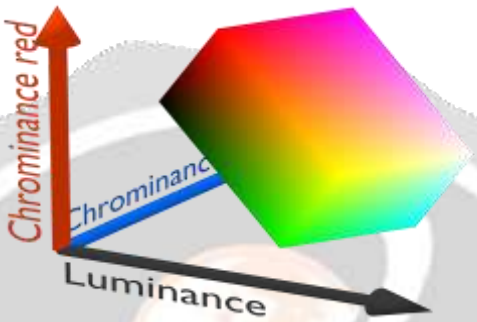


Fig -7: YC_bC_r color model

The purpose of using YC_bC_r color model is given as below,

- Human eye has different sensitivity to color and brightness. Thus there is the need to transform RGB to YC_bC_r.
- In contrast to RGB, the YC_bC_r color space is luminance independent, resulting in better performance.
- YC_bC_r is mostly utilized in video compression standards such as MPEG and JPEG.
- Y can be stored with high resolution or transmitted at high bandwidth, and two chrominance components (C_b and C_r) that can be bandwidth-reduced, sub sampled, compressed or otherwise treated separately for improved system efficiency.

Skin region Segmentation using YC_bC_r color model:

Step 1: Read RGB color image.

Fig -8: RGB Image

Step 2: Convert RGB image into YC_bC_r color space.

YCbCr = rgb2ycbcr (RGB) ----------1

Fig -9: YC_bC_r Image

Step 3: Classify the colors in YC_bC_r color space by using threshold value.

As per the definition of ITU-R BT.601 (International Telecommunication Union – Radio Communication), the range for luminance (Y) component is 16 to 235 and the range for chrominance (C_b and C_r) components is 16 to 240. Fig. 10 & 11 show the classification of C_b and C_r components in YC_bC_r image.

Fig -10: C_b Component of YC_bC_r Image

Fig -11: C_r Component of YC_bC_r Image

The range of C_b and C_r for the skin-color reference map has been identified as: $77 \leq C_b \leq 127$ and $133 \leq C_r \leq 173$ and used to find the human skin from different races [14].

Step 4: To cluster the images (Components of C_b & C_r).

The C_b & C_r components of the face region images are combined or clustered together to retain only the face skin region and to suppress the background details like hairs, etc. The extracted face skin region is shown in Fig 12.

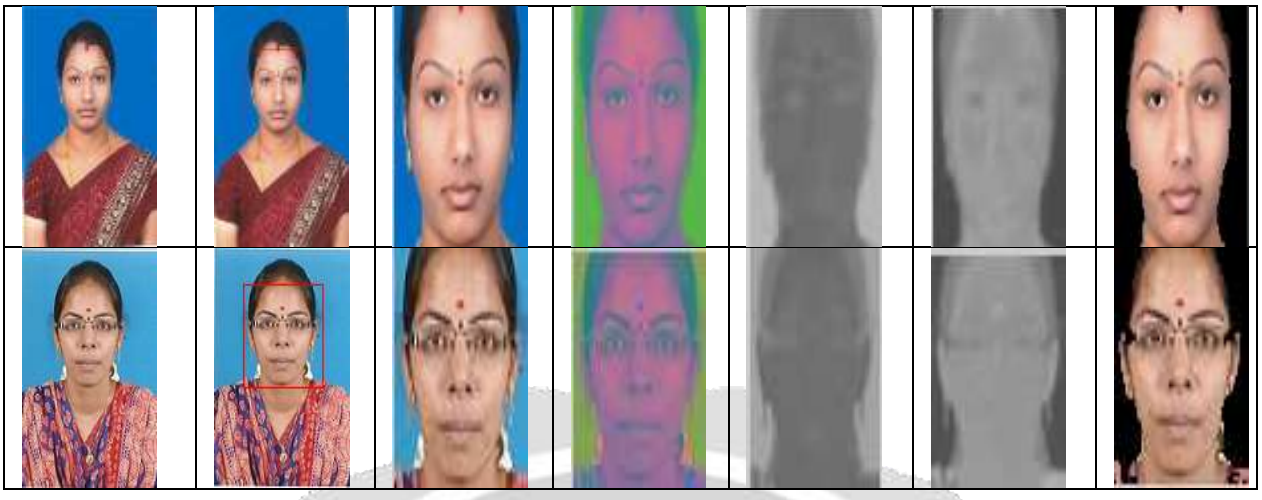
Fig -12: Face Skin Regions

4. EXPERIMENTAL ANALYSIS & RESULTS

In this research work, Viola- Jones algorithm is used to locate the face regions and cropped using crop function. Then face skin regions are detected by applying YC_bC_r color model. The proposed algorithm is executed on various input images and their outputs are shown in Table -1.

Table -1: Proposed Face Region Detection Technique

Original Image	Face Location	Face Cropping	YC_bC_r Color Space	C_b Component	C_r Component	Extracted Face Skin Region
						
						
						



5. CONCLUSION

In this proposed work, initially various face detection techniques are reviewed and analyzed. Viola Jones algorithm is applied to locate the face region, then image cropping and bounding box methods are applied to detect the face region and finally YC_bC_r color model is proposed to extract the face skin region alone from the background. The proposed system gives good performance on images with complex background and effectively detects the face skin region of different sizes, poses and expressions under different environmental conditions. From the extracted face skin regions the features can be extracted to recognize the faces and the system can be extended to detect multiple faces from the single image in future.

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