Face Detection Based on Multi Facial Feature using Fuzzy Logic

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Abstract

The goal of face detection is to locate all regions that contain a face. This paper has a simple face detection procedure, first to segment skin region from an image, and second, to decide these regions contain human face or not. Our procedure is based on hybrid skin color segmentation using three color spaces RGB, YC_bC_r and HIS and human face features using entropy.

For the purpose of extracting feature, rather than looking at the whole image of the face, and put the entropy based on the selection of skin region, which selects high informative segments of the facial image, compared with entropy of ORL image using the Euclidean distance .Also the golden ratio and the size of skin region decide where this region is face or no through the fuzzy system. Fuzzy logic got great acceptance of the various fields therefore it used in this paper to cover the difference in the parameter of face. The method provides a suitable method for extracting information. The proposed method has been tested on various real images and its performance is found to be quite satisfactory with detection accuracy 94.74 %.

Key words: Face Detection, Entropy, Fuzzy Logic.

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1. Introduction

Depicting human face is currently active area of research in computer vision community. Human face localization and detection is often the first step in applications such as video surveillance, Human Computer Interface, face recognition and image database management. It is with the facts or not there is any object in an image, and if it exists, and return the site and the content of each image of your face. This is the first step in any fully automatic system that analyzes the information contained in object (for example, identity, gender expression, age, race and pose). Identification and tracking human faces is a prerequisite for face recognition and / or facial expressions analysis, although that is often assumed that the facial image normalization available [1].

There are different algorithms of face detection including algorithms based on skin color. Color is an important feature of human faces. Using skin color as a feature to track the face has many advantages. Color processing is much faster than processing other facial features. However, color is not a physical phenomenon, but is a perceptual phenomenon associated with the spectral characteristics of electromagnetic radiation in the visible wavelengths striking the retina. The disadvantage of the cue color is their sensitivity to lighting changes color, and especially in the case of RGB, and sensitivity to the intensity of illumination. One way to increase tolerance towards changes in image density is converting an RGB image to the color space that the intensity and color of a separate and use only a part colorimetric detection. In this paper, we present a suitable face detection algorithm that can detect faces with different depth and multi faces in both indoor and outdoor environments [2].

2. Color Models for Skin Color Classification

The skin is the color information very important feature for many researches, but the accuracy of detection of skin color is important for face detection. It is converted from RGB to transactions YC_bC_r. Where are the RGB sensitive to density variation, many skin detection methods ignore luminance component of the color space, to achieve a separate form for differences in the appearance of the skin which may arise from the difference of the human race, and also reduces the space dimension [3].

The color of the skin has revealed to avoid search for a comprehensive faces in the entire picture. This step describes how the color of the skin is rejected by the image so that the image may contain skin just like areas, which will be our skin color segmented image for further processing. Different kind of models of color, in the color model HSV, hue (H) is not guaranteed for the job discrimination when saturation is low, and also in the color model coefficients YC_bC_r, and distribution areas of the skin is consistent across different races in the C_b and chrome color spaces, and color model RGB lighting so it was so, when we use different color models under uncontrolled conditions, and we therefore lead to detect skin color. Detection accuracy of the skin depends on both the color and model classification method pixel skin and detected [4].

The study on skin color classification has gained increasing attention in recent years due to the active research in content-based image representation. For instance, the ability to locate image object as a face can be exploited for image coding, editing, indexing or other user interactivity purposes. Moreover, face localization also provides a good stepping stone in facial expression studies.

2.1 RGB Color Space

The RGB color space consists of the three additive primaries: red, green and blue. Spectral components of these colors combine additively to produce a resultant color. The RGB model simplifies the design of computer graphics systems but is not ideal for all applications. The red, green and blue color components are highly correlated. This makes it difficult to execute some image processing algorithms [2].

2.2 YCbCr Color Space

YCbCr color space has been defined in response to increasing demands for digital algorithms in handling video information, and has since become a widely used model in a digital video. It belongs to the family of television transmission color spaces. The family includes others such as YUV and YIQ [2].

2.3 HSI Color Space

Since hue, saturation and intensity are three properties used to describe color, it seems logical that there be a corresponding color model, HSI. When using the HSI color space, you don't need to know what percentage of blue or green is required to produce a color. It can be simply

adjust the hue to get the color you wish. To change a deep red to pink, adjust the saturation. To make it darker or lighter, alter the intensity [2].

3. Skin Color Segmentation Based on Gaussian Mixture Model for Skin Color

Color is an important feature of the human face. Although the facial color of people of different racials, look different ages, but is the main reason for the differences of lighting. After the elimination of lighting, color distribution in the face of different people and good ownership groups. The statistical distribution in space satisfies transactions YCbCr skin color:

$$98 < C_b < 127 \text{ and } 133 < C_r < 170 \quad (1)$$

Thus, this feature can be applied collect skin color to the face detection. In a two-dimensional color space, the region can be described facial color of Gaussian distribution [5] .The RGB skin color detection is based on the following set of conditions: (R, G, and B) is classified as skin [6].

$$R>95 \ \& \ G>40 \ \& \ B>20 \ \& \ R>G \ \& \ R>B \quad (2)$$

Where *R*, *G* and *B* are the components of RGB color space. The skin color region segmentation by RGB color space was performed by the logical OR operation. Since hue can be effectively used to describe the color, the HSI color space, however is much more intuitive and provides color information in a manner more in line how human thinks of colors. The algorithm uses the range of Hue for the skin detection. The most noticeable range which was used by algorithm to detect the skin for H (hue) value is [7]:

$$0.01 < H < 0.1 \quad (3)$$

Otherwise it is non-skin pixel. By applying the mask based on this rule, HSI segmentation was achieved. The results obtained by the hybrid color based segmentation are shown in the Fig's. [1-4].

4. Entropy Based Selection

Information content of different areas of the image of the human face varies widely. Can show that if the division of image-to-face in certain sectors, and not all sectors and contain the same amount of information. It

is expected that the district close to the eyes, nose and lips contains more information than that owned by other parts of the human face picture. Clear that the area with high information content would be in the interest of the region for the purpose of extracting feature. However, identifying these areas is not a trivial task.

The amount of information can estimate of a particular image and can be used to identify those important areas. In this paper, in order to determine the content of information in a particular area of the facial image, measure the universe based on the known density difference [8].

An entropy based measure of intensity variation is defined as

$$H = -\sum_{k=1}^{m} p_k Log_2(p_k) \quad (4)$$

Where p_k the probabilities are obtained based on the intensity distribution of the pixels of a segment of an image. It is to be mentioned that the information in a face image exhibits variations more prominently in the vertical direction than that in the horizontal direction [8].

Fig. 1 Original images

Fig.2 RGB color space skin color condition based segmented image

Fig. 3 YCbCr color space skin color condition based segmented image

Fig.4 HSI color space skin color condition based segmented image

5. Fuzzy Logic A review

Fuzzy inference systems (FIS) is a popular computing frameworks based on the concepts of fuzzy set theory, which has been successfully applied in many fields. Success is mainly due to their proximity to human perception and logic, as well as to deal with an intuitive and simple, which are important factors for the acceptance and usability of systems [9] Essential parts of a fuzzy inference system is a unit fuzzification, rule base, inference engine and defuzzification (see Fig. 5). Fuzzification unit to convert crisp value of a variable to a value mysterious. The rule base consists of a set of fuzzy rules. Inference engine calculates the value of the mass firing of all rules based on the current values of all fuzzy variables. Defuzzification unit calculates the value defuzzified of value of the overall fuzzy output of the inference engine [10].

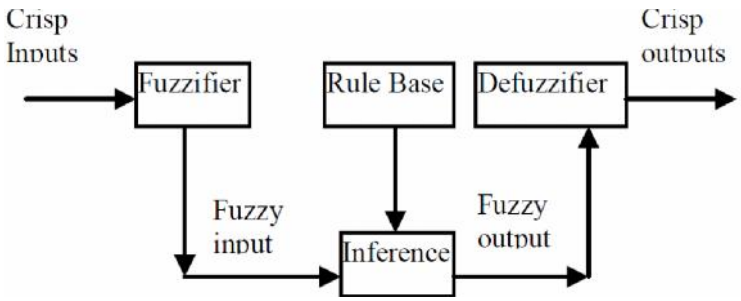

Fig.5 fuzzy inference system

6. Face Detection Algorithm

It assumed that by combining detection from all three areas of algorithms, and the area of the skin Extracted. Thus, combining algorithms on the assumption that their combination gives the skin Detection area of the image and skin the facial image is extracted by extracting the first face Features and then draw a bounding box around face region based on facial features

6.1. Skin Color Segmentation

Assumed that by combining detection areas of all three algorithms, is extracted area of the skin. Thus, combining three algorithms assuming that their combination gives the skin area of the image and the image of the facial skin detection is extracted by extracting facial features and then

drawing a bounding box around the face area with the help of facial features.

6.2. Morphological Bilateral Operations

To the best candidates face zone setting, it is appropriate use of morphological processes the output of the previous step. Using morphological operations and the holes can eliminated which have been formed in some parts of the eye, mouth, nose and skin color in the sectors. Therefore, through the application of morphological operations, the lower areas are an error on the candidates face and use alarms that will create fewer false. So we employ morphological processes such as erosion and dilation, and conclusion.

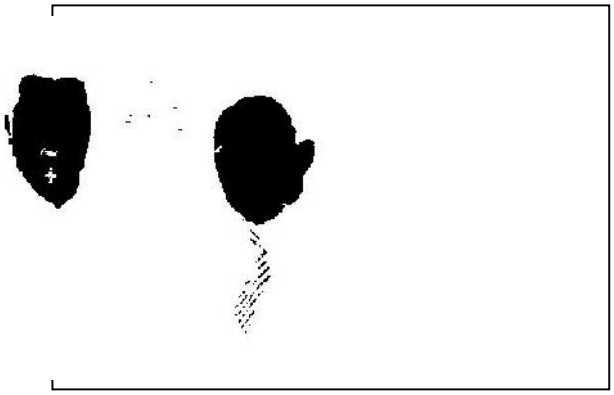

Fig.6 Morphological Bilateral Operations

6.3. Fill Flooding Process.

The process of filling floods binary image to fill the holes created within the region face is import, because of the eyes and lips or holes that were created in the border after the application of the enlargement process. These holes tend to separate all of the objects from each other, and therefore must be removed.

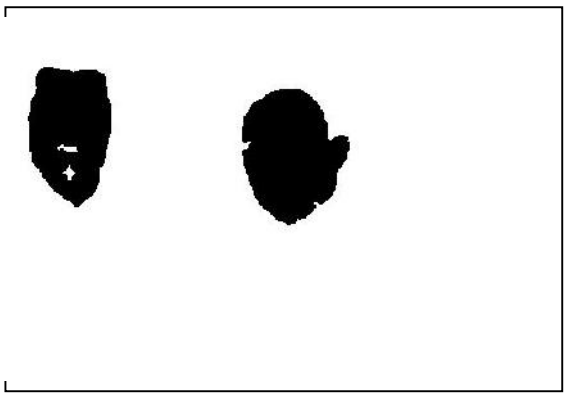

Fig.7 Fill Flooding Process

6.4. Expansion Process.

Expansion of bilateral images with holes contains a structured square radius of 2. This process fine tunes border areas by connecting small breaks and expands little forms for further processing.

6.5. Open Process. The process of opening the disk using the structuring element of size 3 is applied to remove the communication between the regions are closely linked.

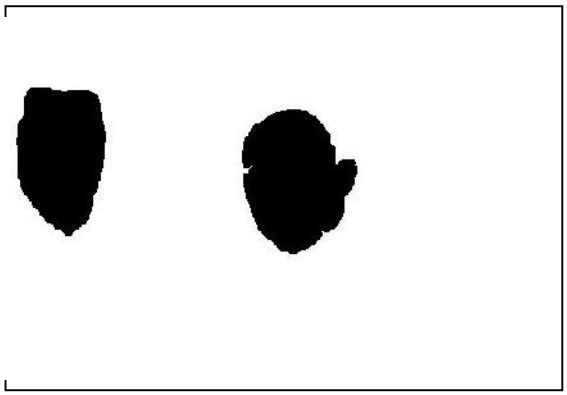

Fig.8 Expansion Process

6.6. Connected Component Labeling

. Apply connected component labeling algorithm for a separate line item for each object. Ideally, each component is expected connected to contain at most one face. However, it is possible that the connected component may contain two or more of the faces. This issue is addressed in the template matching process later.

6.7. Template Matching

The ORL face database [11] is used, which contains all grayscale faces, to obtain a grayscale face template by averaging all the face images in the database. In this ORL database, we have faces with different expressions, different illuminations, and different orientations. There are ten different images for each of 40 distinct subjects. The size of each image is 192×168 pixels with 256 gray levels. The grayscale face template image [12] created from the ORL face database is shown in Fig.9.

The region measures were introduced to determine the likelihood of a skin region being a face region. The measure is golden ratio. Before measuring the region properties, to eliminate the very small regions like width and height each, have less than 20 pixels. This step is useful to eliminate no face regions. The golden ratio is simply defined as the width to height ratio of the region bounding box. The golden ratio value ranges between 0.97 and 2.27 [6].

Fig.9 Mean face created from ORL face database

The detected region may also include non face regions. entropy is taken for the mean image and skin region, by experiment the distance is approximately is 29 .Now the distance ,golden ration and lower dimension of skin are input to the fuzzy system after normalized to cover

the change that occur to the these parameter. In our work there are three membership functions is found (see Fig.10) to the input as shown in figure after normalized normal value of distance is 29, normal value of golden ratio is 2.7, normal value of lower dimension is 25 pixels. Fuzzification is applied on crisp input then performs the rule base to produce the output (see Fig.11) which is converted to the crisp output. Fig.12 shows the block diagram of proposed method. Some of the rule that used in the work

If (distance is Low) and (golden ratio is Low) and (dimension is Low) then (output is no face)

If (distance is Low) and (golden ratio is Low) and (dimension is high) then (output is no face)

If (distance is Low) and (golden ratio is Medium) and (dimension is high) then (output is face).

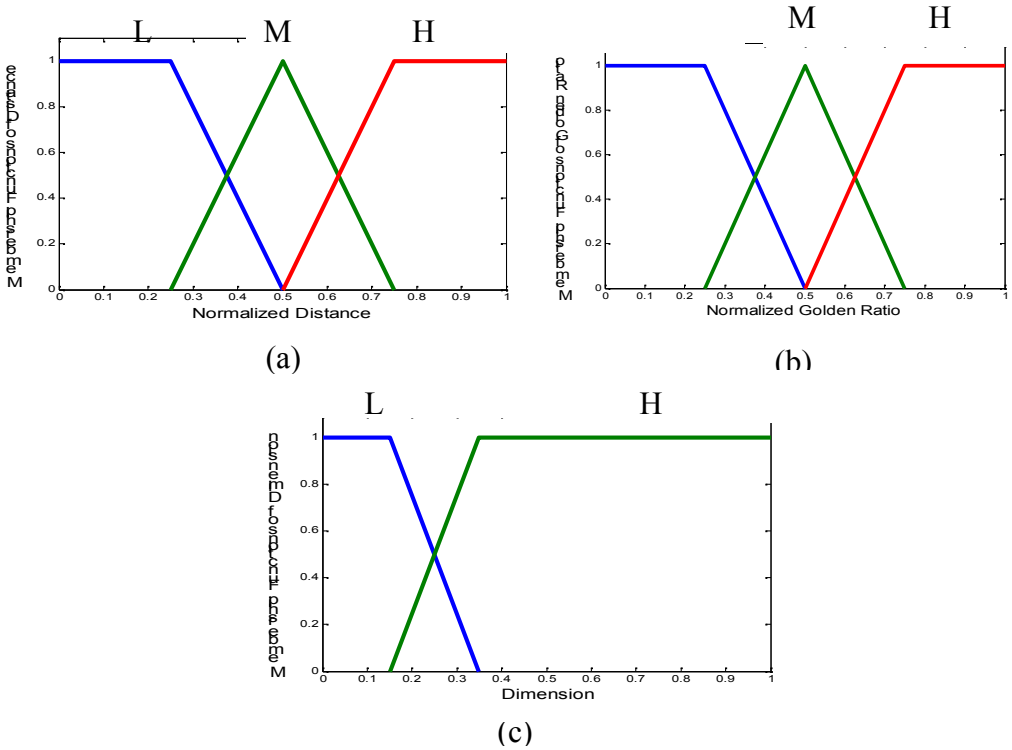

Fig.10 Membership functions of the input

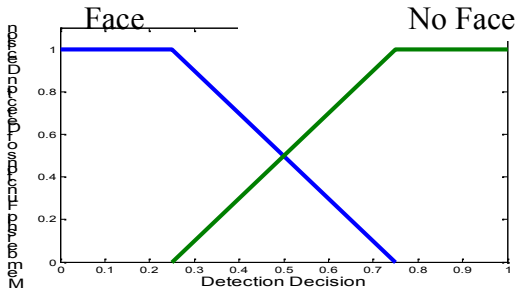

Fig. 11 Membership functions of the output

7. Experimental Result and Discussion

This section presents the experimental results obtained by the method of face detection and rights and conducted with Matlab2010. Experimented suggested human face detection method on color images and faces of the people in various poses. Is made up of various indoor and outdoor scenes that are with different lighting conditions and complex background. Disclosure of the proposed method to our faces with different rotation, impressions, and sizes, and some of them partially occluded. Fig. 13 View area of the skin sample segmentation suggested to us. Finally Fig.14 shows some of test images. Table 1 shows the comparison of the algorithms.

Table.1 Comparison Chart of the Algorithms

Method	Detection accuracies (%)
RGB	81.58 %
HIS	86.84 %
YCbCr	89.47 %
Proposed Algorithm	94.74 %

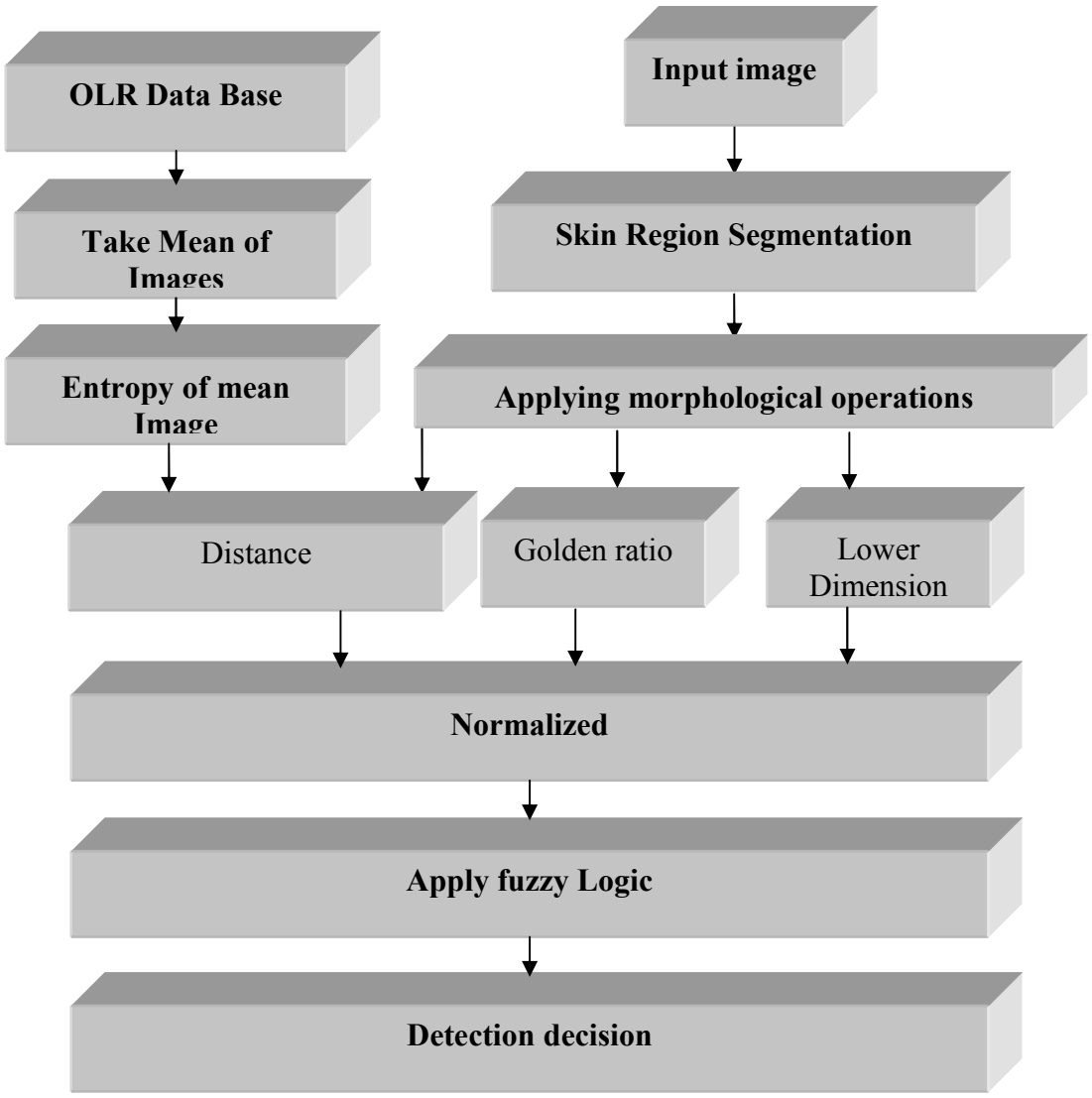

Fig. 12 Block diagram of the proposed method

Fig.13 Detected face

Fig.14 Some of test image

8. Conclusion

It can be concluded that, HIS and YCbCr space is more efficient compared to RGB to segment the skin as shown in the result. But still both cannot give very good results in the detection as shown in the results; the combined from all regions have been extracted to get best segmentation which gives at the end good face detection.

The entropy of skin region suitable feature to represent the face with different points of view and personal image average. ORL database helps us to represent the image of the face and make it a performance indicator to detect the region face in the picture. Combining different color spaces method confirm the skin region , golden ratio and average method from the area of the skin make the proposed method is suitable for the face detection with different distances as shown in the result. Fuzzy system provides robustness to the variation in the feature which makes the proposed method is robust. Difference depth of image does not impact on our way as shown in the result. Different images that are applied multiple faces to verify the proposed method, the faces and one with a different attitude. Effectiveness of the proposed method is confirmed in the result.

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كشف الوجه باستعمال ميزات الوجه المتعددة مع المنطق المظبب

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المستخلص

هدف كشف الوجه هو العثور على جميع المناطق التي تحتوي على الوجه. هذا البحث يقدم طريقة لكشف الوجه, في البداية نكتشف منطقة الجلد من الصورة باستخدام النظم اللونية الثلاثةYCbCr, RGB و HSVبأخذ المنطقة المشتركة لكل هذه الالوان مع الانتروبي للقطعة البشرة ، ومن ثم نقرر ان هذه المناطقة تحتوي على الوجه أم لا حسب بعض المواصفات .
لاستخراج خلاصة البيانات، بدلا من النظر إلى الصورة كاملة ، تتم مقارن الانتروبية لكل مقطع للبشرة مع صورة مبنية من قاعدة بيانات ORL باستخدام المسافة الإقليدية ، اضافة الى ذلك النسبة الذهبية وحجم المنطقة تقرر ان المنطقة هي وجه أو لا من خلال المنطق المضبب. المنطق المضبب اكتسب قبولا واسعا لمختلف المجالات لذلك تم استخدامه في البحث لتغطية كافة الاختلافات المتوقعة لمعلومات الوجه .الطريقة المقترحة توفر طريقة مناسبة لاستخلاص المعلومات. وقد تم اختبارها على صور حقيقية مختلفة و النتائج اكدت جودة الطريقة المقترحة .

قسم الهندسة الكهربائية/ الجامعة المستنصرية