"Review on Human Face Detection based on Skin Color and Edge Information"

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Abstract :

Human face detection system is gradually used for the tracking a human face. Face detection system is mainly used in face reorganization system for detecting human face. Here in this review paper we have describe how face detection system works and where it is useful in real world environment. We have describes different technique like template matching, skin color and edge information based on face detection from skin region, symmetry based face detection and etc.

Keywords: Face, Skin Color, Edge information, Segmentation.

1. Introduction

A biometric is a unique, measurable characteristic of a human being that can be used to automatically recognize an individual or verify an individual's identity. Application for biometric likes [3],

a. Finger-scan
b. Facial Recognition
c. Iris-scan
d. Retina-scan
e. Hand-scan

Face detection is a computer technology that determines the locations and sizes of human faces in digital images [2]. It detects face and ignores anything else, such as buildings, trees and bodies. Face detection can be regarded as a more general case of face localization. In face localization, the task is to find the locations and sizes of a known number of faces (usually one).

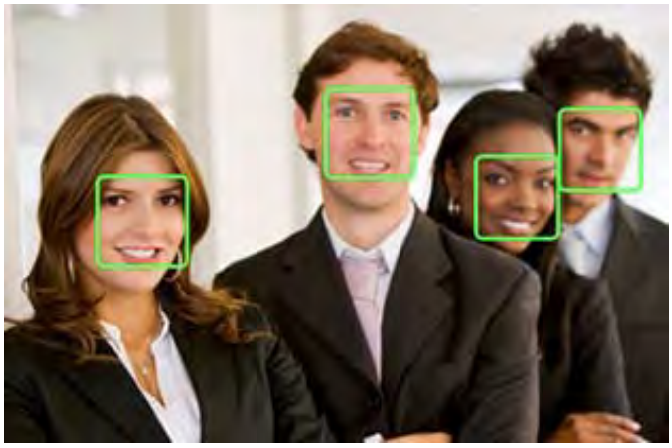

Figure1: Face Detection Demo[3]

Face detection can be regarded as fundamental part of face recognition systems according to its ability to focus computational resources on the part of an image containing a face. A goal of a face detection algorithm is to identify the location and scale of all the faces in the image [4].

The process of face detection in images are more complex because of variability present across human faces such as pose, expression, position, orientation, skin color, presence of glasses or facial hair, differences in camera gain, lighting conditions and image resolution [4].

Face detection is the essential front end of any face recognition system [4]. Face detection is the method of discovering all possible faces at different locations with different sizes in a given image.

If you look at the mirror, you can see that your face has certain distinguishable landmarks [4]. These are the peaks and valleys that make up the different facial features. Software defines these landmarks as nodal points as soon as figure 2.

There are about “80 nodal points” on a human face. Here are few nodal points that are measured by the software [4].

1. Distance between the eyes
2. Width of the nose
3. Depth of the eye socket
4. Cheekbones
5. Jaw line

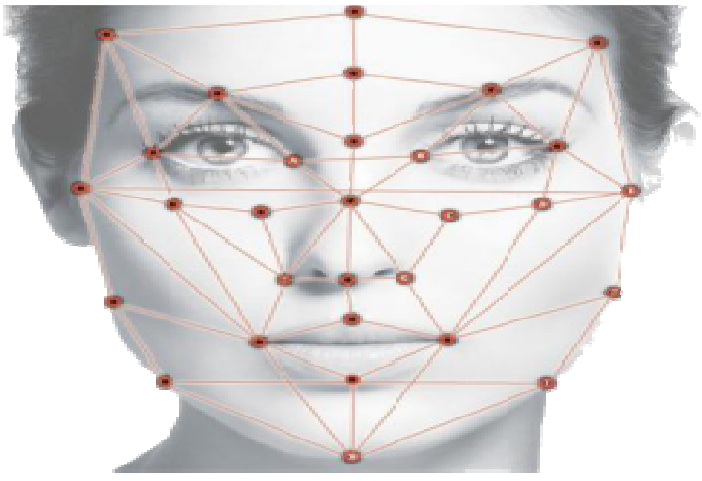

Figure2: Nodal Point on Face [4]

Any face recognition system having front end is called face detection[5]. The output of face detection system is used in face recognition system for the verification as soon as figure3.

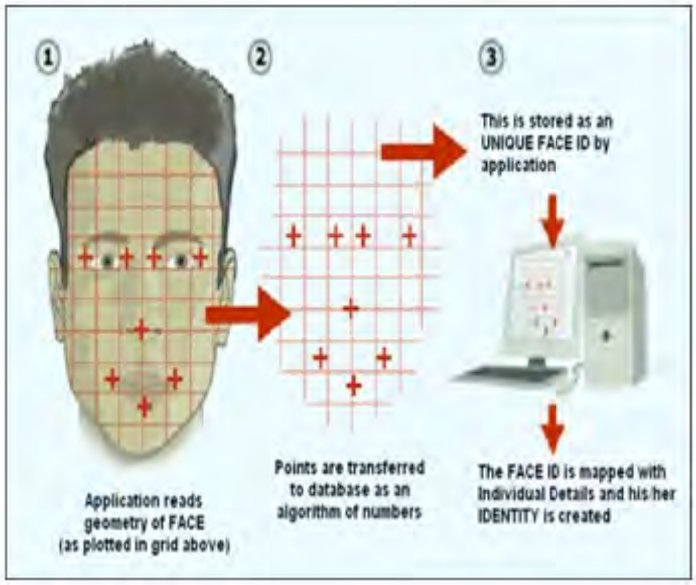

Figure3: Face recognition system work [5]

There are many face detection technique are available for detecting human face. All the research paper having some methods for face detection. That all methods are described in the next session.

Here we are describing related works in session 2 which include research paper on face detection we had read. In session 3 different methods are described such as template matching, symmetry based face detection and etc. Algorithms are also described in this session. After that we have conclude that human skin cooler having problem with same back ground cooler and edge tracking problem.

2. Related Work

A Robust Face Detection method based on skin cooler and edges are used for detecting a human face in various lighting condition and the any pose [12]. In that first, the image celerity improving is applied in the HSV cooler space to convert images in various lighting condition to a one uniform lighting environment and then image segmentation is conducted after the first step result image are coming and then using the edge information to separate the human face from the given image from the background and the other parameters.

A Robust Skin Color Based Face Detection are describe the three color spaces RGB, YCbCr and HSI and then calculate each algorithm results values to each other on that research paper they will find that the YCbCr and HSI color space are more efficient to comparing the RGB to classify the skin area on the images [13]. The next step is that they are combined some facial feature like eyes, ear and mouth and that results they are detect human face on that the given images. This algorithm accuracy is the 95.18%.

Face detection have been studied and compared namely RGB, YCbCr, HSV and CIELAB.The paper concludes that out of these four color models YCbCr yields a better results and performance under varying lighting conditions and changes in illumination [14].

In the automatic face detection using skin color based segmentation research paper are describe why the face detection are used and which condition is help full in real world [17]. This paper are detect face based on the skin color also this paper conclude the accuracy of the proposed algorithm.

In the Human Face Detection in Cluttered Color Images Using Skin Color and Edge Information research paper is work on the HSV space to find a face. This research paper are mainly work on the fast face detection algorithm [7]. This paper also having some problems like false alarm rate when detecting a face.

One of the technique which is based on color and edge information which is having some problem for detecting a human face [8]. Which is that its consider background as the human face, when having a same color on the background.

Skin color algorithm has been developed to detect and track human face in a color image sequence. The algorithm starts with human skin color modeling and uses it in isolating skin pixels(probable face regions). Skin color is found to be a powerful feature for isolating potential face candidates [11]. It is also useful for detecting multiple human faces in an image. It is orientation independent.

Edge detection algorithm for face detection based on edge information and hue has been proposed. Though the results were not accurate for all type of images, the overall performance was quite satisfactory. The algorithm is fast and can be used in other applications. The images used for the experiment were both having a single person as well as group of people taken under uncontrolled conditions [15].

Morphological processing algorithm color space separation was by far the most effective means of eliminating non-face regions from consideration. For the subsequent face segmentation step, we found that the very simple method of looking for face like shapes within the skin probability image to

be effective and computationally efficient [16]. We did not have much success with morphological processing nor detection based on actual face features such as they eyes and mouth.

In this research paper, the authors propose color segmentation based automatic face detection algorithm. 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 73.68% [17].

3. Methods and Algorithms

3.1. Methods

3.1.1. Template Matching Method

Face detection is a process of identify where a face is located in image. Here are four steps for face detection. In first step we locate the face region it means it is represent those parts of image where a face may present. In second step we normalization on detected region it means alignment of facial features are in proper location. In third step we extract various facial features like eyes, nose, mouth, etc. In forth step we verify that parts are face or not. For verification we use some rules, database image or template [6].

In this technique some standard pattern stored in database, this pattern is described the whole face and facial features [6]. It is comparing input image and stored pattern for check where it is face or not. This method is use for both localization and detection.

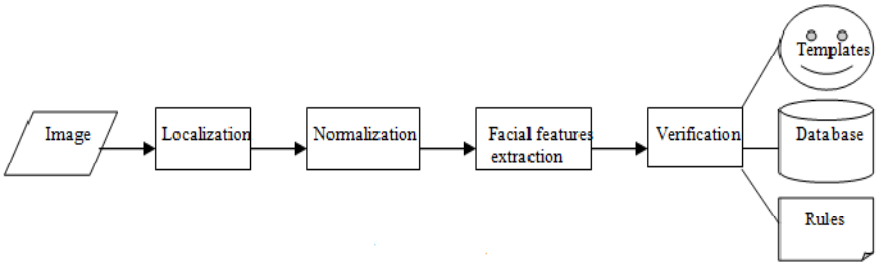

Figure4: Steps of face detection based on template matching method [6].

3.1.2. Based on Skin Color and Edge Information

Face detection system consists of three steps in skin color and edge information technique [7].

Step 1:The first step is to classify each pixel in the given image as a skin pixel or a non-skin pixel.

(a) (b)

Figure 5: Classification of pixels as skin or non-skin (a) Original Image (b) Skin detected Image [7].

Step 2: The second step is to identify different skin regions in the skin detected image by using connectivity analysis.

(a) (b)

Figure 4: (a) Test Image (b) Result of skin color algorithm [7]

Step 3: The last step is to decide whether each of the skin regions identified is a face or not [7].

These are solved by using two parameters. They are the height to width ratio of the skin region and the percentage of skin in the rectangle defined by the height and width.

(a) (b)

Figure 5: Edge detection (a) Test image (b)Edge Image [7]

(a) (b)

Figure 6: Face detection (a) Using skin color only

Using both color and edge information [7].

we are show that this technique having a problem when the detect same as a skin color on a background or other area and it is consider as the human face .Fig. 6 shows a couple with a plain background. The algorithm detects both the faces but gives one false alarm, which is actually a part of the lady's hand.

Figure 7: Results of the proposed algorithm [7].

(a) (b)

Figure 8: Result of the proposed algorithm [7].

3.1.3. Face Detection from Skin Regions

The binary skin map and the original image together are used to detect faces in the image. The technique relies on thresh holding the skin regions properly so that holes in face regions will appear at the eyebrows, eyes, mouth, or nose.

The first step is to ensure that the binary skin map is made up of solid regions (with no holes). Closing holes in the skin map is important because later the program assumes that the only holes are those generated after the thresh holding operation. A whole closing is performed on the skin map image with a 3x3 disc structuring element and then this image is multiplied by a grayscale conversion of the original image. The result is a grayscale intensity image showing only the parts of the image containing skin [8].

3.1.4. Symmetry Based Face Detection Technique

This is use symmetry property of human faces to speedy locate face from background. Here we assume the human face can approximate by an ellipse so we can quickly locate ellipsoidal shaped object in an image. It is not easy task since the size and orientation of the object [9].

Steps for solve the problem

Use sobel operator to find the edge image.

Detect the short segment that contains less than five pixels and delete that segment.

Use the window for scan image from top to bottom and left to right. We use distance to measure the degree of symmetry of the object within the window relative to the center of the window. Here each window one counter and counter is maintained.

Sort the value of count in decreasing order then detect the window which is largest count and that window most possible region containing a face.

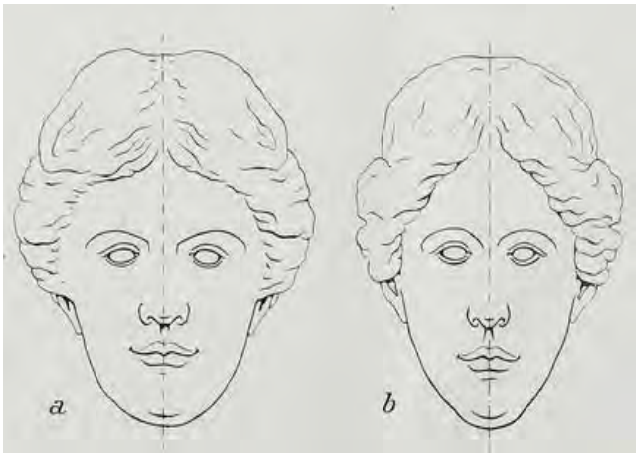

Figure 9: Symmetry Based Face Detection

3.1.5. Based on edge tracking algorithm

The edges are detected from the image by using simple 'sobel' operator. A novel edge tracking method is proposed to extract the face region while ignoring the background region [10].

Edge tracking algorithm:-

- Load the image
- For each row
- For each column
- Find for top-left, top-right, bottom-left & bottom-right coordinates
- Extract the sub-window from the edge image.
- Find the mean (m)
- If mean=0 then the sub-window is think as background and extract the next window
- Else extract the corresponding sub-window from the original image & calculate the rectangle features.

3.2. Method Comparison

Method Name	**Method Component**	**Advantage**	**Disadvantage**	**Reference**
Based on Template Matching Method	Camera	Template already define for face detection.	common problems like variation in illumination, scale, pose, etc.	**[6]**
Based on Skin Color and Edge Information	Camera Matlab	It's based on skin color so it's fast technique compare to other. The time taken by this technique is 11 seconds.	It's having some false alarm rate when same color present on the background.	**[7]**
Face Detection from Skin Regions	Camera	Skin regions threshold value match to the original skin regions value and easily detect the human face.	Only match to skin color regions	**[8]**
Symmetry Based Face Detection Technique	Camera	Based on point symmetry distance using Kd-tree based Nearest Neighbor Computation	Depends on point symmetry distance	**[9]**
Based on edge tracking algorithm	Camera Matlab	regions have the same size and shape and are horizontally or vertically adjacent. Also used mean filter.	Adjust to the vertically or horizontially shape.	**[10]**

3.3. Algorithms

During our literature review we study the basic algorithm for the face detection;that entire algorithm is describing bellow:

3.3.1. The skin color algorithm[7]

The Proposed Algorithm
Step 1. Convert the input RGB image (rgb(i,j)) into HSV image (hsv(i,j))
Step 2. Get the edge map image (edge(i,j)) from RGB image using Sobel operator.
Step 3. For each pixel (i,j), get the corresponding H and S values.
Step 4. If (color histogram(H,S) >skin threshold) and (edge(i,j) <edge threshold) then skin(i,j) = 1 i.e. (i,j) is a skin pixel else skin(i,j) = 0 i.e. (i,j) is a non-skin pixel
Step 5. Find the different regions in the image by implementing connectivity analysis using 8-connectedneighborhood.
Step 6. Find height, width, and centroid for each region and percentage of skin in each region.
Step 7. For each region, if (height/width) or (width/height) is within the range (Goldenratio± tolerance) and (percentage of skin>percentagethreshold)then the region is a face,else it is not a face.

The various thresholds used in the algorithm are shown in the following table. These thresholds are arrived at after some experimentation [7].

Type of threshold	**Value**
Skin Threshold	0.1
Edge Threshold	125
Percentage Threshold	55
Tolerance	0.65

3.3.2 Edge detection algorithm [15]:

Step 1: Load the image and preprocess it.
Step 2: Convert the RGB image to HSV image and calculate the H and S values.
Step 3: Compare the pixel value of the face and cr and cb constants (H and S values).

```
if 140<=cr(i,j) && cr(i,j)<=185 &&
140<=cb(i,j) && cb(i,j)<=205 &&
0.01<=hue(i,j)&& hue(i,j)<=0.1
Segment (i,j)=1;
Else
Segment (i,j)=0;
```

Step 4: Apply edge detection using Sobel operator.
Step 5: Perform binarization and morphological operations to reconstruct the false edges by calculating a mean value.
Step 6: Fill the boundaries of hole (used to represent the face region).

```
BW_filled = imfill(BWa,'holes');
boundaries = bwboundaries(BW_filled);
```

Step 7: Plot shape over the face.

4. CONCLUSION

This review paper describes method and algorithms for detection human face. We have concluded some problem in segmentation of skin color such as skin color and background color of image are same and edge detection of face. The problem in edge detection technique is time consuming process comparing color skin technique.

So required to develop new algorithm for human face detection based on skin color and edge detection techniques. We want to try to develop new algorithm for face detection based on skin color to overcome problem of face detection.

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