# Skin Color Based Segmentation for Multiple Face Detection

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**Abstract- Nowadays, human face is being used as an index for identification. In present days automatic face detection has become an interesting research field. Face detection in an image is "to separate human frontal faces from the background and determine their location in it regardless of their position, scale, in plane rotation, pose, illumination etc". Automating an application process related to image processing needs image analyzing methods. This paper presents a novel face detection approach that uses skin color based segmentation and morphological processing. To perform face detection , the algorithm uses extraction of color planes, thresholding, erosion and dilation morphological operations , filtering (for avoiding false detection). Next, particle analysis is performed to identify or locate only the face skin area in the given image and not the other parts of the body. The color planes are extracted using vision module the RGB represented color space is converted into a suitable color model such as YCbCr. The method presented can be applied to detect or identify single as well as multiple human faces in the given input image. Face recognition is the process of identifying a given input image is available in the stored image database. Face detection is one of the essential preprocessing step for any face recognition approach. Template based face recognition is one of face recognition approach. In this paper the performance of template based face recognition without and with face detection using color based segmentation is measured to evaluate the efficiency and the effectiveness of face detection. Experimental results conducted on FERET database show that the algorithm is efficient in detecting the human faces with an accuracy of 100% for most of the cases and it is also observed that the performance of face recognition is also improved.**

**Keywords- Face detection, color based segmentation, extracting color planes, thresholding, morphological operations, erosion and dilation, particle analysis, face recognition.**

## I. INTRODUCTION

Face detection is an essential phase in an automated face recognition system. It can be also used in systems such as face tracking, video surveillance, facial expression recognition, etc. Face detection can be defined as a process "to separate human frontal faces from their background and find their location in an input image in spite of their location or position, scale or size, in plane rotation, illumination, pose etc ". There are number of ways for performing face detection. These are broadly categorized intofour ways and they are, knowledge based[5][6][8][10],[11] approach, which depends on set of rules, based on human knowledge, for detecting human faces in an image. Feature invariant or feature based[5][8][12] locates the faces by obtaining structural features of a face. In general, a statistical classifier is trained and used for differentiating non-facial and facial areas. Appearance based or image based [5][8][13] depends on a group of alternate training images of faces for finding human face patterns. Template based[5][8][14] approach uses predefined or parameterized face templates to locate the position and identify faces in an image, by evaluating the relationship(correlation) between the input image and stored template image. Every method has its own advantages and disadvantages with regard to speed, complexity , efficiency, accuracy, etc.

Our paper introduces a skin color based segmentation [1][2][3][4][7][9] based on feature invariant face detection approach to extract the skin areas in group image or single image . Skin color based segmentation has number of uses when compared with other face detection techniques, which are unvarying with the change in orientation of face, resolution of face, illumination, noise etc. The main advantage of skin color base segmentation is to identify and locate the pixels related to skin

area and non-skin areas. Once the pixels of skin area or region are detected or identified , next step is to categorize pixels related to face areas and non-face areas.

The color base approach usually considesr RGB or HSV or YcbCr color models. In our algorithm for single face image RGB is converted into HSV model, and from that hue plane is extracted. For multiple face images, RGB is converted into YCbCr space to differentiate the skin color region from non skin regions.

Face recognition is "a one to many matching process where a query input image is compared with saved template images stored in a face database to find and know the identity of the query input image". Face recognition approaches[21][22][23] can be broadly categorized to four types namely Holistic or Appearance based, Feature based, Template based and Part based. Holistic methods use complete information of face patch and apply or perform transformation on this patch to obtain a compressed representation for performing recognition process. Feature based methods exploit more information through image processing, computer vision and domain knowledge in the form of a human. They obtain the feature from facial feature points or the complete face and these are compared for recognition. Part based approaches identify the suitable parts of the face image and then combine these part appearances with the machine learning tools for face identification. Template based approaches are used for comparing the query image with a set of stored templates for face recognition.

In this paper a template based face recognition[19][20][21] performance is measured to know the effectiveness of face detection which is an essential step in the process of face recognition. Here the templates are formed by defining the curves for the images of database such that only detected areas of faces are compared with templates, containing only face area.

Paper is arranged in the following manner: Section-II discusses the steps of proposed algorithm and the flow chart of the algorithm , Section-III deals with face recognition using template based approach , Section-IV discusses evaluation of the specified algorithm and Section-V Conclusion and future work.

## II. PROPOSED ALGORITHM

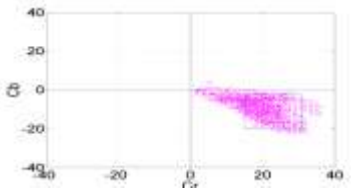
Proposed method is used to identify the availability of human faces in the image utilizing skin color based segmentation based on HSV or YCbCr color space extraction, morphological operations, thresholding and particle analysis.

### A. Extraction of Color Planes

Segmentation of an image is partitioning an image into its elementary areas or regions or objects. The algorithm makes use of the color data to segment or divide human face skin areas or parts from non-skin areas or regions. In general there are several color models such as RGB, HSV, YcbCr[15] etc. But when a RGB image is compared with other color spaces, it has the limitation of not able to precisely separate intensity and color level of pixel, that causes difficult to differentiate skin colored areas or regions. As hue, saturation and value can efficiently be used to define the color data in a similar manner as the manner a human consider about color. In the algorithm the RGB input image color planes are extracted and using vision module the RGB color represented image is converted into the suitable color spaces. For single face images, RGB is converted into HSV space and from that, hue plane is extracted.

YCbCr color model separates the image into component of chrominance and luminosity. The benefit of this is, the effect of luminosity is removed at the time of processing the image. For multiple face images, RGB is modified into YCbCr color space to differentiate the skin color region from non-skin color regions. The hue component range value is between 6 and 18. The range of values used for thresholding for YCbCr is

$$100 < Y < 255$$
$$0 < Cb < 135$$
$$10 < Cr < 195.$$




Skin Pixels in YCbCr Color Space

Images in Figure-1 are the RGB query images, and the result of performing extraction of color planes step of algorithm is shown in Figure-2.

Image no.1

Image no.2

Figure-1

Image no.1

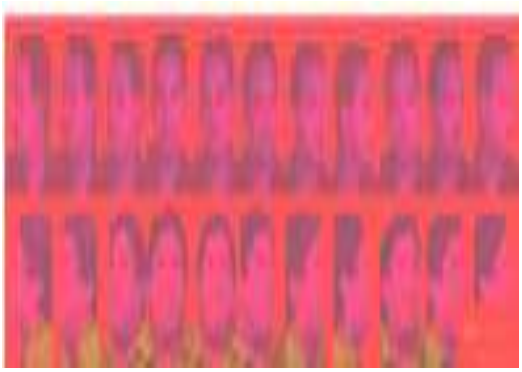


Image no.2

Figure-2

**B. Thresholding**

Thresholding is a module of image segmentation process. It can be used to build binary image. Here in the proposed approach, thresholding is used to change U32 represented image into a binary image that is suitable in further morphological operations.

**C. Morphological Operations on binary image**

Morphological operations[16] can clear up and clean up the image data or information while maintaining their necessary properties or characteristics and can remove irrelevance. More correct contour of skin segments are obtained through these operations. Morphological process includes erosion and dilation. Dilation process adds pixels to edges or boundaries. Erosion removes pixels on the edges or boundaries. As a result exact boundary of the face area is obtained

**D. Particle Analysis**

Particle analysis on a binary image is implemented by using ImageAnalyzeParticles operation. A particle in the image may contain one or more pixels which have level zero. In the presented approach particles in the image are analyzed for knowing the location of the face and a report is created. From the obtained report, the parameters like area, width to height ratio and number of holes are analyzed in order to identify only the face part in the image and not the other remaining parts of the body in the given input image. Generated particle analysis report is shown in Figure-3.

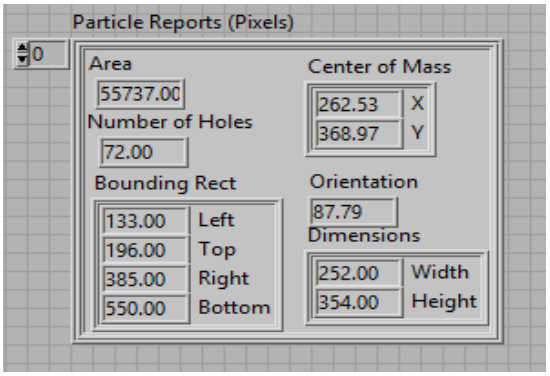



Figure-3

### E. Detected Face Region in the Images

After performing particle analysis cordinates of the face region or area are alone passed to an overlay function to create frame on the face indicating that face is detected. Face frame is drawn as rectangles in the input image . Results are shown in the following figures. Algorithm is experimented for different images of FERET database. Result of the algorithm is shown in Figure-4.

Image no.1

Image – 2

Figure-4

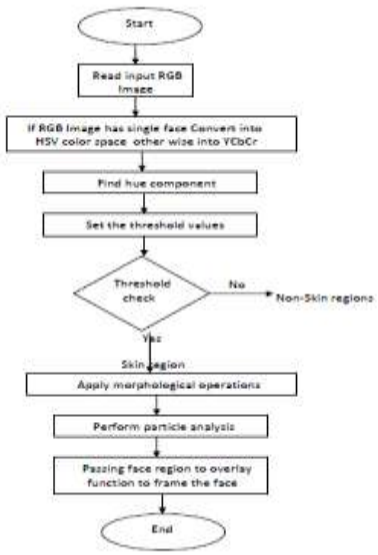



Figure-5

### F. Flow chart of the algorithm

The proposed algorithm and its steps are shown in the flow chart form in the figure-5.

## III. TEMPLATE BASED FACE RECOGNITON

A template based method[19][20][21] compares the input image with a set of templates. The set of templates can be constructed using statistical tools, where templates are represented as features, or by creating pattern by samples, models pixels, curves, textures. The recognition function computes the differences between the input image and stored templates. It uses correlation or distance measures. In our approach curves are defined to form the templates. These templates are used for face recognition process to compare with the query image.

## IV. RESULTS

Efficiency of the algorithm is evaluated by using the parameters such as False Detection Count(FDC)[18] and Success Detection Count(DSC)[18]. False Detection Count(FDC) is defined as "the number of falsely detected faces over the total number of detections".

$$FDC = \frac{\text{no. of falsely detected faces}}{\text{Total number of detections}} \times 100\%$$

Detection Success Count (DSC) is defined as" the number of correct detections over the actual number of faces in the given input images".

$$DSC = \frac{\text{no. of correctly detected faces}}{\text{Total number of faces}} \times 100\%$$

Whereas the number of correctly detected faces is corresponds to the number of faces subtracted from the number of false dismissals. Following section shows the result of detected faces of some sample training images taken from FERET database. Table shows data obtained on the training images.

Image no.3

Image no.4

Image no.5

Image no.6

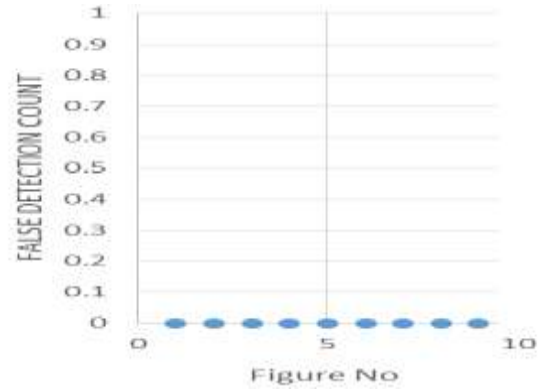
Image no.7

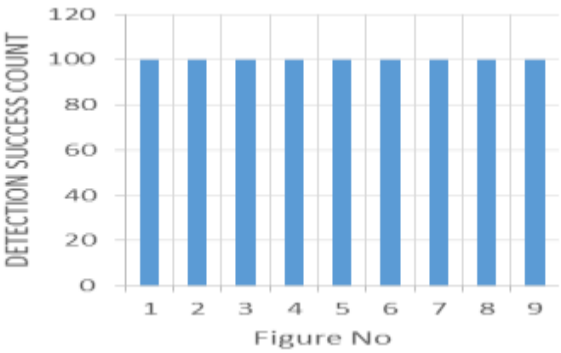
Image no.8

Image no.9

Following table and graphs show the results of face detection algorithm.

| FACE DETECTION RESULTS | | |
|---|---|---|
| **Images No** | **FALSE DETECTION COUNT (FDC) (%)** | **SUCCESS DETECTION COUNT (DSC) / (%)** |
| 1 | 0 | 100 |
| 2 | 0 | 100 |
| 3 | 0 | 100 |
| 4 | 0 | 100 |
| 5 | 0 | 100 |
| 6 | 0 | 100 |
| 7 | 0 | 100 |
| 8 | 0 | 75 |
| 9 | 0 | 100 |




**Face Recognition:**

The effectiveness of face detection in the process of face recognition has been evaluated. Template based face recognition is used for evaluation. Experiments conducted showed that efficiency of template based face recognition without color based segmentation was from 80% to 90% but

with color based segmentation efficiency has been increased to 100%.

## V. CONCLUSION AND FUTURE WORK

**I**n this paper, a novel method for detecting faces is described. The approach is implemented using skin color based segmentation, dilation-erosion morphological operations and particle analysis. The FERET training images are used for testing the performance of the algorithm. Experiment results showed that the face detection efficiency was found to be about 100% for most of the images. Even the number of faces to be detected are increased the efficiency of the algorithm is not reduced . It also showed that the performance of face recogniton has been improved from 90% to 100%.

In future, algorithm can be improved for face detection over images with different orientation and under various lightening conditions.

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