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Implementation of Face Detection and Facial Emotion Recognition Methods

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Abstract: Human face recognition is very important in many applications. The initial step in the procedure of Face Identification and Recognition is to detect it efficiently. A hybrid technique has been proposed using skin detection and block approach. This integration is projected to attain fast skin detection. Block approach means dividing the complete image virtually into blocks in addition to that, corner pixels of it are employed with new skin detection ranges. If all the four corner pixels fulfill the ratios entirely, the complete block will be accounted as a skin block and if no corner pixel fulfils these ratios completely, the entire block will be concluded as a non-skin block. Even if some of the corner pixels match the ratios then the block will be scanned sequentially for skin pixels. Another face-detection algorithm presents an efficient, adept rule depending skin region separation method by means of equalized r-g color model. The proposed pattern eradicates the non-skin pixels applying a quadratic polynomial standard and several color depending rules to select probable lip and eye parts.

Keywords: Face Detection, Facial Feature Extraction, Quadratic Polynomial Model, Block Approach, Facial Expression Recognition

I. INTRODUCTION

Facial expression analysis is the essential field of Human Robot Interaction (HRI) because facial expressions indicate human feelings. The steps of recognizing the human facial expression comprise of three problem areas: encounter face, extracting features from it, evaluating the emotion of facial features and categorize this information into expressions such as Happy, Sad, Smile etc.

Face detection and Facial feature detection is the important and initial step of facial expression recognition. It is the difficult task due to the lighting conditions, pose, scale, variations in orientation, facial expressions and partial occlusions.

Analyzing the emotions and classifying them based on facial features is difficult because the features has to be extracted clearly without any occlusion, or any part of it missing. If features are extracted accurately then classification of expression can be done efficiently.

Recognition of face plays an very significant role in many applications like Computer human interface, Surveillance, Image database management, Content Based Image Retrieval, Bio-metric Analysis etc. The first and foremost basic step in the procedure of face identification is face detection. Face Detection is the active research area in Computer Vision. Advantage of Human Brain is that it can recognize and remember the person with his/her name or with his/her unique characteristics. But whereas implementing the same in computer vision is not easy because of the reason that facial features of a person changes in timely manner and does not get match with the same face images already stored in the machine's database.

To build automatic face detection algorithms that analyzes the knowledge incorporated in face images, require accurate, efficient and robust face identification techniques[1],[2],[3]. Face detection also mainly depends on the location of face, light conditions, intensity of light, background of the image, skin like objects and color of dress. There are many ways to detect face, Neural Networks, Hough Transform, Skin Color Extraction algorithms, PCA, Viola-Jones Face detection algorithm, Template Matching, Appearance Based method. Skin color extraction algorithms are easy and computationally time saving.

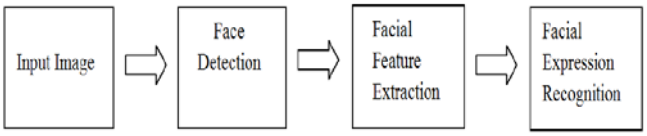

Figure 1: Steps of Expression Recognition

II. EXISTING TECHNIQUES

In [4],[5], there are many face identification methods existing such as Hough transform, template matching, machine learning, neural networks, color analysis[6],[7] and motion extraction. Skin color provides an important parameter for face detection. However, in existence of complicated background and varying illumination situations, color based methods face problems as it cannot detect the skin color accurately. According to this paper, whenever the input image is provided, the color appearance is normalized by using reference white as compensation technique and transform it to YCbCr color model as it is independent of brightness component. Then try to locate eye, mouth by applying eye and mouth detection algorithms respectively. After determining the location of eyes and mouth, algorithm depicts face boundary map.

In [8], Face is identified by means of the Viola and Jones technique and expression recognition is identified by using Neural Network Technique. Face detection is a procedure that targets to find a human face in an input, human face differs from one individual to another. Consequently face detection in real time become a demanding job in computer vision. After face detection the image is normalized using Histogram Equalization technique. A typical ANN has N data; the data layer compose of the values in a data record, that contains inputs to the following layer of neurons. The following layer is

known as a hidden layer and there may be numerous hidden layers. The last layer is the output layer, where each class contains one node. A single brush forward through the network consequences in the allotment of a value to each output node, and the proof is declared to any class's node had the uppermost value.

In [9], author proposes an Automatic Face Analysis (AFA) method to examine facial emotions depending on both eternal facial features (brows, eyes, mouth) and temporary facial features in a almost straight-view face picture series. This scheme identifies fine-grained difference in facial emotion into Facial Action Coding System (FACS) as action units (AUs). By means of these specifications as the data, a collection of action units are predicted in case of they take place in single or in collaboration.

In[10], Haar functions are used for face, eyes and mouth detection; edge detection for extracting the eyes correctly, and finally, Bezier curves to approximate the extracted regions. Then, a set of consecrated distances for each face type is extracted, set that will serve as training input for a multilayer neural network. We analyze the input data using a feed-forward neural network, trained and used for determining the class (Happy, Neutral or Sad) of an arbitrary facial expression.

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 2.

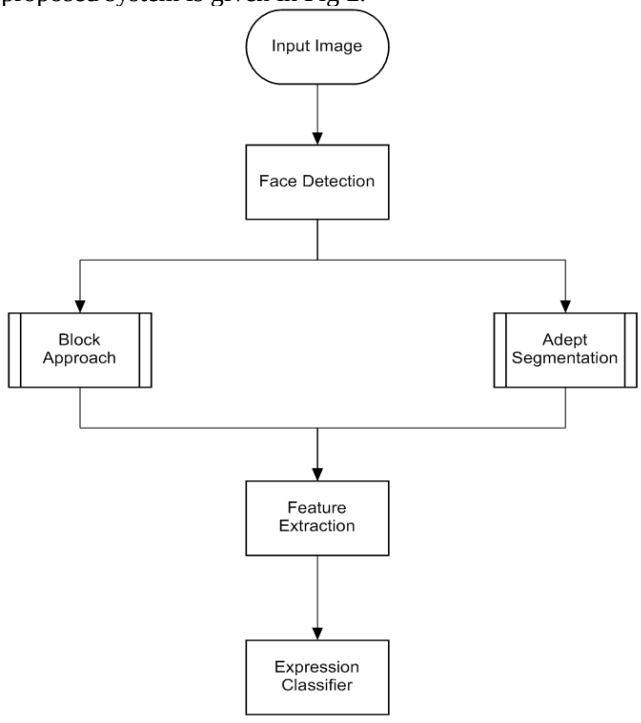

Figure 2: Overview of Proposed method

A. Face Detection:

a. Block Approach based Skin Detection: First the image is virtually divided into blocks, the block size be 8 * 8. If the size of block is smaller, computation time is more, or if the size of block is large then block overlap may occur, accuracy and speed decreases. New skin detectors are used, where it is applied on the corner pixels of each block; if all of the corner pixels fulfill these ratios then the whole block is considered as skin block; if none of the corner pixels satisfy these ratios then the whole block is considered as non-skin block; if some of them satisfy these ratios then block will be searched sequentially for skin pixels. In contrast, by using Block approach, searching time will be reduced approximately to half as compared to the traditional sequential approach.

Skin Detection Ratio

|Red-Green| > 20 and |Red-Green| < 50 and Red > Blue, Red > Green, Blue > Green

Block Approach

$$\sum_i^{row}\sum_j^{col} T < c1(i,j) > 20 \;\&\&\; c2(i,j) > c3(i,j) > c1(i,j)$$

Where c3 , c2 and c1 are the three basic colors (green, red, blue and respectively). T parameter express the highest blue color intensity that a pixel can contain.

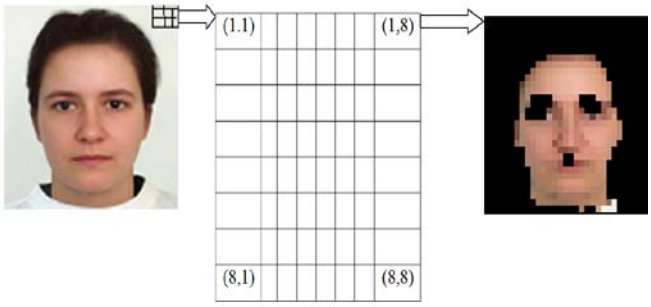

Figure 3: Skin detected using block approach

b. An Adept Segmentation method for Face detection: Here we make use of quadratic polynomial model for the segmentation of skin pixels to decrease the processing time, instead of using probabilistic methods.

RGB color model is influenced by illumination so it has to be converted to a normalized r-g color space.

$$Red_{new} = Red / (Red + Green + Blue) \ldots\ldots\ldots\ldots (1)$$

$$Green_{new} = Green / (Red + Green + Blue) \ldots\ldots\ldots (2)$$

Skin pixels can be found out using these two thresholds

$$F1(r) = -1.3067 * Red_{new}^{2} + 1.0743 * Red_{new} + 0.1452 \ldots (3)$$

$$F2(r) = -0.776 * Red_{new}^{2} + 0.5601 * Red_{new} + 0.1766 \ldots (4)$$

The pixels which meet these threshold are considered as skin pixels and can be extracted using rules

SS1. $F2(r) < Green < F1(r)$

SS2. $Red > Green > Blue$

SS3. $Red - Blue > 10$

Skin Segmentation can be done if all these 3 rules satisfy else it is considered as non-skin pixels.

$$\text{Skin Segmentation} = \begin{cases} 1 \text{ if SS1, SS2, SS3 are true} \\ 0 \text{ otherwise} \end{cases}$$

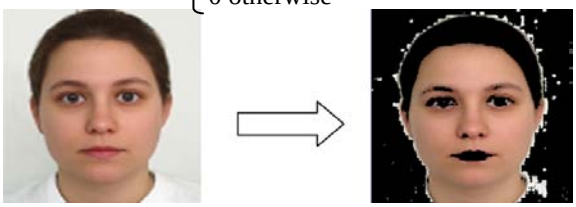

Figure 4: Skin detected using Adept Segmentation Algorithm

B. Feature Extraction:

After Face detection, scan from all the four sides and mark each of its points. Crop the image based on these four points, then take the centroid of the cropped image and divide virtually the whole image vertical and horizontally. Scan the image vertically upwards to the right it results with the right eye and do it towards left it yields with left eye. For Mouth extraction, scan the cropped image vertically downwards for collection of non-skin pixels it will indeed lead to mouth part.

C. Expression Classification:

After Face features are extracted, we use Rule Based Classifier to conclude which expression it results with. We calculate the number of eye and lip pixels for every expression such as Normal, Happy, Sad, Surprise. Then we specify a range for every expression and when a image contained with a face expression is provided, expression is calculated based on ranges pre-calculated.

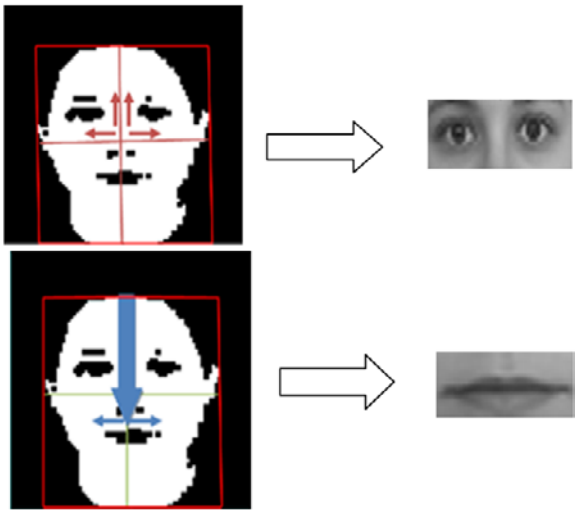

Figure 5: Extraction of Facial Features

IV. RESULTS AND ANALYSIS

A. Results and observations of Face Expression Recognition:

Two main restrictions in face detection and facial expression recognition are:

i. The light condition must be normal. If light variations are present in images then wrong detection of faces might happen.
ii. The Facial components should be clearly visible by having only face images, if we use whole body image then it will be difficult to identify the facial components and their expressions.

In the detection of face, it depends on the conditions of light, image circumstances, and dress color.

B. Face Detection:

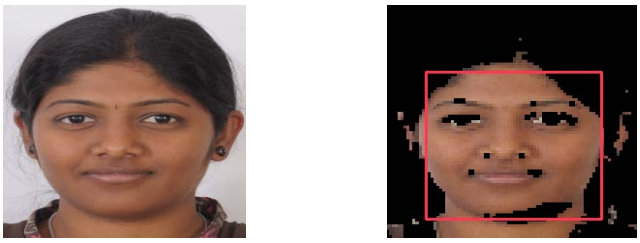

Figure 6: Face Detection using block approach

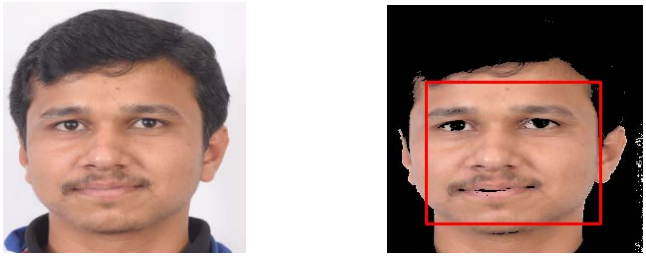

Figure 7: Face detection using Adept Segmentation algorithm

C. Extraction of Facial Features:

To identify the expression of face, the face features are crucial and based on it, expressions are calculated. The facial features are shown below.

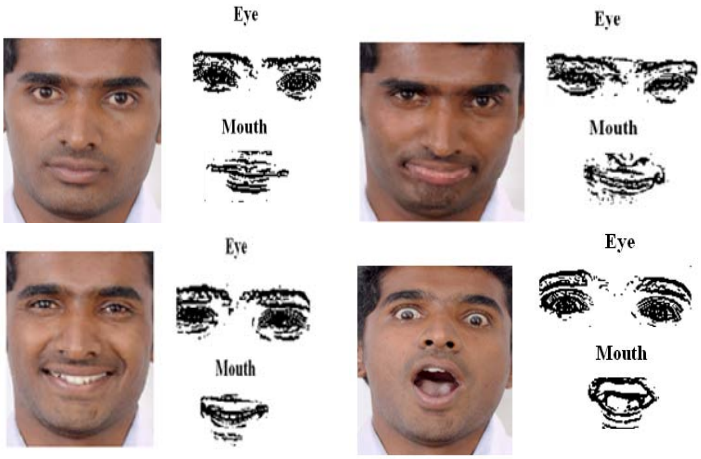

Figure 8: Facial Features extracted of different expressions

D. Facial Feature Extraction:

By using the facial features, identification of face is done and the method used for expression classification is Rule based.

In Rule based method, the ranges of face features (Mouth and Eyes) are calculated for all the images. Employ "if..then rule" for each input image and based on predetermined ranges the expression of a face will be computed.

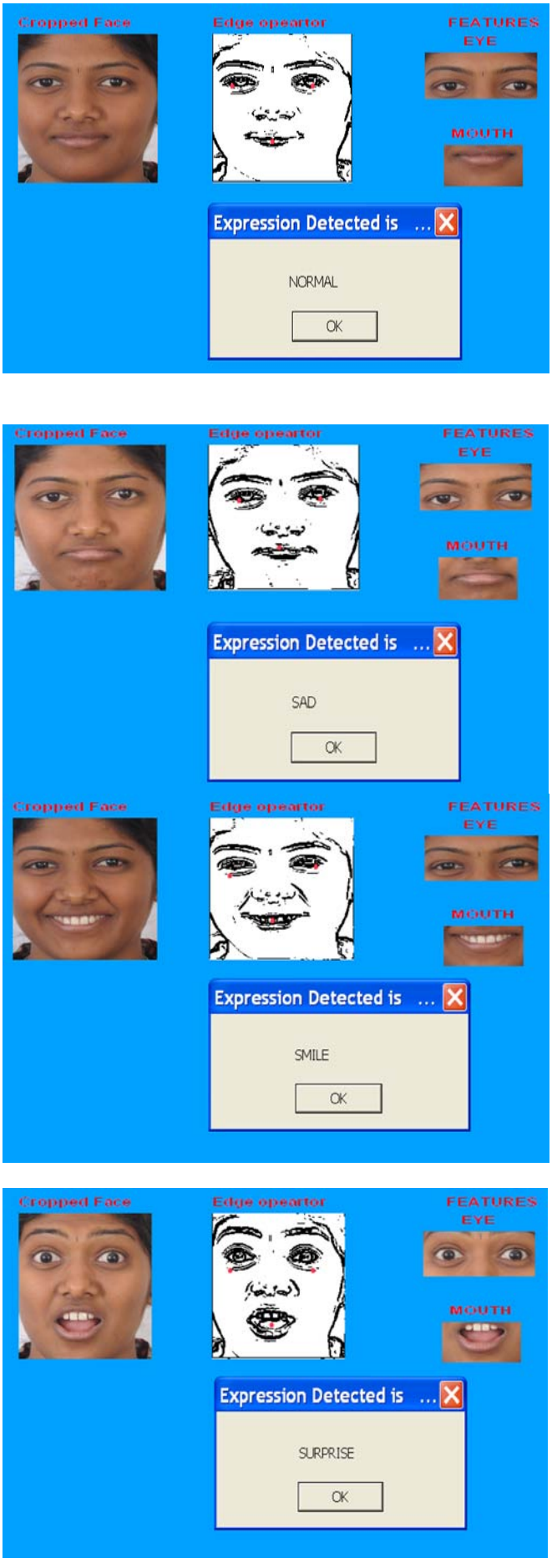

Figure 9: Results of Face Expression Classifier

The face detection using "Block based face detection" and "Adept segmentation algorithm" are shown in Fig 10. Block based approach; it gives the good segmentation of face from the image compared to Adept approach.

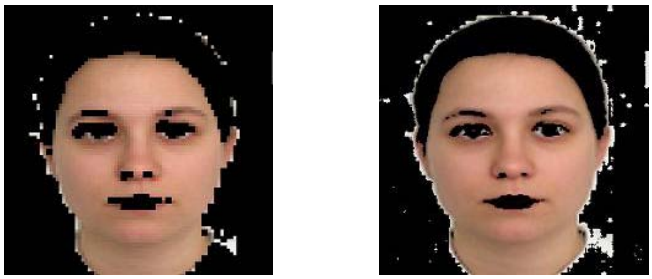

Figure 10: Comparison of Block approach and Adept segmentation

V. CONCLUSION AND FUTURE WORK

The results discussed in the previous section show that the proposed skin detection technique can lead to more efficient and robust process of face detection in real time. It also reduces the searching time as well as more precise skin region gets detected using the new ratios while compared to that sequential approach. Another technique adept segmentation utilize robust rule based skin region extraction algorithm which depends on quadratic polynomial model resulting from the *r-g* chromatic counterparts which reduces time as well.

Feature Extraction is done by using scanning from centroid towards non-skin pixels (eyes, mouth), and extracting it; whereas it can be done also by applying projections. The classification of expression is done by using ranges of eye and lip pixels, where it can be improved by making use of Neural network classifier.

Our future work is to improvise the competence of our face detection technique by generalizing it to operate well in complicated background images in varying light conditions and pose and at the same time minimizing the false detections.

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