Analysis of different feature identification methods for detection of facial expressions

Navpreet Kaur
Assistant Professor
School of Computer Science and Engineering,
Lovely Professional University, Phagwara, Punjab, India.

Abstract The advancement in computer vision and pattern recognition in last two decades has opened the path to automatic face expression recognition system. In this paper, computer vision and pattern recognition both work together to detect the expressions of a human. For this task we have four phases: Detection of face, identification of human face, identification of face features, and identification of facial expression. In Detection of face, input image is taken and face region is detected. After this in identification of human face, human face is identified and located. Then next is identification of face features where the position of different features is identified. With the help of features position, the expressions of different features are analyzed.[3] Now in the last phase facial expression is identified through classifier. Classifier analyzes the position of any feature with its standard facial expressions and finally it provides the facial expression of the human on the basis of the image provided as input.

Keywords: computer vision, pattern recognition, automatic face expression recognition system.

Introduction Facial expressions are the non verbal method of communication which expresses the emotions and mental stability of a human being. The facial expression recognition system provides completely automatic system for human facial expressions. In this images of sample faces are collected and database is created with that.[4] The human faces which we see everyday possess different types of expressions, Here five human facial expressions i.e. happiness, sadness, anger, surprise and fear are focused. These expressions in actual are the movement of the facial muscles which convey the feelings of a human. Facial expressions are adopted by humans either voluntarily or involuntarily. Voluntarily expressions are possessed by human knowingly whereas involuntary expressions are the expressions which occur instantly. Voluntarily expressions occur with the will of a human and is possessed from few seconds to few minutes whereas involuntarily expressions occur without the will of a human and is possessed for a fraction of seconds.

Types of Expressions

Different facial expressions as per emotions are represented as follows:

- Happiness: The expression of happiness represents the joyful state of a human.
- Sadness: The expression of sadness represents the sorrowful state of a human.
- Anger: The expression of anger represents the annoying state of a human.
- Surprise: The expression of surprise represents the response for any unpredicted event.
- Fear: The expression of fear represents the situation of danger.[5]

Fig 1.1 Facial Expressions

Objective of the Facial expression recognition

system

The facial expression recognition system has the objective to recognize the expressions possessed by an individual correctly and efficiently. The problem that occurs while recognizing the facial expression of samples face is that, in some cases the expression depicted in the image is somewhat similar to another expression, so the computer may not identify the actual expression possessed by the person. Therefore a system can be designed which recognizes the facial expression of the images in database correctly and should not confuse in similar facial features of different expressions. Different techniques can be applied for generating better result as compared to the work that has been done.[2]

Scope of facial expression recognition system

Today we are trying to establish a proper understanding and link between the humans and the machines. The steps towards knowing one‘s emotion by their facial expressions and recognizing it using machine is an innovative idea. The facial expression recognition systems can be used by robots. The robots are now designed to interact with humans and become a part of their lives, therefore, we need to establish link so that the robot may become more intelligent in terms of understanding the human‘s expressions and emotions.[1] For better human-computer interaction, robot should be able to identify a person’s facial expression and conclude their emotional state. This may help in developing the process of creation of a better humanoid robot. The facial expression recognition systems are also used in crime branch to detect weather the person is speaking truth or not. In present scenario people may not say the truth but by the movement of their face muscles, we can conclude the person‘s emotion or intention through their expressions. Therefore, facial expression recognition system may play a crucial role in identifying people‘s actual intentions behind their statements. The facial expression recognition system can also be used in detecting faces possessing different or similar expression present in the group of people.

Proposed System

The facial expression recognition system follows steps to generate the desired outcome. The system requires detecting the face of an individual followed by the extraction of features. When the features are extracted from the image, the position of the features is used to recognize the facial expression present in an image. This depiction of facial expression ends the process. The steps that contribute in facial expression recognition system are:

- Detection of human face in the image.
- Identification of human face.
- Identification of face features.
- Identification of facial expression.

Detection of human face in the image

The detection of face from the image can be done by facial recognition process. This includes identification of the face from the images regardless of the expression they carry. The face detection includes image segmentation.

Image Segmentation: In the process of image segmentation, a matrix is generated. This matrix contains different values of the color yellow, cyan and magenta such that the color represents skin color. As we know the skin complexion differs from person to person, hence it was determined by mean and standard deviation of each component. The skin color present in the image is the face itself; hence we can easily recognize the face of an individual in the image. By running the matrix containing skin color causes detection of face in the image.

Identification of human face

Human face in the image can be recognized using artificial intelligence image based approach. In this, it considers the image which is segmented by image segmentation. For this, first of all an image is

selected and then the redundant data from image is removed through image compression using two-dimensional discrete cosine transform (2D-DCT). The DCT extracts features from images based on skin color. These skin color detection is constructed by specifying the values to DCT coefficients.[6] By using unsupervised learning techniques we use DCT based extraction of face recognition. In this process the image analyzed is first converted to gray-scale and then DCT was applied for extraction of the required output. Different face detection techniques are mentioned in the figure below

Knowledge based
Feature Invariant • Facial feature • Texture • Skin color • Multiple Feature
Template Matching
Appearance based • Eigenface • Distribution based • Neural network Support • Support Vector Machine (SVM) • Hidden Markov Model (HMM)

Figure 1.2: Facial Detection methods

Identification of face features

For the identification of face features , there are various feature extraction techniques used to detect the features of the faces and their positions to identify the expression an individual. Some of the feature extraction techniques are mentioned below.

Feature identification using Discrete Cosine Transform: For feature identification using DCT an input image is taken and the Discrete Cosine Transform is applied. The coefficients of the DCT are arranged in zigzag manner. The next step is to convert the 2D DCT image into feature vector using DCT coefficients. The image is divided in blocks and each block has a feature whose position is to be determined. The DCT is applied on these blocks. The DCT coefficient of each feature is then combined with the feature vector. Adaboost classifier is used for the purpose of recognition of the expression.

Feature identification using Gabor filter: In this the images are preprocessed to normalize the faces and Gabor filter is used to separate different expressions. For the recognition purpose and dimension reduction we use different classifiers like Feasibility of Linear Discriminant Analysis (FLDA) and Principle Component Analysis (PCA) .Gabor filters are used to detect the facial expression. By using Gabor filter for feature extraction the complexity is reduced and the dimension of feature space is decreased. This helps in computing the output more efficiently.

Identification of facial expression

The last step in the facial expression recognition process is the identification of the facial expression in the image taken as input. For this purpose we can use different classifier. Some of the classifiers are mentioned below:

AdaBoost: In this, the frontal face in an image is classified in basic expression, these are happiness, sadness, anger, surprise and fear. Here the recognition system is done on the basis of skin color detection. To detect the face we detect the presence of skin color in the image. By applying YCbCr, RGB, HSI the skin color is detected in the image. After this, by using some threshold value we separate the skin color region and the non-skin color region.

Neural Network as classifier: This method for the detection and classification purpose follows two steps that are feature extraction and neural network. In the first step Gabor filters are used to extract the features from the image. The feature vector is obtained from neural network. The Neural network is trained with face and non-face images.

Face Recognition based on Principal Component Analysis (PCA): It was the first widely accepted algorithm for face recognition. Following are the steps explaining in brief.[7]

i. Acquire the training set of face images and calculate the eigen faces which define the face space.
ii. When a new face image is encountered, calculate a set of weights based on the input image and project the input image onto each of the Eigen face.

Determine if the image is sufficiently close to face space by calculating Euclidean distance.

Methodology for Facial Expression Recognition System

The facial expression recognition system follows various steps to generate the desired

outcome. The first and second step includes detection of the face region in the input image. The input image is passed through filter and is preprocessed to normalize the shape, size and intensity. In the next step expression features are extracted from the image. In the last step the extracted features are processed to classifiers, these classifiers helps in recognition of the expression as output.

In the first and second step, an image from the database is taken. This image works as input to the system. The input image is preprocessed to minimize the variations caused due to environmental factors or presence of noise in the image. The preprocessing step includes image enhancement operation such as image scaling, image brightness, contrast adjustment, etc..

The detection of face region is done after the preprocessing step. The complex background of the input image may cause difficulties in detecting the face region, therefore we select light background. There are different techniques used to detect the face region of the input image, for example on the basis color complexion, feature based, template based, etc. It is advised to select the database with same lightening condition. It is required that all the images in the database should be same as the tracking image. This tracking image is the reference image selected for the processing of detection of multiple images.[8]

For the recognition of the facial expressions we need to extract the parameters that determine the difference between the occurrences of the expressions. This parameter is known as feature vector of the image. The information that we extract from the feature vector is the only parameter from which we depict the expression of the image. There are two types of the feature extraction used to describe facial expressions. These are Geometric Features and Appearance features.

There are different database present online. These databases are Cohn-Kanade AU-Coded facial expression database, MMI Database, Japanese Female Facial Expression (JAFFE), etc. The databases collected the individuals and captured their facial expression. All the databases contains specific no of sample subject and their expressions for different expressions (individuals who posed expressions), gender of the subject, total number of images, and an excel sheet. The different database available to us was well studied and analyzed.

Outcome of Facial Expression Recognition System

The output expected from the facial expression recognition system was the identification of the expression present in the input image. The proposed methods of the system, which are, Detection of face, identification of human face, identification of face features, and identification of facial expression should generate the outcome expected, that is detection of face in the image, extraction of features from the detected face and using classifiers classifying the expression present in the input image. The expressions that we try to detect are the basic facial expressions (happy, sad, anger, surprise and fear).

Conclusion

In Facial Expression Recognition system input is considered. The input was then normalized, cropped and scaled using different image enhancement technique. This process is called the preprocessing of the image. The face region from the input image was then cropped by using the technique the skin detection. The cropped image was the output of face detection block. This cropped image was provided to feature extraction block as the input. In the feature extraction block the features of the face is detected. The feature includes the eyes, nose, mouth and eyebrows detection. Therefore, the image was again divided in small blocks where each block contains feature of the face. The position of features is then compared with the Action Units (AUs). The classifiers compare the AUs of the input image with the AU assigned to basic expressions and conclude the presences of type of expression in the input image.

References

1. Anil, J., and L. Padma Suresh. "Literature survey on face and face expression recognition." *2016 International Conference on Circuit, Power and Computing Technologies (ICCPCT)*. IEEE, 2016.
2. Byeon, Young-Hyen, and Keun-Chang Kwak. "Facial expression recognition using 3d convolutional neural network." *International journal of advanced computer science and applications* 5.12 (2014).
3. Gautam, Sumit. "Facial Expression Recognition and Analysis Techniques." *Available at SSRN 3370149* (2018)
4. Ilbeygi, Mahdi, and Hamed Shah-Hosseini. "A novel fuzzy facial expression recognition system based on facial feature extraction from color face images." *Engineering Applications of Artificial Intelligence* 25.1 (2012): 130-146.
5. Lopes, Andre Teixeira, Edilson De Aguiar, and Thiago Oliveira-Santos. "A facial expression recognition system using convolutional networks." *2015 28th SIBGRAPI Conference on Graphics, Patterns and Images*. IEEE, 2015.
6. Owusu, Ebenezer, Yongzhao Zhan, and Qi Rong Mao. "A neural-AdaBoost based facial expression recognition system." *Expert Systems with Applications* 41.7 (2014): 3383-3390.
7. Zhang, Ziyang, Xiaomin Mu, and Lei Gao. "Recognizing facial expressions based on gabor filter selection." *2011 4th International Congress on Image and Signal Processing*. Vol. 3. IEEE, 2011