Facial Expression Recognition System Using Facial Characteristic Points And ID3

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Abstract: Facial expression is one of the most powerful, natural, and abrupt means for human beings which have the knack to communicate emotion and regulate inter-personal behaviour. In this paper we present a novel approach for facial expression detection using decision tree. Facial expression information is mostly concentrate on facial expression information regions, so the mouth, eye and eyebrow regions are segmented from the facial expression images firstly. Using these templates we calculate 30 facial characteristics points (FCP's). These facial characteristic points describe the position and shape of the above three organs to find diverse parameters which are input to the decision tree for recognizing different facial expressions

Key Words: decision tree, facial characteristics points extraction, facial expression recognition, feature extraction, template matching.

I. INTRODUCTION

Human facial expression recognition (FER) has attracted much attention in recent years because of its importance in realizing highly intelligent human-machine interfaces. Facial expression play important role in cognition of human emotions and facial expression recognition is the base of emotions understanding [9]. Human facial expression contains extremely abundant information of human's behavior and can further reflect human's corresponding mental state. As human face plays a crucial role in interpersonal communication, facial expression analysis is active in the fields of affective computing and intelligent interaction.

Several FER methods have been proposed. See for examples, [1]- [8] and the references therein. The Facial Action Coding System (FACS) developed by Paul Ekman and Wallace V. Friesen is the most widely used and validated method for measuring and describing facial behavior. Ekman and Friesen [1] defined six basic emotions (*happiness*, *sadness*, *fear, disgust, surprise*, and *anger*). Each of these six basic emotions corresponds to a unique facial expression. They defined the facial action coding system (FACS), a system developed in order to enable facial expression analysis through standardized coding of changes in facial motion. FACS consists of 46 action units (AU) which describe basic facial movements. It is based on muscle activity and describes in detail the effect of each AU on face features.

Hence, among the 46 AU that shows the basic movement of face muscles, except for 5 AUs corresponding to movement of cheek, chin and wrinkles, 41 AUs are directly associated with movement of eyes, eyebrows and mouth [10]. However all 41 AUs are not necessarily required for facial characteristics points (FCP) calculation. Therefore we calculate 30 FCP's. In order to extract these 30 FCP's we firstly apply template matching mechanism to match the eyes, eyebrows and mouth template. Then we define these 30 FCP's to compute the position and shape of the different components of the face, such as, eyes, eyebrows and mouth. Using these FCP's we compute the different parameters to be inputted in the decision tree algorithm for recognizing different facial expressions. The proposed work which is being carried out is described in Figure 1.
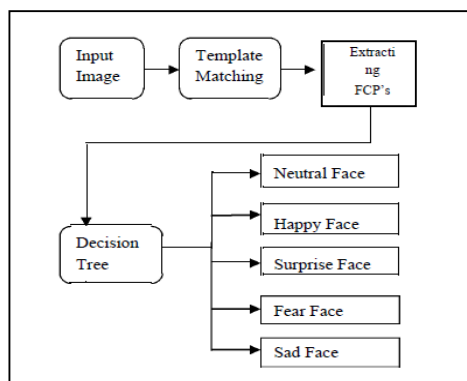

Fig. 1 : Procedure for Facial Expression Recognition

II. TEMPLATE MATCHING

Template matching is being carried out by making use of convolution and correlation coefficients for the highest and perfect matching. The desired eyes, eyebrows and mouth template are being excerpt from the image and the extracted results are shown in the form of bounded rectangles. Table 1 shows the size of image and templates used in our project.
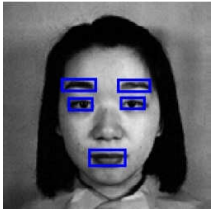
TABLE 1

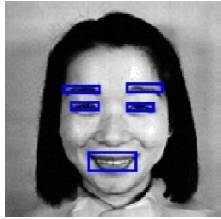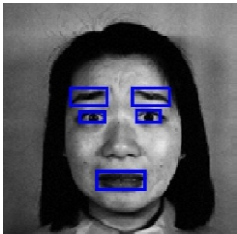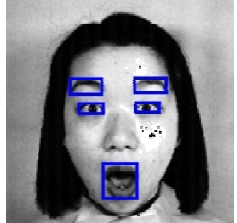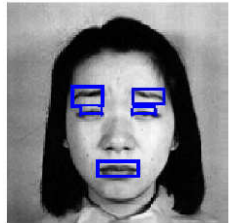| Image/Template	Height (in pixel)	Width (in pixel)
Input Image	256	256
Eye Template	15	30
Eyebrow Template	15	40
Mouth Template	20	45

The bounding rectangles is being drawn according to the specified templates size. Now we make use of these bounding rectangles to calculate the FCP's by extracting the top and left coordinates of the rectangles. The template matching algorithm we implemented in this proposed project is detailed as follows:

Step 1: Send the respective image and it's template as input to the template matching procedure.

Step 2: Convert the image and template into the gray scale by using rgb2gray().

Step 3: Find the convolution of the original image and mean of the template required to be matched.

Step 4: Then we find the correlation to get the highest matching of the template in the whole image

Step 5: Now, we find the four values, i.e. maximum of rows, maximum od columns, template height and template width to draw the bounding rectangles.

Table 2 defines the template matching of the different components to be matched of different faces.

TABLE 2

Neutral Face	Detected Area

Detected Area of Happy Face

Happy Face

Detected Area Of Fear Face

Fear Face

Detected Area Of Surprise Face

Surprise Face

Detected Area Of Sad Face

Sad Face

III. EXTRACTING FACIAL CHARACTERISTICS POINTS

The FCP's is being computed by knowing the top-left coordinate of each template bounded by rectangles. And by using width and height of the template size specified in the TABLE 1 we compute all the 30 FCP's [11].

IV. COMPUTING DIVERSE PARAMETERS] FROM FCP'S

From the 30 FCP's extracted above we compute different parameters such as , opening of eyes, width of eyes, height of eyebrows, openness of mouth, width

of mouth in the following way[12]:

Openness of eyes:

((fc7_y-fc5_y) + (fc8_y-fc6_y))/2

Width of eyes:

((fc1_x-fc3_x) + (fc4_x-fc2_x))/2

Height of eyebrows:

((fc19_y-fc1_y) + (fc20_y-fc2_y))/2

Opening of mouth:

(fc26_y - fc25_y)

Width of mouth:

(fc24_y - fc23_y)

In this way we can set the threshold value for recognizing different facial expression by analyzing the above parameters.

IV. DECISION TREE.

Once we obtained the parameters from FCP's we set the threshold value and proceed for creation of Decision tree. As decision trees are powerful and popular tools for classification and prediction [13]. The attractiveness of decision trees is due to the fact that, in contrast to neural networks, decision trees represent *rules*. Rules can readily be expressed so that humans can understand them. *Decision tree* is a classifier in the form of a tree structure (see Figure 1), where each node is either:

a *leaf node* - indicates the value of the target attribute.

a *decision node* - specifies some test to be carried out on a some threshold value.
Here we make use of ID3 algorithm In decision tree learning, ID3 (Iterative Dichotomiser 3) is an algorithm used to generate a decision tree invented by Ross Quinlan. ID3 gives rules for classifying the data.

Id3 build the tree in the form of top-down approach with no back tracking. In this we need to evaluate Entropy and Information Gain, were both metrics can be defined as

Entropy= -S p(I) log2 p(I).

Gain(S, A) = Entropy(S) - S (($|S_v|$ / $|S|$) * Entropy(S_v)).

where,

p(I) is the proportion of S belonging to class I. S is over c. Log2 is log base 2.

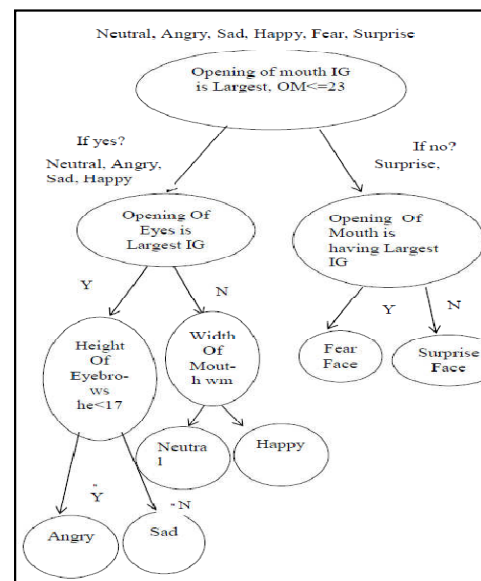where: S is each value v of all possible values of attribute A

S_v = subset of S for which attribute A has value v $|S_v|$ = number of elements in S_v

$|S|$ = number of elements in S

Information gain is used to select the most useful attributes for classification. It can be drive as follows:

1. The entropy of total dataset is calculated

2. The data set is then split on the different attributes.

3. The entropy of each branch is calculated then it is added proportionally, to get the total entropy for the split.

4. The resulting entropy is subtracted from the entropy before the split with the result is the information gain.

5. The attribute that have the largest IG is chosen for the decision node.

6. A branch set with entropy of zero is the leaf node.

7. Otherwise, further splitting to classify its dataset.

8. The ID3 algorithm is run recursively on the non-leaf branches until all data is classified.

Figure 2 specified how to take decision in order to recognize different Facial Expression.

The above figure 2 is constructed based on the following data derived on the above defined techniques specified in the proposed work. Table 3 specified the data entries on which ID3 is implemented.

For Neutra-l Face	Opening of eyes oe	Width of eyes we	Height of eyebrows He	Opening of mouth om
Face 1	10.5	27.5	21.08	14.16
Face 2	11.5	26.5	23.5	14.16
Face 3	10.5	23	21.56	13.33
Face 4	10	23.5	22.83	14.16
Face 5	14	29	22.10	16.66

Table-3

For happy Face	Opening of eyes oe	Width of eyes we	Height of eyebrows He	Opening of mouth om
Face 1	8.5	32	21.26	17.5
Face 2	11.5	25	25.38	19.16
Face 3	9.5	25	21.76	11.6
Face 4	8.5	27	16.41	27.5
Face 5	11	22	17.65	20.8

For Fear Face	Opening of eyes oe	Width of eyes we	Height of eyebrows He	Opening of mouth om
Face 1	12	26.5	20.65	16.6
Face 2	10.5	24.5	17.73	23.33
Face 3	12	25	14.65	25
Face 4	14	25.5	22.25	20.8
Face 5	9.5	28	18.76	20

For Angry Face	Opening of eyes oe	Width of eyes we	Height of eyebrows He	Opening of mouth om
Face 1	8.5	24	15.13	16.6
Face 2	11	29	18.9	13.3
Face 3	11	24.5	15.4	11.6
Face 4	10	25.5	15.9	13.3
Face 5	12	25	16.3	12.5

For Sad Face	Opening of eyes oe	Width of eyes we	Height of eyebrows He	Opening of mouth om
Face 1	12	23.5	19.4	15
Face 2	9	27	19.8	15
Face 3	8.5	28.5	16.4	14.16
Face 4	8.5	24	17.6	15
Face 5	7.5	27	16.6	15

VI. TESTING

We use the above specified methods to determine different facial expression on JAFFE database and test it for very small set of the data, in which it is proven to be successful. The program is implemented in MATLAB. The full preparation and testing is yet to be carried out in this on -going project. But the test performed on the JAFFE Database is resulted as shown in figure 3
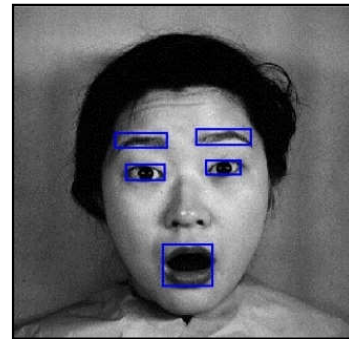
Detected area of test face

Figure 3

For Surprise Face	Opening of eyes oe	Width of eyes we	Height of eyebrows He	Opening of mouth om
Face 1	11.5	26.5	23.8	32.5
Face 2	14.5	28.5	29.16	35.8
Face 3	11.5	28	24.88	29.16
Face 4	14	24.5	23.28	28.33
Face 5	13.5	25	19.53	26.66

The face is input to the facial expression recognition system where the face is recognized as surprise face correctly by the program

VII. CONCLUSION

Extensive efforts have been made over the past two decades in academia, industry, and government to discover more robust methods of assessing truthfulness, deception, and credibility during human interactions. In this paper we proposed a decision tree based approach for expression identification. The future work is to train the neurons for training and testing.

VIII. FUTURE WORK

As it is specified the proposed work is on-going project, hence there are many scope for the project to explore, by improving template matching procedure, and trying out the project for different images other the JAFFE database. Also, to implement it with different novel techniques like neural network, artificial intelligence etc.

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