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Face Detection using L*A*B using Color Space

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ABSTRACT

This paper Human face detection is the preprocessing step in many applications from the captured images (or) videos. Mostly used surveillance cameras for crime investigation and other security purposes, research in biometrics etc. Face is dynamic object in high variations in pose, light, complex background, skin color, time complexity, appearance, eyes position etc. Face detection using L*a*b color transformation. skin and non skin analysis using binary segmentation. Absence of luminance component increases performance of the detection rate.

Key Words - Face Detection, Image processing, Binary segmentation.

1. INTRODUCTION

For a human vision system performing the process of face detection is an easy task compared to an intelligent machine. Face detection is used to locate faces in images. Face detection is an active area of research spanning disciplines such image processing, Pattern recognition and computer vision. Face detection and recognition are preliminary steps to wide of applications such as personal identity, video surveillance etc. the detection efficiency influences the performance of these systems, there have been various approaches for face detection, which classified into four categories viz (i) knowledge based method (ii) feature based method (iii) template matching method and appearance based method. There are several challenges in a face detection system as human face has varying posture, orientations, expressions and skin color. The first and foremost important step in any of these systems is the accurate detection of the presence and the position of the human faces in an image or video. There also exist some exterior factors such as compound backgrounds, occlusion, and quality of image and differing illuminating conditions. These all factors contribute extensively to the overall problem.

Human face detection has a wide range of application in biometric research. Most importantly is found to be useful in,

- identifying and authenticating users
- Looking up matching faces of human database in crime investigations
- Automatically detecting facial features to recognize to facial expressions
- Detecting of faces on still images and video streams in real time

The inspiration to use skin color analysis for initial classification of an image into probable face and non-face regions stems from a number of simple but powerful characteristics of skin color. Firstly, processing skin color is simpler than processing any other facial feature. Secondly, under certain lighting

conditions, color is orientation invariant. The major difference between skin tones is intensity e.g. due to varying lighting conditions and different human race.

Feature selection process play important role in face detection system. The process of feature extraction in face detection implies as skin color and morphological structure of human face. Human often uses faces to recognize persons and advancement in computing capability over the past few decades. The growth of face detection system is quite essential in a variety of application such as criminal surveillance and document verification etc. Face detection is technology to determine human face in videos and images. The aim of face detection is to detect faces in images in videos. This is the first step in many applications such as face recognition, facial expression analysis, content based image retrieval, surveillance system and intelligent human computer interaction. Therefore, the performance of these systems depends on the efficiency of face detection. Face detection is an easy task for a human, but still there is difficulties as faces are subjected to lots of variations of image appearance, such as pose variation (front, non- front), occlusion, image orientation, illumination and facial expression.In the early stage, face detection algorithms mainly focused to detect the frontal human face.

Many methods was implemented to resolve each variation. For example, template-matching methods used for face localization and detection by computing the correlation of an input image to a standard face pattern. The feature invariant approaches used for feature detection of eyes, mouth, ears, nose, etc. and appearance-based methods used for face detection with edge detection and neural networks. Many several face detection algorithms that are use neural networks, and support vector machine. For color images, various literatures shown that is possible to separate human skin regions from complex background based on either YCbCr or HSV color space. Nevertheless, implementing the methods altogether is still a great challenge.

Color is an important feature of human faces. Using skin-color as a feature to detect a face has several advantages. Color processing is much faster than processing other facial features. Under certain lighting conditions, background and color is orientation invariant. The color-based approach labels each pixel according to its similarity to skin color, and subsequently labels each sub-region as a face, if it contains a large blob of skin color pixels. Numerous research has been conducted for face detection based on skin color. Skin color in combination with the edge of the input image is used to detect the face to improve the detection accuracy can be found

Skin color has proven to be a useful and robust cue for face detection, localization, and tracking. Numerous techniques for skin color modeling and recognition proposed. Feature-based face detection methods using skin color as a detection cue, have gained strong popularity. Color allows fast processing and is highly robust to geometric variations of the face pattern. The method of skin detection falls into two main categories: pixel-based methods and region based methods. Pixel-based methods classify each pixel as skin or non-skin individually, independently from its neighbors. In contrast, region-based methods try to take the spatial arrangement of skin pixels into account during the detection stage to enhance the method's performance. Some popular examples of color spaces are RGB, Normalized RGB, YCbCr, HSI (Hue, Saturation,Intensity), TSL (Tint, Saturation, Lightness), HSV (Hue, Saturation, Value), HSL (Hue,Saturation, Lightness), as well as many others. The transformation simplicity and explicit separation of luminance and chrominance components make the YCbCr color space very popular. Many researchers believe that skin segmentation in the YCbCr space provides better results. The final goal of skin color detection is to build a decision rule that will discriminate between skin and non-skin pixels. The explicitly defined rules to build the skin classifier. The simplest model is to define a region of skin tone pixels in the YCbCr color space using Cr and Cb values.

Face detection using feature-based techniques depend on feature derivation and analysis to gain the required knowledge about faces. Features may be skin color, face shape, or facial features like eyes, nose, etc....Human skin color is an effective feature used to detect faces, although different people have different skin color, several studies have shown that the basic difference based on their intensity rather than their chrominance.. Some others use the blobs and the streaks instead of edges. For example, the face model

consists of two dark blobs and three light blobs to represent eyes, cheekbones, and nose.

2. RELATED WORKS

The color segmentation generates a binary mask with the same size of the original image. However some regions similar to skin also appear white: pseudo color pixels like clothes, floors, building etc. The goal of the connected component algorithm is to analyze the connection property of skin regions and identify the Face, which are described by rectangular boxes. It is necessary to remove the unwanted specs in order to speed future processing. Hence the open (erode followed by dialate) operation was performed using a structuring element. It was observed that the open operation has resulted in huge reduction in the number of small noisy specs.(Vandan s.Bhat,2014)

Once the face images are separated, template matching is used as not only a final detection scheme, but also for locating the centroid of the faces. The idea of template matching is to perform cross-covariance with the given image and a template that is representative of the image. Therefore, in application of face detection, the template should be representative face being either an average face of all faces in the training images, or an Eigen face. The template matching measures the level of similarity and concludes whether it is human face or not. The algorithm presented here uses a template face to determine if the segmented region that has at least one hole and a height to width ratio in the range of 0.6 to 1.2.(Vandan s.Bhat,2014)

Face detection is a visual task which can be done by humans without any effort but in computer vision this task is very difficult. Given a single image, detect and localize the number of faces regardless of pose, illumination and expression. Face detection is used for self-serviced immigration clearance, for person verification, security, image search and research is being done in the area of energy conservation etc. The goal of face detection is to identify and locate all of the human faces regardless of their positions, scales, orientations, poses and light conditions and this is a challenging problem because human faces are highly non-rigid with a high degree of variability of in size, shape, color and texture.(Rewar,2013)

Detection and recognition of faces are challenging because face has a wide variability in poses, shapes, sizes and texture. The problems or challenges in face detection are Illumination, Facial Pose, Facial Expression, Age Span, Motion, Occlusion, Image orientation, Image condition, Background Complexity, Environment Changes, Noise, Textural differences among Faces etc,..These are the most general problems that occur during face detection. The author can remove most of the drawbacks by increasing the efficiency and by applying the loops to get better results.(Rewar,2013) Face detection is an interdisciplinary field which integrates different techniques such as (i) image processing, (ii) pattern recognition, (iii) computer vision, (iv) computer graphics, (v) physiology, and (vi) evaluation approaches. In general, the computerized face recognition/face detection includes four steps. (i) Face image is acquired, enhanced and segmented. (ii) Face boundary and facial features are detected. (iii) The extracted facial features are matched against the features stored in the database. (iv) The classification of the face image into one or more persons is achieved. After acquisition of image, preprocessing operation is carried out. The unique features of the image are extracted with the help of different image processing algorithm. After the features are extracted, it is matched with the feature database and the final result is obtained.(Tayal,2012)

Color model is to specify the colors in some standard. Some of the color models used is RGB color model for color monitors, CMY and CMYK model for color printing. HSV color model is the cylindrical representation of RGB color model. HSV stands for hue, saturation and value. In each cylinder, the angle around the central vertical axis corresponds to "hue" or it form the basic pure color of the image, the distance from the axis corresponds to "saturation" or when white color and black color is mixed with pure color it forms the two different form "tint" and "shade" respectively, and the distance along the axis corresponds to "lightness", "value" or "brightness" or it provides an achromatic notion of the intensity of the color or brightness of the color.(Ghazail,2011)

Among various low facial features such as edge, shape, skin color and texture; skin color is prominent tool for extracting face region due to its fast processing and ease of implementation. Although color processing

is advantageous but sensitive to following conditions (Hani k.Al Mohar, 2012)

Possible face regions are selected by means of the Genetic Algorithm (GA). Experimental results indicate that the system is capable of detecting human faces in a complex scene with a high degree of variability in expression, pose, and facial details.(Moazzam,2011)

The original image is obviously a color image. For detecting the face area, the image content is first converted from RGB to HSV color space. In the HSV color model, a color is described by three attributes: hue, saturation, and value. The conversion from RGB to HSV has been accomplished. (Moazzam,2011)

Automatically selected threshold value for each image by the system without human intervention is called an automatic threshold scheme. This is requirement the knowledge about the intensity characteristics of the objects, sizes of the objects, fractions of the image occupied by the objects and the number of different types of objects appearing in the image. (Salem Saleh Al-amri 2010)

These techniques improve people's ability to accurately search for target items. These techniques are similar to one another P-Tile technique in that they all use the component segments of original images in novel ways to improve visual search performance but it is different from p-tile don't active when the noise is present in the image. (Salem Saleh Al-amri 2010)

Simulation results developed the algorithm shows the Real time human face detection and tracking supporting up to 50 human faces. This algorithm computes data and produce results in just a mere fraction of seconds. (Jatin Chatrath 2014)

The goal of skin color segmentation is to reject non-skin color regions from the input image. It is based on the fact that the color of the human face across all races agrees closely in its chrominance value and varies mainly in its luminance value HSV model has the best performance for skin pixel detection as compared to chrominance(YCbCr) model and RGB model. In the HSV color model, H means for hue component, which describes the shade of the color, S stands for saturation component, which describes how pure the hue (color) is while V stands for value component, which describes the brightness. (Gayatri A.Patil1, 2013)

3. PROPOSED SOLUTION

The input image is processed primarily and RGB mode is being converted to L*a*b* color space. The image is then analyzed for getting pixel values for skin and non-skin region. After identification of pixel values, each color component will be given a threshold value. Then the skin and non-skin pixels will be separated via binary skin classifier where black and white represents the skin and non-skin region. Finally it will detect the face region easily and define the face boundary. The absence of the luminance component increases performance, which also supports in finding the appropriate color space for skin detection. Combination of color components reduces the computational complexity and processing time.

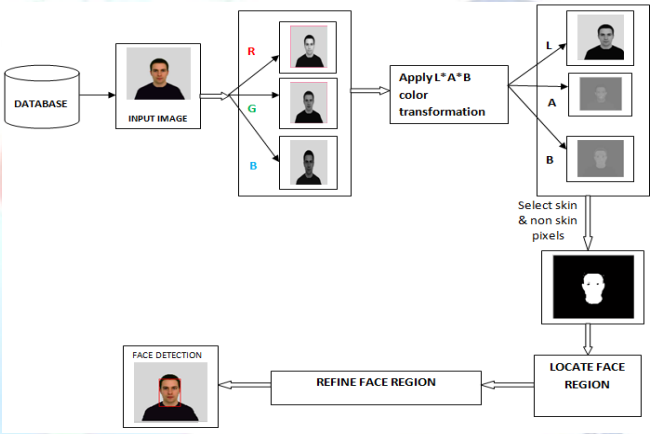


Fig 3.1 System Architecture

3.1 Color transformation

A color represented in one space can be changed to another spatial representation by performing some linear or non-linear transformation. Here we are using CIELAB color space for color transformation .CIE L*a*b* or CIELAB consists of the components luma, green/red and blue/yellow. If you pass a certain threshold in positive or negative direction for a* or b* values you are navigating out of RGB color space gamut and therefore RGB values do not change anymore.

Color transformation equation for L*a*b

$$L = 116f(Y/Yn)-16$$

$$a^* = 500[f(X/Xn)-f(Y/Yn)]$$

$$b^* = 200[f(Y/Yn-f(Z/Zn)] \quad \ldots\ldots\ldots \quad (3.1)$$

3.2 Global threshold module

In global thresholding, a single threshold for all the image pixels is used. When the pixel values of the components and that of background are fairly

consistent in their respective values over the entire image, global thresholding could be used.

Global thresholding consists of setting an intensity value (threshold) such that all pixels having intensity value below the threshold belong to one phase, the remainder belong to the other. Global thresholding is as good as the degree of intensity separation between the two peaks in the image.

3.3 Binary classifier module

Binary classifier that separate the given image with white regions showing skin regions and the black area showing non-skin regions, then each skin region must be labeled. The segmented skin region is now evaluated assuming that the face would consists of at least one hole as it consists of eyes, nose and a mouth. If the hole is absent then it can be treated pseudo-skin pixel or area.

3.4 Bounding box properties module

Rejection of non human face skin region based on height to width ratio [4, 6, and 8]. Generally, height to width ratio of skin regions is measurable factor because it is also big factor for rejecting non human face like regions. If height to width ratio of skin region is less than by threshold value, then this skin region will be discarding from class of probable human faces. Here we decided 1.8 threshold values for height to width ratio. For determining height to width ratio of each skin region, through region properties based on Bounding Box MATLAB function.

3.5 Face detection module

Combinations of binary images from the *a &*b chromo components that separate the skin and non-skin region. Detection of face can be defined and refined the face region in an given image using bounding rules.

3.6 System Flow Diagram

Read the input image from the database. Create color transformation which converts RGB into L*a*b color. Then apply transformation which coverts RGB into L*a*b color space.

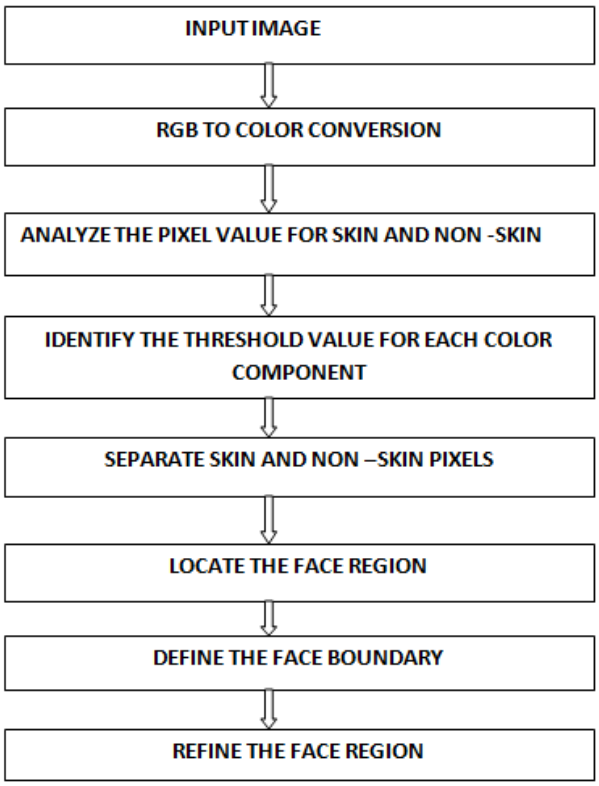


Figure 3.2. System flow diagram

Analyze the pixel value for skin and non-skin region through histogram analyses. Apply global threshold to convert intensity image into binary image for each color component in L*a*b. Separate skin and non-skin pixels through the conversion of grey scale image to binary image. Then locate the face region by combination of the chromo components of binary image. Define and refine the face by bounding box region properties.

4. RESULT

Read an image from the dataset containing different face images with different lighting, pose, illumination etc., so that the software can detect the face in that image. Various image formats are supported by MATLAB including the most commonly used ones, such as JPEG, TIFF, BMP, GIF and PNG. Images can be read, processed and then saved in a format other than their initial one.

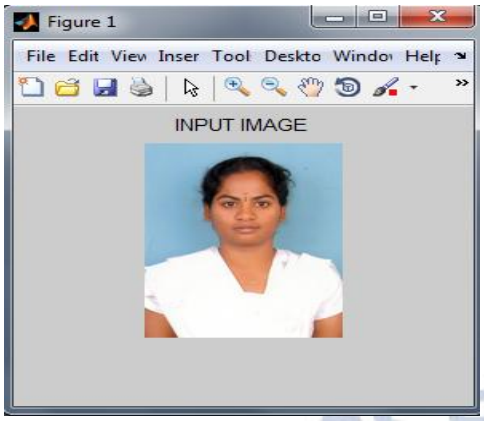


Fig 4.1 Input image

The input image is then retrieved for splitting the color components. the Red, Green, Blue color components in the image split separately.

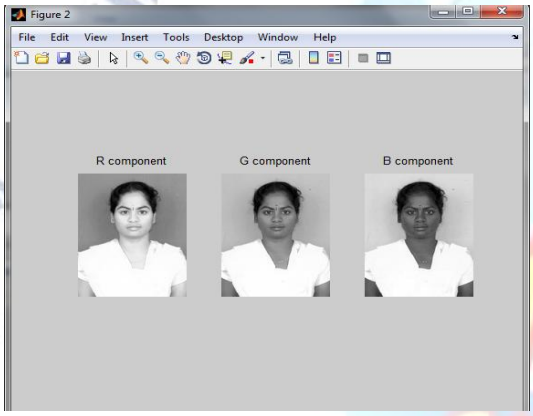
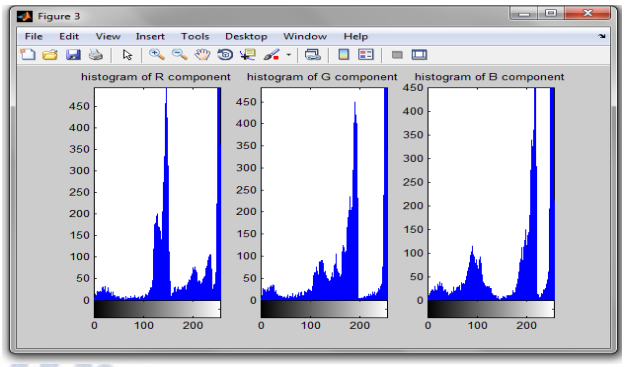


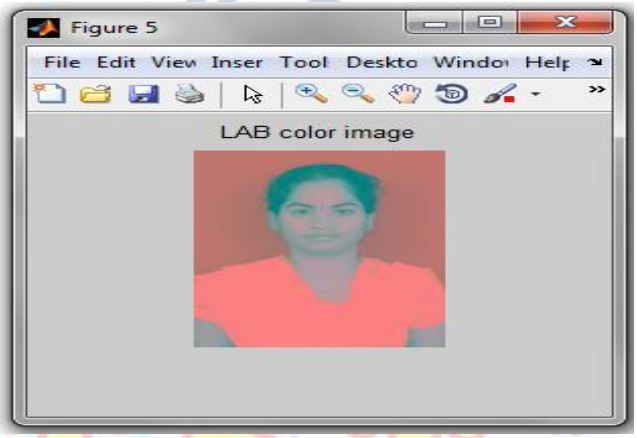
Fig 4.2 Splitting of RGB components

Histogram analysis for each RGB component is generated. A histogram is a useful intensity representation as it reveals the pixels' intensity distribution. The histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image It can be obtained using the function imhist. This information can be used for selecting an appropriate threshold value.

L*a*b color space is a color component space with dimension L for lightness, *a represents negative values indicate green while positive values indicate magenta and *b represents negative values indicate blue and positive values indicate yellow for the color components based on non linearly compressed CIE XYZ color space co-ordinates.



4.3 Histograms of RGB components



4.4 Input image is converted to L*a*b color space

L*a*b components are then split from the L*a*b image. So that the face in the image can be detected by using the chromo color components. It is designed to approximate human vision and aspires to perceptual uniformity. L component closely matches human perception of lightness.

Histogram analysis for each RGB component is generated. A color histogram of an image represents the distribution of the composition of colors in the image. Histogram analyses shows the different types of colors appeared and the number of pixels in each type of the colors appeared.

Binary skin segmentation method segments skin based image based on lower and upper bound of threshold values. If the value is true then the skin region is represented as 255 (white pixel) otherwise 0 (black pixel). Here, the threshold value is set on every individual and combined color spaces which segments human skin regions from source image.

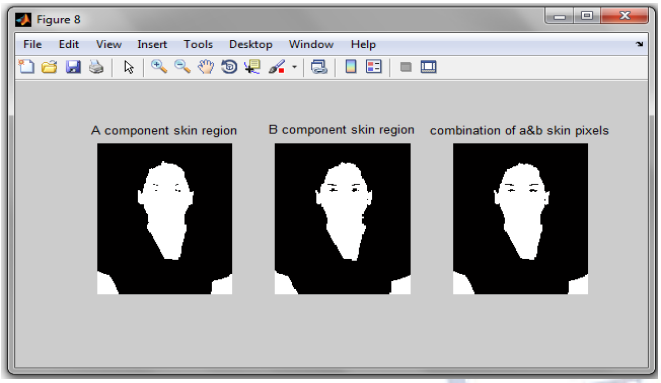


Fig 4.5. Binary skin segmentation of A, B and combination of A&B components

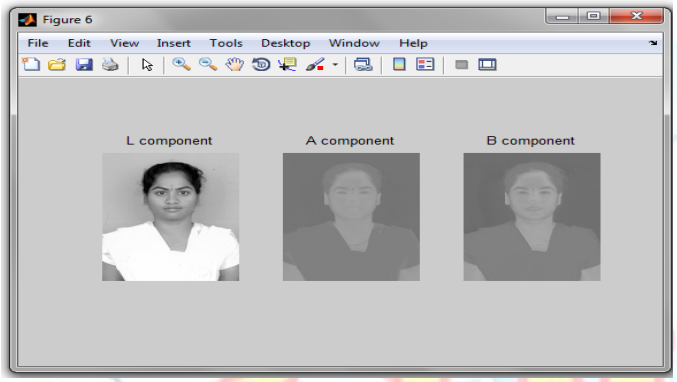


Fig 4.5. Binary skin segmentation of A, B and combination of A&B components

The face suggests that the ratio of the bounding box width to its height is in some fixed range , so any component satisfying the following condition is classified as the face region.

Fig 4.6. Face detected using bounding box rules

5. CONCLUSION

In this paper, Face detection is an important aspect for various fields of study such as face recognition, expression detection, video monitoring, status authentication, and others for which it remains an important research field till date. In this research finally detected the face region from the given image. The given image is processed primarily and RGB mode is being converted to L*a*b color space conversion. Then the skin and non-skin pixels were separated via binary skin classifier where black and white represents the skin and non-skin region. Here the illuminant component is dropped and the chromo components were used. The absence of the illuminance component increases performance, which also supports in finding the appropriate color space for skin detection. Finally it detected the face region easily and defined the face boundary. The experimental result shows that the proposed method is invariant to the lighting condition under which the image was taken. The results also revealed the robustness and efficiency of this method under varying conditions, such as pose, and expression.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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