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Facial Expression Detection using Correlation in Image Processing

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Abstract: ***Emotion intelligence in human computer interaction is increasing day by day. Human easily detect emotion can see as they are associated with mood, temperament, personality and disposition but for computer its difficult tasks. Computer can detect emotions using digital image analysis. Human can detect emotion using speech with different parameters tone, pitch etc. But emotion detection using digital image analysis is unique technique. In this paper we proposed software which uses digital image to recognize different emotions like angry, happy, sad, surprise etc. This software is divided into two phases 1. Train the software about emotions. 2. Detect the emotions. In this first we preprocessed an image to detect face, and then we select our region of interest using some thresholding. On cropped face, we then applied lip detection algorithm and this lips are stored in database as template with corresponding emotion name. In second phase, we processed give image till lip detection and then we co-relate it with our stored templates. This is simple and in-expensive method to detect facial expression than that of using brain activity or speech.***

Keywords: Facial Expression, Emotion Recognition,Correlation

I. INTRODUCTION

It is widely accepted from psychological theory that human emotions can be classified into six archetypal emotions: surprise, fear, disgust, anger, happiness, and sadness. Facial movements and the tone of the speech are important in expressing these emotions. In our day to day life, we interact with people and it's quite necessary that one should aware about the expressions of the person he is interacting. The muscles of the face can be changed and the tone and the energy in the production of the speech can be intentionally modified to communicate different feelings. Human beings can recognize these signals even if they are subtly displayed, by simultaneously processing information acquired by ears and eyes. Based on psychological studies, which show that visual information modifies the perception of speech [7], it is possible to assume that human emotion perception follows a similar trend.
This paper analyzes the software for 5 different emotions i.e. Sad, Angry, Neutral, Happy and Surprise.

II. IMPLEMENTATION

In order to implement this software there 5 major steps as defined below:

A. Face Detection
B. Cropping Face
C. Lip Detection
D. Lip Segmentation
E. Template Creation (Phase I of software)
F. Template matching (Phase II of software)

A. Face Detection

This software is designed on assumption that our input image should contain single face. If this is not the case then we cannot force software to process any specific face. This approach also defines scope of straight images only. We applied threshold of skin region to detect face. Skin color and textures are important cues that people use consciously or unconsciously to infer variety of culture-related aspects about each other. Skin color and texture can be an indication of race, health, age, wealth, beauty, etc. [3]. However, such interpretations vary across cultures and across the history. In images, skin color is an indication of the existence of humans in such media. The human skin is a fraction of the actual color cube, about 0.25 % of the total colors. Except for extremely hairy subjects, which are rare, skin has only low-amplitude texture. We used three color spaces i.e. RGB, HIS and YCrCb defined in literature to achieve our goal. Skin is unique and efficient feature to detect faces. Skin texture varies from person to person, but

chrominance is same only the intensity differs. Generally, face detection algorithm uses skin segmentation rules to define range of color values to define skin color. After some experiments we defined the set of rules to detect skin color in image as follows.

RGB Model:

$0.836G - 14 < B < 0.836G + 44 \Rightarrow$ Skin OR $0.79G - 67 < B < 0.78G + 42 \Rightarrow$ Skin

HIS/HSV Model:

$19 < H < 240 \Rightarrow$ Not skin

YCrCb Model:

$140 < Cr < 165 \Rightarrow$ Skin OR $140 < Cr < 195 \Rightarrow$ Skin

Fig 1.Orignal Image

Fig.2 Image after Skin Thresholding

For fast processing, after skin thresholding we convert our image into binary. The noise in this black and white image is removed with suitable skin particles. To remove non skin particles we perform morphological operations on binary image. First we erode the image and then dilate it.

B. Face Cropping

After detecting face, our next step is to detect lip. For lip detection we are going to apply red color thresholding but if image contains red color in background except lips, then probability of detecting lips falsely increases. Hence first we select our region of interest from whole image i.e. face. Hence we performed Cropping of face before moving to lip detection, so that we can concentrate on limited area. For cropping, our goal is to find four boundary point i.e. top, bottom, left and right. And on the basis of these points we found the height and width of required rectangle.

C. Detection of lip

After face detection, we applied lip detection algorithm on our area of interest. Human face reflects changes of expression in eyes and in lip region. But maximum changes are visible in lip region rather in eye region. Hence we selected lip detection for more accurate results. Again the process of lip segmentation is same as face detection .In which we need to define first four boundary points i.e. top, bottom, left and right points of detected lip. From this point we will find width and height of lip region which is further used to create rectangle and extract lip region. To avoid any confusion between lips and any other area of face we applied fact i.e. Width of lips is 3 times greater than the height.

D. Template Database Generation And Emotion Detection

Design of our software is divided in two phases 1. Train the software and 2. Judge the software. In first phase we provide training to our software and create template database. We use Roipoly function to create template in database generation. It is out of box function in MATLAB. Roipoly function specifies the polygonal region of interest (ROI) within an image. Its output is in the form of binary image which is used as mask for filtering. BW = Roipoly creates an interactive polygon tool, associated with the image displayed in the current figure, called the target image. With the polygon tool active, the pointer changes to cross hairs,,,+ ,, when you move the pointer over the image in the figure. Using the mouse, you specify the region by selecting vertices of the polygon or any area of interest. You can move or resize the polygon or figure using the mouse. When you are finished positioning and sizing the polygon/figure, create the mask by double-clicking, or by right-clicking inside the region and selecting Create mask from the context menu. Roipoly returns the mask as a binary image, BW, the same size as I. In the mask image, Roipoly sets pixels inside the region to 1 and pixels outside the region to 0. This binary image BW so returned is in logical format and as such cannot be used for implementation. It needs to be converted to a format that can be processed on i.e. double or uint8. After this the masks are cropped

in the similar manner used for face cropping and lip cropping i.e. finding four points and creating rectangle and finally cropping.[5] In second phase, we actually recognize the emotion. In this step we performed cross correlation on the input image with the template present in the database, as cross correlation is generally used to fine degree of similarity between to objects.

III. RESULTS

We have different steps involved in this emotional detection software. So for better conclusion and to outline the performance as well as areas of improvement we studied different steps of this algorithm at individual level. We provide all types of inputs to the system and come across the following different studies with their result sets.

Study I: Face Detection: In the process of face detection, the challenges associated with face detection can be attributed to the following factors: pose, presence of structural component like glasses, faces may be partially occluded by other objects, image orientation, Image lightning conditions etc. So we provided different types of inputs to test accuracy of face detection process. Different inputs provided and their result sets are as follows:

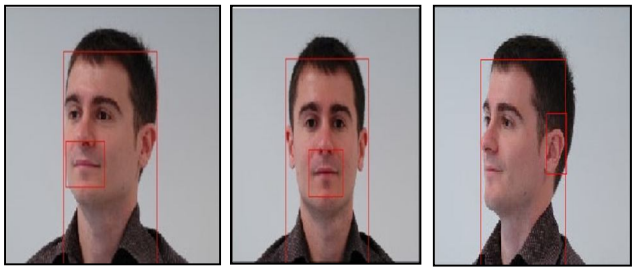

Fig 3: Faces in Different Angle

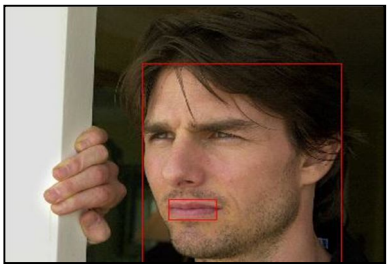

Fig 4 : Face with other skin

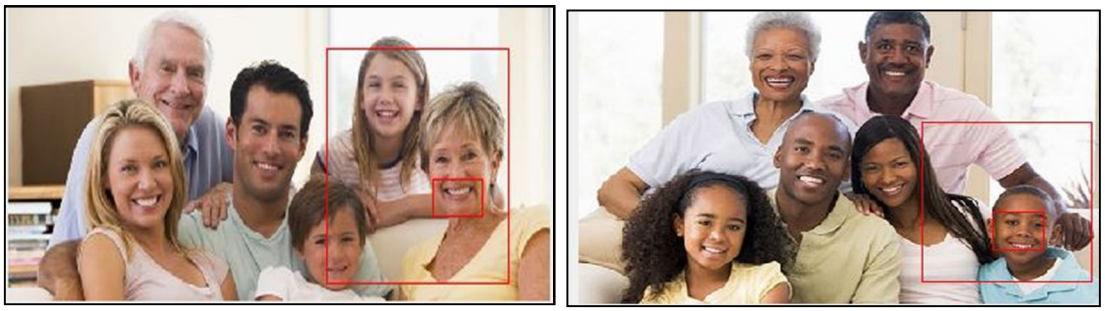

Fig 5 : Multiple Faces

Input Parameter	Successful Detection Rate %
Faces with different Angles	100
Images with multiple faces	22
Faces with Skin	60

Table 1Study I: Results

Study II: Lip Detection: In the process of lip detection, the main challenge associated with lip detection is different person can have different lip colours.

Image 4: Lip detection for different color lips

Input Parameter	Successful Detection Rate %
Lips of different colours	96
Lips with similar emotions	50

Table 2- Study II: Results

Study III: Emotion Detection: This section consists of overall accuracy of the system. In above section we analyzed results of individual processes but there are many scenarios which insist us to analyze the overall system accuracy. The following table consists of statistics which are calculated for all images with single face given to the system for different emotions.

Successfully Detected Emotions %					
Total	Angry	Surprise	Happy	Normal	Sad
76.6	69	80	79	88	67

Table 3- Study III: Results for all emotions

Study IV: Performance Analysis: In this section we observed the response of our system of emotion detection for images of different sizes. These readings are taken from system with 2 GB RAM and Dual-To Core Processor.

Image Size	Time for face detection	Time for Lip Detection
192x163	0.79	0.663
259x194	0.746	0.529
1720x1290	73.483	73.483
437x480	3.536	2.771
133x197	0.502	0.391

Table 4 - Study IV- Results for performance analysis

IV. CONCLUSION

After testing this software on different images, We conclude that this algorithm is faster and easy to implement than existing algorithm based on speech recognition and by ECG in which physical contact with human brain is needed which is quite expensive than this. We worked on five emotions i.e. .happiness, grief, anger, surprise and neutral. These emotions give us successful results on majority of images.

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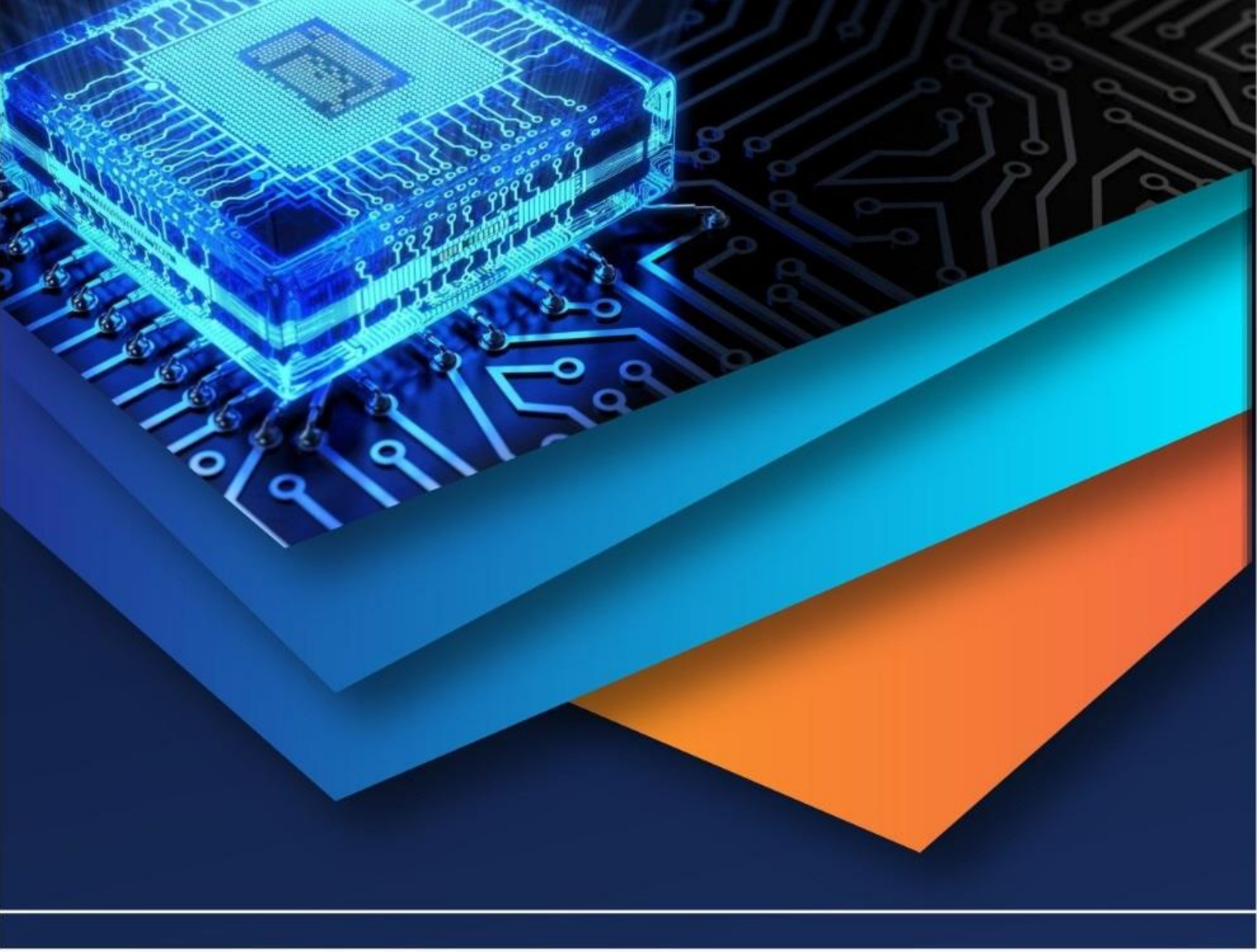

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