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Facial Expression Recognition using 2D-DCT and Self Organizing feature Map (SOM)

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Abstract:- The combined concept of image processing [9] and neural network [3] [4] can be used in many applications like security system, medical imaging system, forensic identification system, biometric identification system and human computer interaction system (HCI) etc. Face recognition [4] [6] [7] [8] is a common approach used in security system, forensic identification system and biometric identification system. In this paper we will show how the concept of face recognition can be used to recognize the facial expression of a person. Here we use some image processing techniques like 2D-DCT [2] to compress the digital images and some preprocessing techniques to enhance the performance and then we use the concept of neural network like SOM (Self Organizing Map) [3]-[8] to recognize the facial expression efficiently. Here we use an image database consisting a number of faces of each expression to make a face space. For example, we use 10 sets of smiley faces (same person or different persons) to make a smiley face space. Now if a given image has to be recognized, the SOM will detect in which class it belongs to. The accuracy of our approach is depends on the number of epochs used in the SOM and the number of training face images.

Keywords:- Face detection, face recognition, facial expression recognition, 2D- DCT, Self Organizing Map (SOM).

I. INTRODUCTION

Facial expression recognition [1] [3] is another fruitfulness of computer vision research. Computer vision is the way to electronically represent the human vision with the help of some data analysis techniques. In a Human Computer Interaction (HCI) system, the communication between human and computer can take place through different aspects (like verbal, non-verbal) of a human. Here we are considering only the non-verbal aspects of human being like, facial expression, body movement etc. In this paper we are mainly concern about the facial expression recognition process, which needs a face image on which we should apply our facial expression recognition algorithm. Now once we have the face image data, we need to apply some processing techniques with the help of pattern recognition, artificial intelligence, mathematics, computer science, electronics or any kind of scientific concept. Hence there are huge numbers of applications in computer vision research, but we will discuss only face recognition and facial expression.

There are many applications, where facial expression detection process plays an important role. Researches in the field of social psychology show that facial expression are more natural in nature than the speaker's spoken words and truly reflects the emotion of a person. According to statistical reports verbal part of a message contributes only for 7 percent to the effect of the message as a whole. The vocal part contributes for 38 percent, while facial expression of the speaker contributes for 55 percent to the effect of the spoken message. The facial expression recognition system was introduced in 1978 by Suwa et. al [12]. The main issue of building a facial expression recognition system is face detection [10] and alignment, image normalization, feature extraction, and classification. There are number of techniques which we use for recognizing the facial expression.

In the following section we will discuss about a very simple facial expression recognition algorithm, optimizing the time complexity.

II. FACIAL EXPRESSION RECOGNITION

In recent technology we have seen that how the advance image processing techniques with the help of pattern recognition and artificial intelligence can be effectively used in automatic detection and classification of various facial signals. Among them face recognition and facial expression recognition are the best ones to describe the concept of man-machine interaction efficiently. In both of these techniques we are doing patter recognition. For example, in face recognition we consider two patterns 'known' and 'unknown' whereas in facial expression recognition we consider five patterns 'neutral', 'happy', 'sad', 'angry', 'disgust' etc. Facial expression recognition can be used in behavior monitor system and medical system. In this paper we will show

how the concept of face recognition with the help of neural network can be used in facial expression recognition process. The following figure shows the concept of a typical facial expression recognition system.

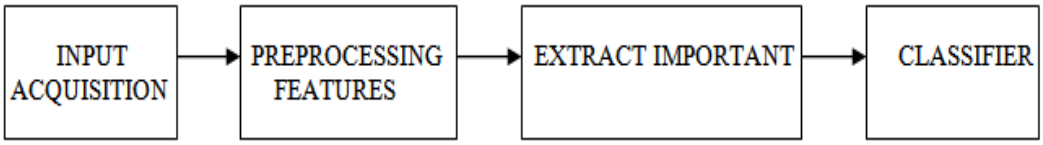

Figure 1: Block diagram of a typical facial expression recognition system.

A. INPUT ACQUISITION

At first we need to acquire the image on which we will apply our facial expression recognition techniques. Input image can be captured by any kind of imaging system. There is no specific standard regarding the size, format or color (RGB or gray) of the image. It is the responsibility of the next phase to transform the input image from one form to another, which is suitable for our processing.

B. PREPROCESSING

The input image can be of different size, format, color (RGB or gray) etc. Hence we should preprocess the input image, so that we can efficiently apply our algorithm to get better result. In the preprocessing technique we use some compression technique like 2D-DCT to compress the data, because an image consists a large number of data, which increases the computation time. Also, we can apply some filtering techniques to remove the noise from the input image, because the presence of any artifacts can lead to false detection of facial features, which could produce wrong output.

C. EXTRACT IMPORTANT FEATURES

In this stage we will extract important facial features, on which we will apply the pattern recognition algorithm. As we are recognizing facial expression, hence we need to detect and extract the face region from the background. There are a variety of face detection algorithms, but among them we use a very simple skin color based face detection algorithm [11].

D. CLASSIFIER

Here we determine on which class the given input image belongs to. For a face recognition algorithm we classify the input image in two classes either ‘known’ or ‘unknown’. But in case of a facial expression recognition algorithm, we classify the input image in four classes like ‘neutral’, ‘happy’, ‘sad’, ‘angry’, and ‘disgust’.

III. PROPOSED FACIAL EXPRESSION RECOGNITION ALGORITHM

In this paper we have implemented a very simple facial expression detection algorithm. This algorithm is not only an efficient one but also reduces the computation time.

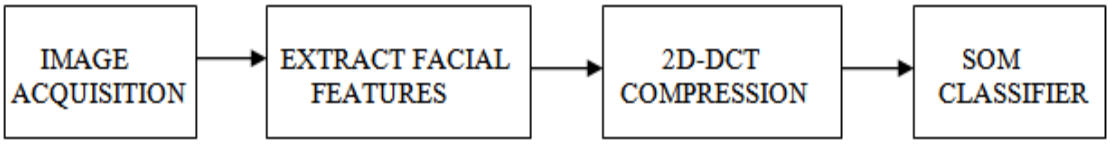

Figure 2: Block diagram of our proposed facial expression recognition system.

A. IMAGE ACQUISITION

Image acquisition can be made using any kind of imaging system or they can be collected from an image database. There are many image databases available on the Internet and hence acquiring image data from database is the most fast and inexpensive way. But in case of a real-time system, we should install the proper imaging system to capture the face image of a person.

B. EXTRACT THE FACIAL FEATURE

Once we acquire the face image, we need to extract the facial features from the background of the image. In this paper we use skin color based face detection technique, which uses RGB and HSV color model [11]. There are another color model (YCbCr) that can also be used to detect skin color region.

C. IMAGE COMPRESSION

In this stage, we use 2D-DCT to compress the extracted facial feature, which can make our processing faster. As our algorithm uses an image database, we have to apply the compression technique in all the images in the database.

D. SOM CLASSIFIER

Self Organizing Map (SOM) is a well known artificial neural network, which uses unsupervised learning process. Here the learning process is dependent on the input data, which is known as unlabeled data and is independent of the desired output data. The success rate of SOM network is dependent on the number of training data we are using, higher training data means higher success rate.

SOM can also be termed as topology preserving map. There is a competition among the neurons to be activated and only one neuron that wins the competition is fired and is called the "winner". Kohonen rule is used to learn the winner neuron and neurons within a certain neighborhood of the winning neuron. This rule allows the weight of neuron to learn an input vector so this makes it perfect for recognition. Hence in this system SOM is used as classifier.

In our proposed approach we populate the training data set with 25 training images. As we are recognizing facial expressions, we need to store images for every expression. In our proposed approach we have used five types of expression: 'neutral', 'happy', 'sad', 'angry', 'disgust'. For each expression we use five different individuals. Hence our database has 25 train images. If we populate the database with more training images, we will get better results.

IV. EXPERIMENTAL RESULTS

In this section we have shown some screen shots of (a) the input image; (b) the image which, closely matches with the input image and (c) the expression.

(a) (b)

(d)

Figure 3: (a) Input image, (b) Matched database image, (c) Input image with expression details the top.

V. CONCLUSION

In this paper we have shown, how the concept of image processing and neural network can be effectively used to design a facial expression recognition system. The working principle is very similar with the working principle of face recognition system. In face recognition system we find out whether a given face Image is present in a specified database or not. Whereas, in our facial expression recognition system we find out in which class a facial image is belongs to and output will be the expression of the matched database image.

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