

Implementation of Emotion Detection System Using Facial Expressions

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Abstract— The premise of this paper is to develop a system that detects human emotions through consecutive video frames. Emotions of a person can be detected using facial expressions because the most expressive way a human can show his emotions is through facial expressions. Emotion detection using facial expressions is widely used in various fields like computer science, medicine, and psychology. Automated facial expression recognition is also used in HCI system for better results. Human-computer-interaction can become more natural if computers are able to understand human emotions and their behavior. In this paper a new system for emotion detection using facial expression has been proposed. Input to the system is a sequence of video frames captured using a built-in webcam or external video device. A process of face extraction and cropping is carried out on the video frames captured and then emotions are detected by calculating the Euclidean distance of input image to the train images. The proposed system is implemented in MATLAB version 8.1.0.604 (R2013a).

Keywords: - Facial Expression Recognition System, PCA, and Human Computer- Interaction.

I. INTRODUCTION

Emotions can be detected using speech, gesture, head movement, body movement, attitude as well as using facial expression. Facial expressions transmit many important communication cues in social interactions. These cues help the listener to recognize emotions of a person. Mehrabian suggested that only 7% of message is transmitted using spoken words, 38% of message using tone of voice while 55% of message is transmitted using facial expressions [1]. Facial expressions are formed by movement of facial features. In the recent years recognition of facial expressions has become the immense area of interest for many researchers.

Facial expression recognition (FER) system is mainly used to provide good human-computer-interface so that computers can able to recognize the emotion of the user and suggest operations in response to the mood of the user. Human-computer-interaction can become more natural if computers are able to understand human emotions and their behavior. Fear, surprise, sadness, happiness, anger and disgust are six basic emotions that universally accepted. These emotions can be classified as negative and positive emotions [2, 3]. Fear, anger, disgust and sadness are negative emotions and the majority of people do not like them whereas happiness is a positive emotion and everybody wishes to enjoy it. Anger is the most dangerous emotion and at some point in this emotion a person can hurt other purposefully.

In this paper emotion detection system using facial expressions has been implemented. Firstly, video frames are captured using a built in webcam or external video device.

Then face extraction and cropping is carried out from these video frames and a training and test database is prepared. Then a low dimensional face space is constructed of training database using principle component analysis (PCA) and emotions are detected using Euclidean distance between various feature points of test image to the train images.

II. RELATED WORK

A facial expression analysis method required to deal with three basic problems that are face detection, face extraction and facial expressions classification from still images or image sequences [4]. Good lightning conditions and frontal face view is assumed to be present in all expression recognitions systems. Viola & Jones present an algorithm to find the exact location of face in the image or video frames [5]. The basic principle behind the Viola-Jones algorithm is to scan a sub-window that is capable enough to detect faces in the input image or video frames. Spatial and filtering was together used with thresholding to extract the motion blobs from consecutive image sequences[6]. Then eigenfaces are used to evaluate these blobs via principal component analysis (PCA). Emotion detection systems can be used for new generation of intelligent user interfaces. These interfaces familiarize there self to particular users by choosing proper exercises for study or intervention and give users feedback about their present level of understanding [7]. Optical flow (OF) is used by Mase [8] to recognize facial expressions. He used image-processing techniques to recognize facial expressions. Martinez [4] proposed an indexing method based on the detection of frontal face images under different facial expressions, and occlusions. Almost all the methods discussed above for facial expression recognition are similar in a way that they first extract some features from the face images, and then use a classification system to categorize emotions. They differ generally in the features extracted from the video frames and the classifiers used to categorize different emotion. In this paper Principal Component Analysis (PCA) is used to detect emotion using facial expressions. At first the eigenspace are formed with eigenvalues and eigenvectors. This eigenspace are then used to construct the eigenfaces and then the most suitable eigenfaces have been selected using Principal Component Analysis (PCA). With the help of these eigenfaces emotions of input test images are detected based on Euclidian distance.

III. SYSTEM ARCHITECTURE

Generally an automated emotion detection system includes a web cam or external video device for capturing the facial image frames. These frames are then pre processed to minimize the variations in the image like lighting variations, removal of background etc. After that facial feature

extraction process is applied and then a classifier like Euclidian distance is used to classify emotions. Emotion detection system purposed in this paper is consisting of 5 steps. First step is image acquisition using live streaming. In second step face detection and cropping is performed. Third step is edge detection and formation of eigenfaces using PCA. In fourth step distance between various feature points is calculated using Euclidian distance and in last step emotions of test images are detected using these distances. Figure 1 shows the architecture of proposed system.

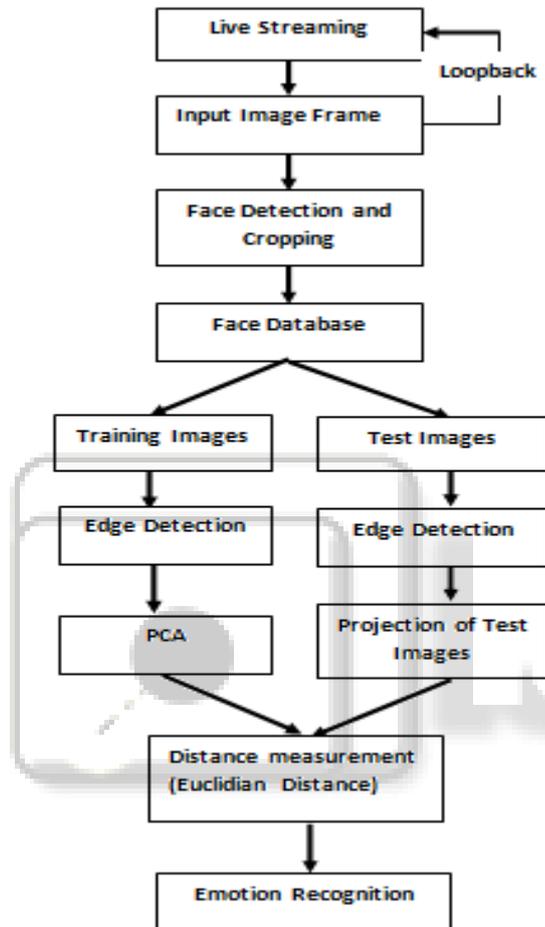


Fig. 1: System Architecture

A. Live Streaming

The very first step of any vision system is image acquisition. Here image acquisition in real time is carried out using live streaming, where image frames are received using streaming media. In this step, the system captured images from built-in webcam or external video camera device. The live streaming using webcam continues till when required input image frame is acquired. The acquired image frame should contain a single face of a person with light color background and face in upright frontal position.

B. Face Detection and Cropping

Face detection in this system uses the Viola-Jones detection algorithm. The basic principle behind the Viola-Jones algorithm is that it scans a sub-window which is capable of detecting faces in the input image frame [5]. After detecting the face a simple extraction function is used to extract the face and then cropping of face is performed. Performance of the system is improved by using cropping of face as it

involves removal of non skin part like hairs and background from the extracted face image. Cropping of face used in this paper is best described in [9].

Figure 2 shows the result of face detection, extraction and cropping.



Fig. 2: Result of face detection and cropping.

Cropped face images in this step are used to construct face database consisting of train and test images. This database will be used in later steps to detect emotions based on the distance measurement between various feature points of test and trained face images.

C. Edge Detection and Size Reduction

In this step edges of the cropped faces are detected. Edge detection uses the image processing tool box of MATLAB. End points of various features like eyes and lips are detected using it. Figure 3 shows the result of edge detection.

After edge detection the low dimensional face space of trained images of face database is constructed using principal components analysis (PCA) and eigen vectors with greater Eigen values are selected. Then the test images of face database are also projected on face space



Fig. 3: Result of Edge detection.

PCA is now frequently used for dimensionality reduction in computer vision and mainly in face recognition systems. It is also known as Karhunen-Loeve methods. PCA chooses a dimensionality reducing linear projection that maximizes the scatter of all projected samples. The feature vectors were normalized to zero mean and further compressed using a linear data reduction method called the Principal Component Analysis [10] [11]. The PCA is an orthogonal linear transformation that transforms the data to a new coordinate system such that the variance by any projection of the data is the largest for the first coordinate (called the first principal component), and then decreases along coordinates reaching the smallest value for the last coordinate. Assuming that the high variance of the data

describes interesting dynamics and that low variances are linked to noise, the reduction of data dimensionality can be achieved by keeping high order principal components and ignoring lower-order ones.

D. Distance Measurement

Euclidean distance is used to calculate the distance between various feature points. If the features have n-dimensions then the generalized Euclidean distance formula between the feature points (x, y) is given by

Euclidean Distance(x, y) =

$$\sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2 + \dots + (x_n - y_n)^2}$$

Using this we also calculate other distances between any features points.

E. Emotion detection

Detection of emotions is based on the calculation of distances between various features points. In this step comparison between distances of testing image and neutral image is done and also it selects the best possible match of testing image from train folder. It also detects the emotions on the basis other distances calculated. And the final results are displayed.

IV. RESULTS

Proposed algorithm is evaluated by 50 still images. The size of image is 120 × 120 pixels. Emotions of the test images are calculated and the results are stored in Results.txt file. Besides, the identification of emotions this algorithm also shows the distance of test image from neutral image and the best match of test image from trained images. Figure 5 shows the five test images for emotion detection and table 1 shows final results or emotions of these images.



Figure 5: five test images

Table. 1: Final result of 5 test images.

Test Image	Distance From Neutral	Expression	Best Match
Test1.jpg	10346	Happy	10.jpg
Test2.jpg	10090	Sad	20.jpg
Test3.jpg	9260	Angry	26.jpg
Test4.jpg	9768	Surprise	34.jpg
Test5.jpg	7165	Neutral	42.jpg

There by our proposed algorithm is suitable for use in real-time systems with high performance.

V. CONCLUSION AND FUTURE WORK

In this paper, an accurate and high speed emotion detection system is proposed. The color and feature-based detections were adopted to find skin-color fast and selected candidate

blocks carefully. Lighting compensation and face cropping is used to improve the performance and reduce the computation of feature-based scheme. The major contribution of this paper is that the proposed method can detect edges of the images and from that edges distance between various features is calculated by using Euclidean distance Formulae. This distance is different for every image posing different emotions. On the basis of this distance emotions are classified. For future work, the proposed method can be applied to hardware implementation. Because of the simplicity of proposed method has simple structure, it is appropriate to be implemented in hardware to accomplish very high performance and low power system.

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