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Recognition of facial expression with Mean distances matrices difference method and classification by using support vector machine.

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Abstract — Humans can conveniently interpret face and facial expressions. However, doing the same thing using machine is considered very difficult. There is the problem of accurate classification in automatic facial expression recognition system (AFERS).

In real world scenario, facial expressions are associated with the geometry of facial features and when they are extracted, many redundant and noisy features also get extracted. This noise severely degrades the recognition performance for the facial expressions.

Accordingly, the feature selection methods have been proposed. In this method, mean for each binary facial expression image and the neutral image is calculated and distance from this mean point to all white pixels are obtained. Now difference between the mean distance matrix of expression images and neutral images is obtained. This image difference matrix is converted to feature vector by converting the m×n matrix into 1x (m×n) single row matrix.

These proposed methods can successfully recognize the static, off-line captured facial expression images.

Index Terms — Image difference matrix, Machine learning, Mean distance matrix, Pattern recognition, WEKA data mining tool.

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1 INTRODUCTION

The proposed method which is based on *Geometric feature based*. We have taken the standard images from Japanese Female Facial Expression (JAFFE) Database [1]. The geometric facial features represent that how geometry of face changes. The shape of faces, relative distance between facial components and locations of facial components alters according to facial expression.

The faces have detected by viola and Jones method [2] from JAFFE standard image Database and feature is extracted from these faces. Face is detected from gray neutral images and expression images. Then both the face images are resized in same size of 100×100 pixels. After resizing these Images, Gray images are converted into binary images and then mean of each binary image is calculated. In this way mean distances matrix are obtained for each binary images. Mean distances matrices are computed for each expression and corresponding neutral image of models.

Feature matrices are obtained by taking the differences between expression mean distance matrix and neutral mean distance matrix of each model.

Feature matrices are converted to feature vector of size 1×10000. In this way for each expression, one matrix of size 100×100 is obtained and resized in 1×10000 feature vector.

Model has approximately either two or three same expressions images with different intensity. Whole experiment is conducted on these six universal expressions. Paul Ekman [3] has defined six basic universal emotions (Anger, disgust, fear, happy, sadness, surprise). These six expressions are Happiness, Sadness, Anger, Fear, Disgust and Surprise.

These feature vectors appended and makes complete training and testing data sets and saved in .csv file. In this manner 10000 attributes computed and 105 instances are used for facial expression recognitions. In this way feature vectors are obtained. These data sets are pre-processed in WEKA data mining tool before classification with Support Vector Machines (SVM). Support Vector Machines (SVM) is producing the good result.

2 RELATED WORKS

In recent years researchers have developed computational intelligence models for accurate recognition of facial expression. Padgett [4] presented an automatic facial expression interpretation system that was capable of identifying six basic emotions. Facial data was extracted from 32 × 32 pixel blocks that were placed on the eyes as well as the mouth and projected onto the top 15 PCA eigenvectors of 900 random patches, which were extracted from training images.

Altogether 97 images of six emotions from 6 males and 6 females were analysed and 86% generalization performance was measured on novel face images.

Lyons [5] presented a Gabor wavelet-based facial expression analysis framework, A generalization rate of 92% was obtained for the recognition of new expressions of known subjects and 75% for the recognition official expressions of novel expresers.

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Kobayashi and Hara [6] used a geometric face model consisting of 30 facial characteristic points (FCP). They measured the intensity distribution along 13 vertical FCPs crossing facial lines with the aid of a neural network. They achieved an 88% generalization performance.

3 Face Detection

Image acquisition is a process of getting images from some sources like video. Frames are extracted from videos to get still face image data. The acquisition of huge amounts of image data has helped research enormously from different sources.

Face detection is done from still images. Face detector to detect face for each frame or detect face in the first frame and then track the face in the remains of the video sequence. In face detections method Paul Viola and Michael Jones [2] method is a rapid face detection method which is very much helpful in real time face detection. Usually it is called simply the Viola-Jones method, or just Viola-Jones.

The image acquisition technique includes a number of issues, such as the properties digitizer and number of video cameras, the ambient lighting and the size of the face image comparative to whole image dimensions. All of these factors may influence facial expression analysis. Images picked up in low light or at uneven resolution can provide less information about facial features. Similarly, when the face image size is small comparative to the whole image size, less information is available.

If all images are enlarged to the same size at 48 x 64 pixels the facial features such as the corners of the eyes and the mouth become hard to detect. Facial expressions are not recognized at 24 x 32 pixels [4, 5]. Therefore there is trade-off between face image size and facial information loss.

We have detected some faces from images by using viola-Jones algorithm [2]. Detected faces for different expression from standard facial images JAFFE are shown in Fig. 1. We have been using Matlab 2013 for face detection. After the locating the face in the image, the next step is to represent and extract the facial variations caused by human emotions on faces.

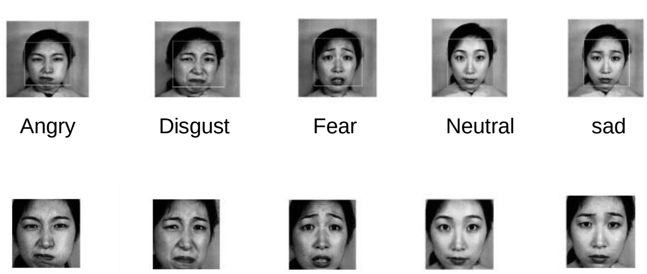

Fig.1 Detected Face

3.1 Proposed Technique of Facial Features Extraction

Face is detected from gray neutral images and expression images. Then both the face images are resized in same size of 100×100 pixels. After resizing these Images, Gray images are converted into binary images and then mean of each binary image is calculated by using the given formula:

$$X_c = \frac{1}{M}\sum_{i=1}^{n} x_i w_i \qquad 3.1$$

$$Y_c = \frac{1}{M}\sum_{i=1}^{n} y_i w_i \qquad 3.2$$

Where M is the sum of intense it may be black or white pixels. The value x_i and y_i are pixel location on the image, n is the total number of pixels. (Xc, Yc) is the centroid point. For binary images w_i will be 1 or 0. The distances are computed from this mean point to each white pixel and kept at the location of that pixel. In this way mean distances matrix are obtained for each binary images. Mean distances matrices are computed for each expression and corresponding neutral image of models. Feature matrices are obtained by taking the differences between expression mean distance matrix and neutral mean distance matrix of each model.

3.2 Flowchart of the Proposed Technique

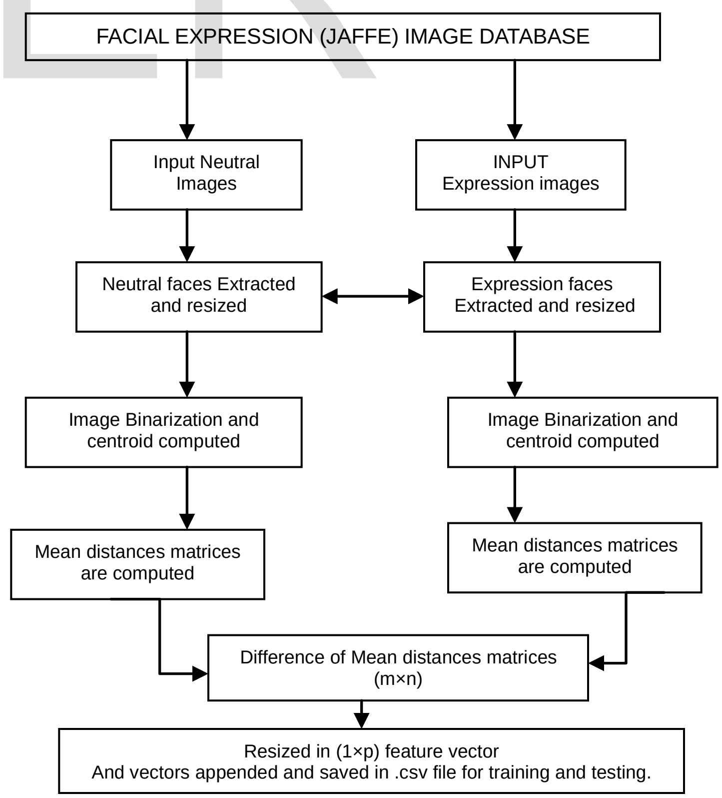

Fig.2 Framework of proposed technique

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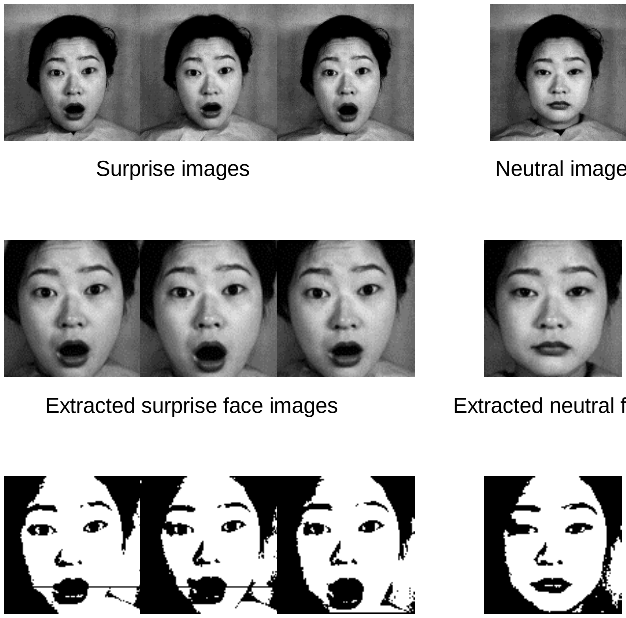
3.2. Implementation of Proposed Technique



Surprise images — Neutral image

Extracted surprise face images — Extracted neutral face

Binary surprise face Images — SBinary neutral image

Fig.3 Images processed according to the proposed technique

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3.2.1. Centroid Computed

Centroid for the binary neutral facial image is calculated according to equation 3.1and 3.2, given below

Xc = 50.4094, Yc = 50.0143.

Centroid for above left most binary surprise facial image is calculated according to equation 3.1and 3.2 and given below

Xc = 51.1695, Yc = 52.0387.

After calculating the centroid, mean distances matrices are obtained then Difference of these mean distances matrices are taken and converted to feature vector these feature vectors are appended and saved in .CSV file format.

4. Expression Recognition Results

Support Vector Machine (SVM) has been used as a new technique for pattern recognition. The SVMs [9] with a binary tree recognition approach are used to challenge the face recognition problem. We demonstrate the potential of SVMs on the JAFFE Database, which consists of 216 images. These images are containing moderately a high degree of variability in expression, facial details and pose.

We have seen the range of different learning algorithms. Within supervised learning, the performance of many supervised learning algorithms will be pretty similar. Support vector machine, and compared to both the logistic regression and neural networks, the support vector machine or the SVM sometimes gives a cleaner and sometimes more powerful way of learning complex nonlinear functions [10].

Learning of optimal hyperplane: Separating hyperplane that maximizes separation between Classes. This algorithm effectively maps original feature vectors into a high dimensional space.

These data sets are pre-processed in WEKA data mining tool before Support Vector Machines (SVM) classification. In the pre-process, attribute of data sets are normalized by using unsupervised WEKA filters.

For Support Vector Machine (SVM) classification method 25 fold cross validation is applied. i.e. the data sets are divided into 25 parts (fold),24 parts for training and 1 part for testing is used and this procedure is repeated turn by turn each data point used ones for testing ,24 times for training.

WEKA outputs an extra model built on the entire dataset. Support Vector Machines (SVM) is producing the good result. These proposed methods can successfully recognize the static, off-line captured facial expression images.

Table.1 Confusion Matrix for Implementation of proposed facial feature extraction algorithm.

Expressions	a	b	c	d	e	f	Total	classfied as
a	15	0	0	0	2	0	17	a = HAP
b	0	16	1	0	1	0	18	b = ANG
c	0	0	15	1	0	0	16	c = DISG
d	0	0	1	15	1	1	18	d = FEAR
e	1	0	0	0	16	1	18	e = SAD
f	0	1	0	0	1	16	18	f = SURP
Total							105	

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Table.2 Framework classification rates for six discrete expressions for proposed Algorithm

Expressions	Classification rates
HAPPY	88.2%
ANGRY	88.9%
DISGUST	93.8%
FEAR	83.3%
SAD	88.9%
SURPRISE	88.9%
Overall	88.6%

5. Conclusion

This proposed framework attempts to recognize the six universal facial expressions. Expression recognition has been a challenging task due to the high degree of freedom in facial motions.

The proposed methods can successfully recognize the static, off-line captured facial expression images. The used approaches have got very good outcome result. We can see in Table 1 and Table 2.

However, the overall results remain insufficient, expression like fear in proposed algorithm are recognize with less classification accuracy. So there is still scope for improvement. We believe that experimental results could be significantly increased by selecting the proper classifier with proper facial feature extracted data.

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