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CASE STUDY AND REPORT

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Development Of Human Facial Expression Recognition System

Shashikumar PS
M.Tech Scholar (CS&E)
Nitte Meenakshi Institute of Technology
Bengaluru, India

Santhosh Kumar K.L
Asst Professor, Department of CS&E (PG)
Nitte Meenakshi Institute of Technology
Bengaluru, India

Abstract: Two approaches are proposed for face detection. These approaches are used for expression recognition. In our first approach, the face detection is done using the correlation among face and hair region. The skin color tones are used to locate the region of a face. Further, the hair portion is decided by the process of color spectrum of the hairs. In the second approach, the combination of three color space (RGB, YCbCr and HSI) is used to detect the face. Further, the proposed approach finds the facial features such as eye and mouth regions. Using Rule-based technique, the facial expressions are classified into normal, sad, surprise and smile.

Keywords: Face Detection, Color Model, Polynomial Model, Features Extraction, Facial Expression Recognition

I. INTRODUCTION

Face detection and expression recognition is presently effective analysis in the field of computer vision. Generally, identifying the human face is the initial step in the applications such as image database management, human computer interface, video surveillance, face recognition. Face detection and recognition is applicable where ever text (captcha) security is not sufficient .It is helpful in biometric services. Human Face detection and recognition has many applications in the field of security, surveillance, outdoor surveillance camera service. In normal words, face detection is defined as separating the face regions from the circumstances and accurately discover its area in the input image. To locate the face in an image, we want to capture an input using a camera, explore the image for crucial facial features like mouth, eye and then use its features to find out the area of face section. There are so many approaches are available to identify the human face. Many methods which are established on the ways, like template matching, Eigen face decomposition, pattern recognition, etc., efficiently practiced in the disclosure of face area. All those methods are having their own specific benefits and losses in terms of speed and accuracy.

The approaches such as Machine learning, Neural networks, Hough transform, Template matching, glimpse-based and network-based method needs training database and that are constructed to discover the face in the images.

Face knowledge is a crucial component of human recognition. Human faces are rich in clue about the individual identity and also about mental and state of emotion. It has broad area of application. Cognition of this is an integrative work. Generally, there are six set of emotions such as disgust, anger, fear, sadness, surprise, happiness.

II. RELATED WORK

In [1], cognition of facial expression system has been recommended. The recommended method has three phases such as detection of human face[2], extraction of features, and cognition of facial expression. The initial stage is the detection of face using skin color on the YCbCr color model[3]. Normalization of face image to maintain the uniform intensity. Further, performing dilation and erosion operations to get the face part. The results of the first stage is used as input for extraction of features of face (eyes, mouth and nose) using Active Appearance Model (AAM) method. The last phase involves the cognition of facial expression (Happy, Sad, Smile, Disgust, Fear, and Surprise) using simple Euclidean distance method.

The face detection method has three stages. First is detection of skin color and normalization, Skin color feature is an important, for detecting human face, since this color feature allows fast manipulate. Next stage is to select the appropriate color space (RGB, HSI, YCbCr)[4] to get the portion of skin region by employing the threshold.

The Lighting compensation is very important because the input image is affected by the variation of light so we have to normalize this before proceeding further[5].

In [6], deals with the development of Particular mood detection. The method incudes the pre-processing of input image data like normalizing the image and employing a mask, and extracting the features of human face using the methods like Gabor filters and PCA and then uses Support Vector Machine(SVM) for the analysis and cognition of facial expressions. The Eigen faces are used to find out masks that are specific to the class and those are employed to the image data[7].

In [8], the method Eigenvector is implemented to identify the expressions of face for the facial images. In this method, initially images have to be taken and cropped with respect to five important portions in order to extract and save the eigenvectors for the particular expressions. The Eigenvectors are calculated for the trained images, and the input of face image was identified by computing the minimum Euclidean distance between the trained image and the input face image.

III. PROPOSED METHOD

The initial step of proposed method is face detection, next is feature extraction and last is classification of facial expression recognition. The overall architecture of the proposed system is given in fig 1.

A. Face Detection Using Three Color Models

The methods (RGB, YCbCr, HSI) are used to find the skin color.In this approach first input color image is transformed to RGB model, like that transform the color input image to the

YCbCr model and HSI model, and apply the respected skin tones to the respected transformed color model, to get the skin region for each color model combine this to get the more accurate region of skin, after getting the skin region put bounding box to extract face region in skin portion. The flow diagram is provided in figure 2.

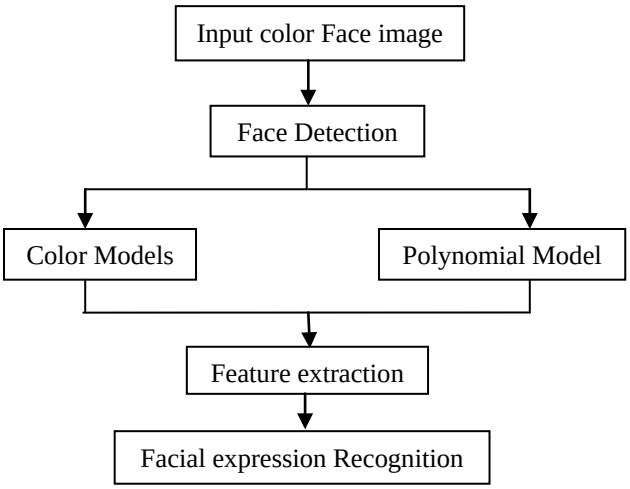


Fig 1 overview of proposed method

Algorithm 1:
Step1: Give the color Input Image.
Step2: Do the pre-processing i.e. Normalization.
Step3: Transform the color input image to YCbCr, HSI color models.
Step4: After the conversion, apply the respected color models tone values to get the skin image.
Step5: The results of three color models are combined, to get the new result (skin region).
Step6: Check the maximum skin pixels for the step 5 output Image.
Step7: Draw a Rectangular box for that region.
Step8: Finally extract the face of the image.

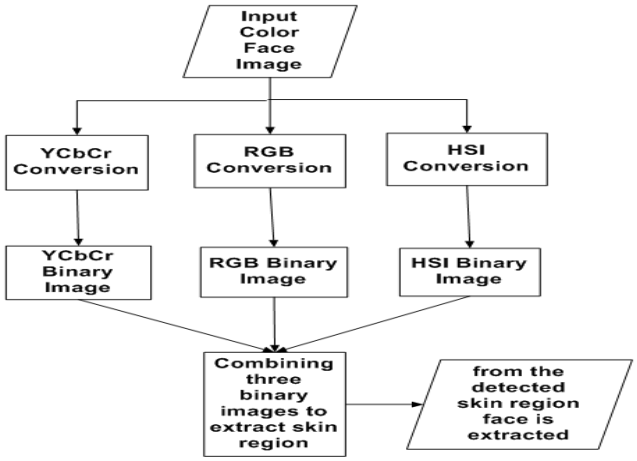


Fig 2 Face Detection Using Three Color Models

B. Face Detection Using Quadratic Polynomial Models

Detecting the human face using quadratic polynomial model, first apply the normalization to the input image to make the variations of light in the input imageuniform, and this method uses Intensity component of HSI color model to obtain the hair region, and it uses skin and hair ranges to extract face region.

Algorithm 2:
Step1: Select the Color Input image
Step2: Perform the preprocessing i.e. Histogram Equalization.
Step3: Separation of Hair color pixels from the normalized image.
Step4: Employ the Skin tone values, to separate the Skin region.
Step5: Check the maximum skin pixels in the image.
Step6: Draw the bounding box around those skin pixels.
Step7: Extract that face region.

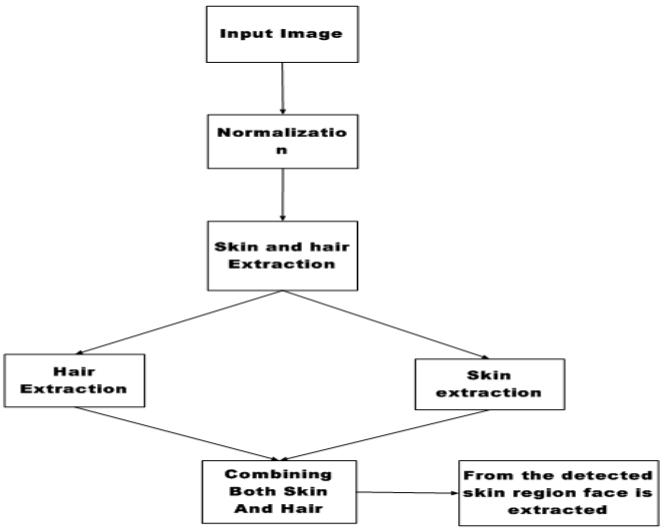


Fig 3 Face Detection Using Quadratic Polynomial Models

Skin region extraction using the Using polynomial quadratic equations:

$$face_{upper(red)} = 0.576 * red^2 + 1.0743 red^2 + 2.2$$

$$face_{lower(red)} = -1.776 * red^2 + 0.7601 red^2 + 0.08$$

Rule1:green > face $_{upper(red)}$ and green > face $_{lower(red)}$
Rule2: White = $(red - 0.33)^2 + (green - 0.33)^2 <= 0.0004$
Rule3: Red > Green > Blue
Rule4: Red – Green ≥ 45 if it satisfies all the four rules then the pixel is a skin pixel otherwise it is non-skin pixel.

Hair region is extracted using the Intensity component of HSI color model which is shown below:
Sum= Red + Green + Blue, Intensity= Sum/3
Rule 4: ((Intensity < 80) && ((Green-blue <15) || (Green-Red < 15)))

If the rule 4 is satisfied then the pixel is a hair pixel otherwise it is a non-hair pixel.

C. Face attributes extraction

To extract facial features, take the output of face detections method as input, the flow diagram is as shown figure 3 and the algorithm for face attributes extraction is shown below:

Algorithm 3:
Step1: Give the face image as an input.
Step2: Transform that image to gray color image.
Step3: Apply edge detection operator(sobel) for this gray image.
Step4: Calculate the centroid of the edge detected image.

Step5: From the centre of the image scan left and right downwards, to extract mouth region.
Step6: From the centre of the image scan left and right upwards, to extract eye region.

D. Facial Expression Recognition

The facial features of eye and mouth are used to classify different expressions using the rule based method.

Steps in Rule based classification are:

Training:

- Find the ranges of features of face(mouth and Eyes) for all the input images.
- Employ "if..then rule" for all range of values.
- Add the expression of a face.

Testing:

- Take the unknown face image.
- Find the features of an face image i.e. module 2
- Find the range of values to the features of face.
- Classify the expression of a face.

Algorithm 4:

1 Take the Features of face (mouth and eye).
2 Check the variations of eyes pixels and mouth pixels.
3 Observe the variations to different expressions and note down the variations in Eye pixel and Mouth pixel to different expressions.
4 Apply the Rule Based classification to identify the expression.

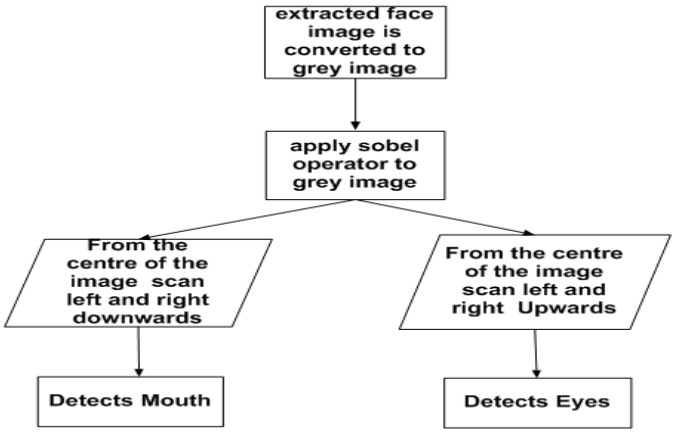


Fig 4 Face attributes extraction

IV. RESULTS AND ANALYSIS

A. Results and observations of Face Expression Recognition

Two major limitations in detection of face are:

i. The lighting condition must be uniform, normal. If the input image is too dark or too bright , then faces cannot be detected. In addition, the implemented method will not let on the massive darkness on the faces since they may be conflicting with the geometric parameters of facial attributes.
ii. The input image must be clear so that attributes of face must appear clear. If the input image is incomplete, the algorithm cannot detect the face.

B. Face Detection Using Three Color Models

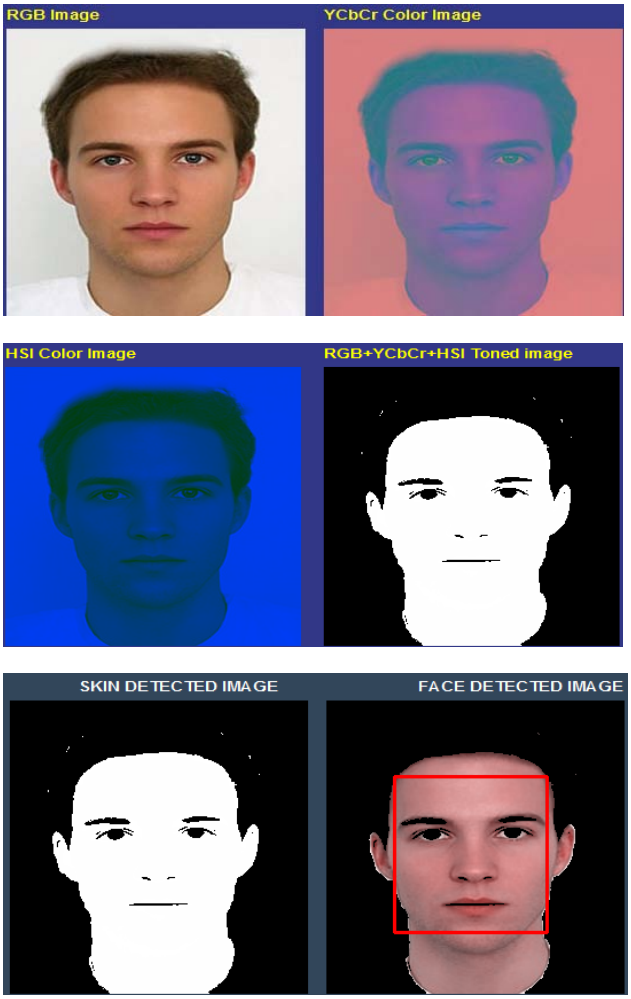


Fig 5 Face Detection using three color model

C. Face Detection Using Quadratic Polynomial Models

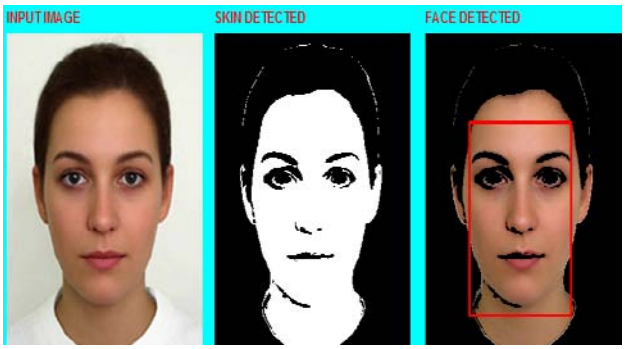
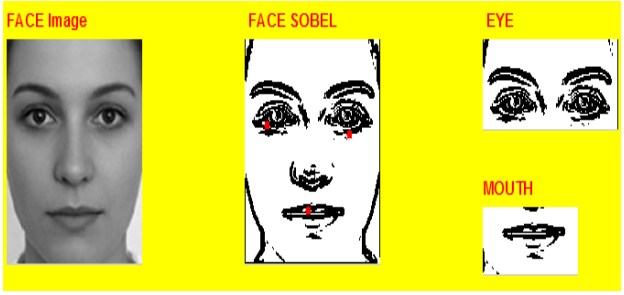


Fig 6 Face detection using Quadratic Polynomial Model

D. Extraction of Facial Features

To identify the expression of face, the attributes of face are crucial. The essential attributes of face are mouth (lips) and eyes. The facial attributes results are shown below.



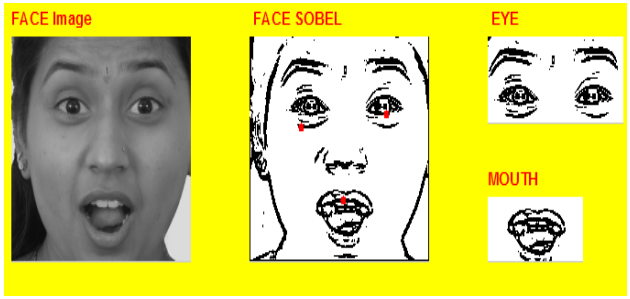
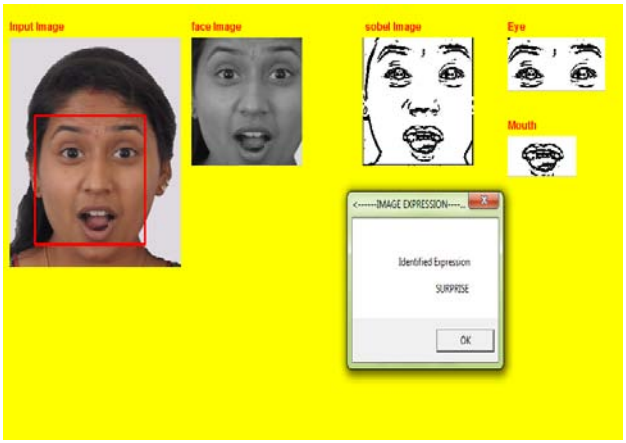


Fig 7 Identification of attributes of face using edge detector

E. Identification of Facial Expression

By using the facial attributes identification of face is done, the method used for expression classification is Rule based method. In Rule based method it Finds the ranges of features of face(mouth and Eyes) for all the images. Employ "if..then rule" for all range of values. And get the expression of a face. The Results of rule based method are shown below:



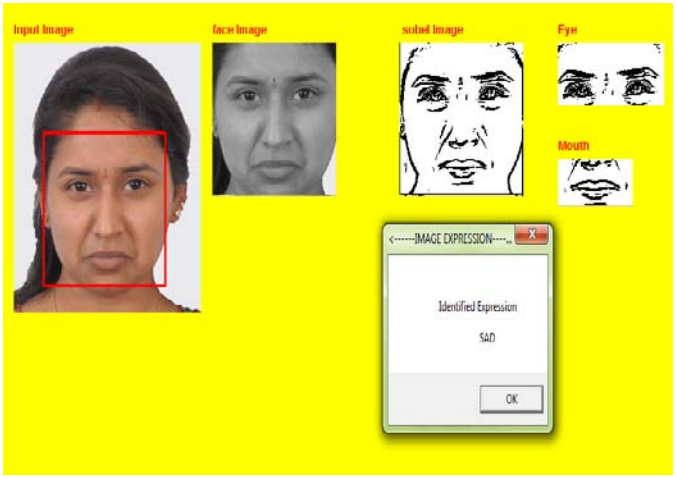


Fig 8 Identification of facial expressions

From the above two proposed methods the quadratic polynomial model takes less processing time when compared to the other proposed method (three color models).

V. CONCLUSION AND FUTURE WORK

In this paper, two different approaches are discussed for the facial expression recognition system. The drawback of the proposed method, the lighting condition must be uniform. If the input image is too dark or too bright, then the face cannot be detected. In addition to this the implemented method will not let on the massive darkness on the faces since they may be conflict with the geometric parameters of facial attributes. The input image must be clear so that attributes of face must appear clear. If the input image is not proper, the algorithm cannot detect the face.

The future work will be the enhancing the projected method to detect the faces in the complicated background images, and detection of faces in the varying light conditions, reducing the false detection rates and reducing the computational time.

VI. REFERENCES

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