

Face Detection –A Comparison Of HSV With LAB Color Space Model

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Abstract—Because of the increasing instances of identity theft and terrorism incidences in past few years, biometrics based security system has been an area of quality research. Modern day biometrics is a cutting edge technology which enables the automated system to distinguish between a genuine person and an imposter. To detect a face from an online surveillance system or an offline image, the main component that should be detected is the skin areas. This paper proposes a skin based segmentation algorithm for face detection in color images using HSV color space model with the detection of multiple faces and skin regions. Skin color has proven to be useful and robust for face detection, localization and tracking. A comparison with face detection based on skin color with LAB color space model is then applied. After analysing the performance of images to both models and determine the results.

Keywords-Lab color space model, HSV color space model, Face Detection, Morphology operations, Skin detection

I. INTRODUCTION

Different aspects of human physiology are used to authenticate a person's identity. The science of ascertaining the identity with respect to different characteristics trait of human being is called biometrics. The characteristics trait can be broadly classified in to two categories i.e. physiological and behavioural. A person can be identified on the basis of different physiological and behavioural traits like fingerprints, faces, iris, hand geometry, gait, ear pattern, voice recognition, keystone pattern and thermal signature.

This paper presents an improved color based segmentation technique to segment the skin regions in a group picture and use of skin based segmentation in face detection. Skin based segmentation has several advantages over other face detection techniques like this method is almost invariant against the changes of size of face, orientation of face. The primary aim of skin based segmentation is to detect the pixels representing the skin regions and non-skin regions. After detection of pixels which represents the skin region, the next task is to classify the pixels which represent the faces and non faces. Skin color is an important feature of human faces. Skin color has proven to be a useful and robust cue for face detection, localization and tracking.

II. FACE DETECTION SYSTEM

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.

Figure 1 shows the basic block diagram of face recognition system. The first step of face recognition is to acquire an image either online or offline. 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.

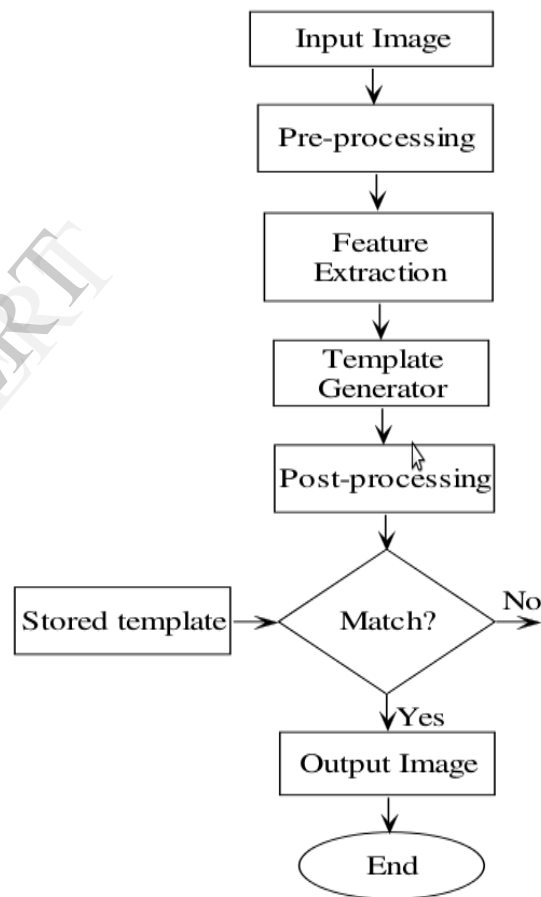


Figure 1: Block diagram of face detection/face recognition system

III. RELATED WORK

YogeshTayal, RuchikaLamba, SubhransuPadhee [2]proposed and successfully implemented automatic face detection using color based segmentation using HSV color space. Sanjay Kumar Singh, D. S. Chauhan, MayankVasta, Richa Singh [3]

developed a skin color based face detection algorithm. E. Hjelmas and B. K. Low[4] made a survey on face detection. H.C. Vijay Lakshmi and S. PatilKulakarni[5] proposed a segmentation algorithm for multiple face detection in color images. ChiunhsunLin, and Ching-Hung Su[6] used HSV color space and neural network for face detection. Zarit, B. D.; Super, B. J. and Quek, F. K. H[7] made a comparison of five color models.

Face Databases

There are different standard face databases available in internet. This section shows some of the standard face databases.

GTAV Face Database

This database shows 95.65% accuracy. This database correspond to different pose views under three different illuminations (environment or natural light, strong light source from an angle of 45, and finally an almost frontal mid-strong light source. The resolution of the images are 240x320 and they are in BMP format. It is taken in controlled conditions and includes 46 images.

Mixed Database

This database shows about 95% accuracy. It contains images from varying light and focuses. It includes group photos of about 40 different images.

Bao Database

This database shows about 97.02% accuracy. It contains a total of 370 images for face detection and recognition. 221 group images and 149 one face images are in another sub directory with an uncontrolled background. All images are in JPEG format.

IV. SKIN COLOR BASED FACE DETECTION IN LAB COLOR SPACE.

The first step in implementing this algorithm is to read all the images of the database from a directory (pathDatabase), then process them, and save the output results in another directory (pathResults). This process is implemented in Matlab is named as readImages.m. The most important operations of readImages.m are implemented. The images are processed using the proposed algorithm developed using Matlab, named as faceDetection.m. The second step in the development of this program is to modify the original image for detecting faces. To eliminate the effects of light, it is necessary to take the input color image to the system and convert to another color space because the space in which is the original color image is not reliable for the characterization of skin colors, because the three components (r, g, b) represent not only color, but also represent the brightness or luminance, which can vary the face of a person due to environmental conditions of light, thus is not a reliable measure in separating skin regions that contain and which do not contain. Luminance can be removed from the color representation, and putting it to chromatic color space. This method uses CIE Lab color space, which is valid because it has image intensity as one of its components. The third step of the program creates, from the previous image (Lab color space), two grayscale images with the peculiarity that the first

represents the intensity levels of green in the image, and the second one represents the intensity level of blue. The aim of the process is that from these images, set a level for subsequent thresholding segmentation. Because the skin regions are brighter than elsewhere in the grayscale image, skin regions can be segmented from the rest of the image through a process where the threshold for segmentation is not to be a fixed value for all input images, since the images contain some people with different skin types, so a fixed threshold is not possible. In the code Otsu method is used to obtain the optimal threshold value for each grayscale image. Otsu algorithm assumes that the image that has to be thresholded contains two classes of pixels (e.g. foreground and background) then calculates the optimum threshold separating those two classes so that their combined spread is minimal[3].

Once the optimal threshold value is determined (for each image), the grayscale images are converted to a binary image. The binary image has values of 1 (white) for all pixels in the input image (grayscale image) with intensity levels greater than optimum threshold value, and 0 (black) for all other pixels. There are two binary images created from the intensity level of blue and green. The next step is to multiply both images. The next step is to create a matrix that label the properties. The BoundingBox property is used for this. It is a property which calculates the position and dimensions of the minimum rectangle that surrounds the region. The following steps performed are necessary to ensure that these data are displayed in matrix form. At first it creates a structure array, which becomes a cell array and finally becomes a matrix. The last step of the proposed code is to find the position where to draw the rectangle with the position of the face. To do this, the code uses the loop that loops through all the bounding boxes generated before, trying to find the bounding box that has the largest aspect ratio less than 1.8. Once position of the face is detected then draw the rectangle to finish the program. Final cropped image is saved in a directory. Workflow algorithm for face detection using LAB color space is shown in Figure 2.

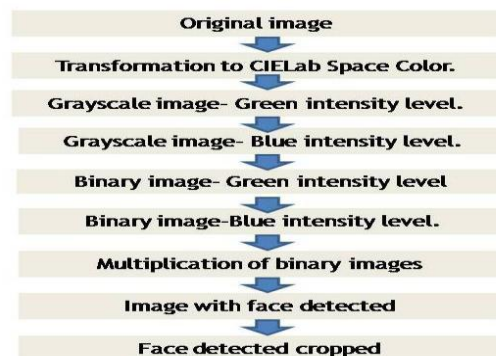


Figure 2: Workflow Algorithm for Lab Color Space

V. THE PROPOSED ALGORITHM

Color is a prominent feature of human faces. Using skin color as a primitive feature for detecting face regions has several

advantages. In particular, processing color is much faster than processing other facial features. Furthermore, color information is invariant to face orientations. However, even under a fixed ambient lighting, people have different skin color appearance. In order to effectively exploit skin color for face detection, a feature space has to be found, in which human skin colors cluster tightly together and reside remotely to background colors. The first step of face detection is to segment the color image into skin and non skin region. Different color space has different ranges of pixels which represents skin region and non skin region. From the ranges the skin and non skin segmentation is performed. So now the output image only shows the skin regions and non skin regions are blackened. After segmentation, morphological operators are implemented with a structuring element. After application of morphological operators, the standard deviation of the area is calculated and rectangles are drawn in the skin regions. If any unwanted rectangles are created, it is then removed. Workflow of face detection using HSV color space is shown in Figure3 .

The image retrieval process using segmentation of HSV is carried out by converting its RGB color space to HSV colorspace[2] . This paper presents an improved color based segmentation technique to segment the skin regions in a group picture and use of skin based segmentation in face detection. Skin based segmentation has several advantages over other face detection techniques like this method is almost invariant against the changes of size of face, orientation of face. The primary aim of skin based segmentation is to detect the pixels representing the skin regions and non-skin regions. After detection of pixels which represents the skin region, the next task is to classify the pixels which represent the faces and non-faces. Color is a prominent feature of human faces. Using skin color as a primitive feature for detecting face regions has several advantages. In particular, processing color is much faster than processing other facial features. Furthermore, color information is invariant to face orientations. However, even under a fixed ambient lighting, people have different skin color appearance. In order to effectively exploit skin color for face detection, a feature space has to be found, in which human skin colors cluster tightly together and reside remotely to background colors. The first step of face detection is to segment the color image into skin and non-skin region. Different color space has different ranges of pixels which represents. From the ranges, the skin and non-skin segmentation is performed. So now the output image only shows the skin regions and non-skin regions are blackened. After segmentation, morphological operators are implemented with a structuring element. After application of morphological operators, the standard deviation of the area is calculated and rectangles are drawn in the skin regions. If any unwanted rectangles are created, they are removed. The automatic face detection algorithm is applied on a wide variety of images taken under different lighting conditions and with different backgrounds. The images also have areas containing skin from other parts of the body such as hands, necks and areas with

color very similar to that of skin. These areas get classified as skin[5].

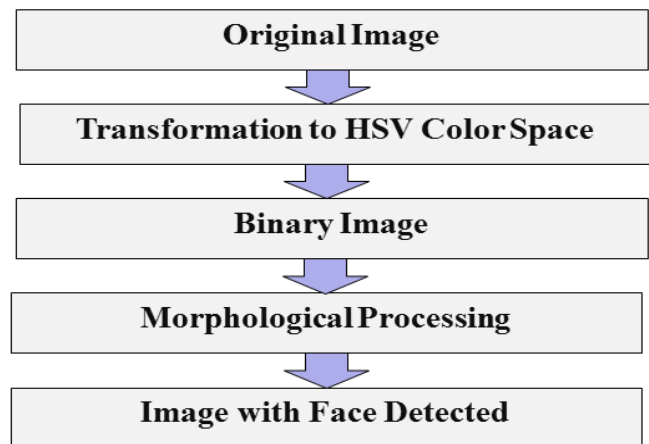


Figure 3: Workflow of the proposed algorithm

VI. EXPERIMENTS & RESULTS

The existing algorithm based on LAB and proposed algorithm based on HSV are compared based on various parameters. It is observed that the proposed algorithm is giving better results than the existing one in terms of accuracy. The evaluation and results for LAB color space based face detection is shown in Figure 4 & Figure 5. Success and error rate of 243 images are tested. The evaluation and results for HSV color space based face detection is shown in Figure 6 & Figure 7. Success and error rate of 456 images are tested. The comparison table for LAB and HSV based face detection is shown in Figure 8.

Evaluation & Results

Database	No. of Images	Successfully Detected faces	Error Rate	Success Rate
A	50	49	2%	98%
B	30	13	56.67%	43.33%
C	163	134	17.79%	82.20%

Figure 4: Evaluation Table for face detection using LAB color space.

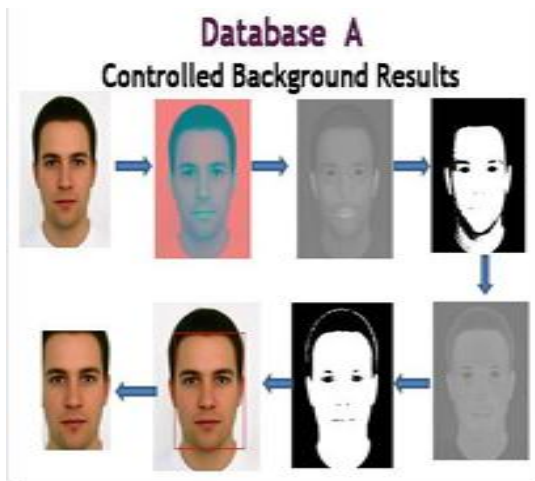


Figure 5: Results for face detection using LAB color space.

COMPARISON TABLE

Color Space Model Used	No:of Images	Successfully Detected faces	Error Rate	Success Rate
HSV	456	441	3.29%	96.71%
LAB	243	196	19.35%	80.65%

Figure 6: Comparison Table for face detection using HSV & LAB color space.

Evaluation & Results

Database	No:of Images	Successfully Detected faces	Error Rate	Success Rate
Images1	46	44	4.34%	95.65%
Images2	40	38	5%	95%
Images3	370	359	2.97%	97.02%

Figure 6: Evaluation Table for face detection using HSV color space.

VII. CONCLUSION

This paper proposes an algorithm with good accuracy for face detection based on HSV skin color segmentation. Though there are some cases of false positives, the overall performance of the proposed algorithm is quite satisfactory. The training images on which the algorithm is tested are natural images taken under uncontrolled conditions. The efficiency of the face detection was found to be 96.71%. In addition, HSV color model is chosen because it is fast and compatible with human color perception. Hence it can be concluded that the present algorithm demonstrates better performance with respect to speed, low false positive rate and high accuracy than face detection using LAB color space with an efficiency of 80.65%.

Face Detection Results

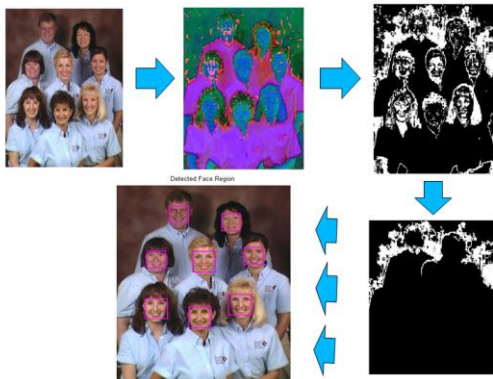


Figure 7: Results for face detection using HSV color space.

VIII. REFERENCES

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