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Classification of Emotion from Facial Image Using Dimensionality Reduction Technique

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Abstract: ***Expression detection is useful as a non-invasive method of lie detection and behavior prediction. However, these facial expressions may be difficult to detect to the untrained eye. A facial expression recognition system needs to solve the following problems: detection and location of faces in a cluttered scene, facial feature extraction, and facial expression classification. Facial expression plays very important role in the communication within the human beings. It is very important to understand the presence of mind using face expression such as the situation of mind can be read by their mouth, eyes, eyebrows etc. No wonder automatic face expression recognition has become an area of immense interest within the computer science, psychology, medicine and human-computer interaction research communities. In this thesis, an investigation has been made on classification of emotion through facial images using Principal component analysis (PCA) as a dimensional reduction technique.***

Keywords: Face Detection, Emotion Detection, PCA, Eigen Value, Eigen Vector

1. Introduction

Emotion recognition is a promising area of development and research. The voice interactive systems can adapt as per the detected input emotion. This could lead to more realistic interactions between system and the user. Expression is the most important mode of non-verbal communication between people. Recently, the facial expression recognition technology attracts more and more attention with people's growing interesting in expression information. Facial expression carries crucial information about the mental, emotional and even physical states of the conversation. Facial expression recognition has practical significance; it has very broad application prospects, such as user-friendly interface between man and machine, humanistic design of goods, and emotional robot etc. With facial expression recognition systems, the computer will be able to assess the human expressions depending on their effective state in the same way that human's senses do. The intelligent computers will be able to understand, interpret and respond to human intentions, emotions and moods. The facial expression recognition system applied in different areas of life such security and surveillance, they can predict the offender or criminal's behavior by analyzing the images of their faces that by are captured the control-camcorder. Furthermore, the facial expression recognition system has been used in communication to make the answer machine more interactive with people.

Facial expression recognition has attracted increasing attention in computer vision, pattern recognition, and human-computer interaction research communities.

2. Related Work

The importance of facial expression system is widely recognized in social interaction and social intelligence. The system analysis has been an active research topic since 19th century. The facial expression recognition system was introduced in 1978 by Suwa et. al. The main issue of building a facial expression recognition system is face detection and alignment, image normalization, feature extraction, and classification.

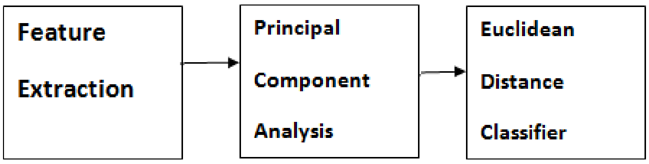
Bartlett explores and compares techniques for automatically recognizing facial actions in sequences of images. These techniques include analysis of facial motion through estimation of optical flow; holistic spatial analysis, such as independent component analysis, local feature analysis, and linear discriminant analysis; and methods based on the outputs of local filters, such as Gabor wavelet representations and local principal components .Lien describes a system that recognizes various action units based on dense flow, feature point tracking and edge extraction. The system includes three modules to extract feature information: dense-flow extraction using a wavelet motion model, facial feature tracking, and edge and line extraction.

The system that used color information, Rajapaskse et The system that used color information, Rajapaskse proposes the use of non-negative matrix normalization (NMF) with color cannel encoding. This process is performed by representing the (RGB) color channel as a three indexed data vector separately: red, green and blue channel for each image. Then the color using non-negative matrix (NMF), a decoding method, is applied. This technique makes better use of the color image because of the excessive iterative matrix and the decoding operation that involves inverting the matrix; the inherent processing cost was so big.

3. Proposed Methodology

In objective of this paper is to detect human emotions using facial expression first it takes an image, than by skin color segmentation, it detects human skin color than it detects human face.

In this paper the three main component of the system: a Feature Extraction, Principal Component Analysis or Euclidean Distance Classifier.



4. Feature Extraction

Feature extraction can converts pixel data into a higher-level representation of shape, motion, color, texture, and spatial configuration of the face or its components. The extracted representation issued for subsequent expression categorization. Feature extraction generally reduces the dimensionality of the input space The reduction procedure should (ideally) retain essential information possessing high discrimination power and high stability. Such dimensionality reduction may mitigate the curse of dimensionality. Geometric kinetic, and statistical or spectral transform-based features are often used as. Alternative presentation of the facial expression prior to classification.

5. Principal Component Analysis (PCA)

Principal component analysis is a standard technique used in the statistical pattern recognition for data reduction.

As the pattern often contains redundant information, mapping it to a feature vector can get rid of this redundancy and yet preserve most of the intrinsic information content of the pattern. These extracted features have great role indistinguishing input patterns. A face image in 2-dimension with size N × N can also be considered as one dimensional vector of dimensionN^2. Each of these vectors are of length N^2 , this describes N× N image and is a linear combination of the original face images. As these vectors are the eigenvectors of the covariance matrix corresponding to the original face images, and because they are face-like in appearance, they are referred as “Eigen faces”. After estimation of the covariance matrix, significant eigenvectors of the covariance matrix are computed. The number of Eigen-vector depends on N image and is a linear combination of the original face images. As these vectors are the eigenvectors of the covariance matrix corresponding to the original face images, and because they are face-like in appearance, they are referred as “Eigen faces”. After estimation of the covariance matrix, significant eigenvectors of the covariance matrix are computed. The number of Eigen-vector depends on application and accuracy that the system needs and it is clear that if number of Eigen-vectors is large the accuracy of the method improved but computational complexity increased.

We can retain the maximum information by retaining the coordinate axes that have largest eigen values and delete those that have less information.

This technique involves

- Gather xi where i= 1 to p.
- Compute the mean m and subtract it to obtain xi-m.
- Compute the covariance matrix
- Cij = (xi-m)$(xi-m)^T$.
- Determine Eigen values and Eigenvectors of covariance matrix

C such that CV=AV where
A=dig (λ1, λ2 ...λp.), a diagonal matrix is defined by the eigenvalues of the matrix C and V = (V_1,V_2 ....V_P) be the associated eigenvectors.

- Sort the eigenvalues and corresponding eigenvectors such that $\lambda_1 \geq \lambda_2 \geq$,..........≥ λ p .
- Select the first l ≤ p eigenvectors and discard p-l eigenvectors to find the data in new directions.
- If the orthogonal matrix contains the eigenvectorrs of C, then C can be decomposed as C= VAVT where A is diagonal matrix of eigenvalues.

6. Facial Expression Classification

The proposed approach to the facial expression recognition involves following steps.

1) The train images are utilized to create a low dimensional face space. This is done by performing Principal Component Analysis in the training image set and taking the principal components with greater
2) Eigen. In this process, projected versions of all the train images are also created.

3) The test images also projected on face space, all the test images are represented in terms of the selected principal components.

4) In order to determine the intensity of the particular expression its Euclidean distance from the mean of the projected neutral images is calculated.

5) The Euclidian distance of a projected test image from all the projected train images are calculated and the minimum value is chosen in order to find out the train image which is most similar to the test image.

6) The test image is assumed to fall in the same class that the closest train image belongs to.

7. Experimental Results

Japanese Female Facial Expression Database

The database used for facial expression system is Japanese Female Facial Expression (JAFFE) Database contains 213 images of 7 facial expressions including neutral posed by 10 Japanese female models. Each image has been rated on 6 emotions adjectives by 60 Japanese subjects. For the implementation of facial expression recognition JAFFE database captured face data is used.

JAFFE database

The main useful statistical measurements that were utilized to evaluate the emotion recognition system are: Recognition Rate, Precision and Accuracy.

$$\text{Precision} = \frac{\text{truepostive}}{\text{truepostive } + \text{falsepstive}}$$

$$\text{Accuracy} = \frac{\text{truepostive } + \text{truenegative}}{\text{truepostive } + \text{truenegative } + \text{falsepostive } + \text{falsenegative}}$$

	Happy [10]	*Sad [10]*	*Disgust [10]*	*Anger [10]*	*Neutral [10]*
Happy	04	00	00	00	01
Sad	00	07	00	02	01
Disgust	00	00	07	01	01
Anger	00	00	00	08	00
Neutral	01	01	00	00	08

Confusion Matrix of Five Basic Facial Expressions

8. Conclusion

We have implemented a facial expression recognition system using Principal component analysis method. This approach has been studied using JAFFE image database. The experiment results demonstrate that the accuracy of the JAFFE images using Principal component analysis is 91.63%.Similarly precision rate obtained is 72.82% in case of Principal component analysis.

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