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Human Face & Emotion Recognition Using Deep Neural Networks Based On Local Binary Patterns

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***Abstract* - Facial expressions play a major role in Face Recognition Systems and image processing techniques of Human computer Interface. There are several techniques for facial features selection like Principal Component Analysis, Distance calculation among face components, Template Matching. This algorithm describes a simple template matching based facial feature selection technique and detects facial expressions based on distances between facial features using a set of image databases. For interactive human computer interface (HCI) it is important that the computer understand facial expressions of human. With HCI the gap between computers and humans will reduce. The computers can interact in more appropriate way with humans by judging their expressions. There are various techniques for facial expression recognition which focuses on getting good results of human expressions. Most of these works are done on standard databases of foreign origin with six (Neutral, Happy, fear, Anger, Surprise, Sad) basic expression identification. We propose Zernike moments based feature extraction method with support vector machine to identify eight expressions including Disgust, and Contempt.**

***Keywords*- Facial Expression Identification, Neural Networks, Zernike Moments, HU Moments.**

I. INTRODUCTION

Since the last three decades of face recognition technology, there is several commercially available systems to recognize human faces, however, face recognition is still a leading challenging problem. This challenge can be attributed to

- large intra-subject variations such as pose, illumination, expression, and aging are generally found in face recognition and
- large inter-user similarity. Meanwhile, this technology has enlarged its role to Human-Computer-Interaction (HCI) and Human-Robot Interaction (HRI).

Person identity is one of the important responsibilities while interacting with the robots, utilizing the unattention system security and authentication of the human interacting with the system. This problem has been discussed in many scenarios by researchers resulting in commercially available face recognition systems. However, other higher-level applications like facial expression recognition and face tracking still remain leading problems along with person identification. This gives rise to a concept for producing a framework suitable for resolving these problems together. In humans, mammals and some other species when the muscles under the face skin move are the outcome is facial expression. These movements are used to help one produce the emotional state to another person. The neural mechanism in the brain manages these expressions. The primary works on this human spectacle were begun by psychologists with knowledge of individual and social perspectives. They have shown that Expressions on face plays a vital role in coordinating human dialogue through the multitudes of information it delivers. The expression on the face is also identified as a kind of non-vocal communication. Fig. 1 shows the causes of facial expressions in humans. The Human face can create more than 10,000 different facial expressions. With these various expressions non-vocal communication becomes enormously effective and accurate. Ekman et al. recommended that the facial expressions of several emotions are universal. These expressions are not culture-specific. Regardless of gender, the muscles that concurrently produce the facial expressions are worldwide identical.

Darwin proposed that there is a link between mental states e.g. sensed emotions, belief and thought. Sources of facial expressions carry the Mental States along with Vocal, Non-Vocal and Physiological Causes. ’Expression’ and ’Emotion’ are not equivalent. Emotion is relevant in nature, for example, expression laugh or smile to the emotion happiness. Expressions on the face are not actually being the outcome of human emotion. Hence we can say that facial expression is just a physiological act of different face parts, and these parts can be mouth, nose, eyes, eyebrows, etc. To map Emotions to Expressions is a complex area till date hence, for now, we can focus on Expressions only. For an

interactive human-computer interface (HCI) it is necessary that the computer understands facial expressions only as it is hard to capture emotions. Human Face Detection and Facial Expression Identification can get this interaction with more efficiency. This type of system can also be utilized in the research in behavioral science and medicine. This research concentrates on a Zernike moment based feature extraction method with a support vector machine to gain more reliable results of human facial expression identification.

II. LITERATURE SURVEY

Various researchers have produced outstanding work on Expression identification. The propositions of some authors are discussed in this section.

Pew-Thian et al. have explored orthogonal moments of development using discrete classical Krawtchouk polynomials. The Krawtchouk moments result is improved as compared to the HU moment. Krawtchouk provides a reconstruction of up to 94% with 1% noise whereas HU has an outcome of 69%.

Koutlas et al. have explored Region Based Methodology. With this methodology along with the Gabor filter, they are recognizing facial expressions. They have operated on analytic as well as holistic approaches and as per their findings, Gabor functions performed superior as compare to any other method.

Velusamy et al. have worked on the benchmark as well as real-world data sets and proposed a great method. This method maps facial Action Units (AUs) detected by the system to six basic emotions. Then analyzed rule-based methods with the proposed technique and found that the proposed technique shows improvements. Saaidia proposed a neural network-based approach for recognition of expression, for example, the laughing face is completely different from the angry face as per results but 'surprise' is mistaken for laughing face or annoyed face. With Yale output for neutral is 40% whereas surprise is 60% correct. With Jaff output for surprise is 70% correct.

Mandal et al. have proposed a classification method for the classification of facial expressions. The expressions are classified in either positive or non-positive emotions using the Zernike moments. The developed system gives a 69% average facial expression classification rate whereas 78% is reached by human subjects. The method proposed by Gupta et al. is a modified version of Facial Action Coding System which is known as FACS. The system recognizes Fifteen facial feature vectors of an image. For the classification of emotions, they have used a clustering based approach and supervised self-organizing maps.

M. Owayjan et al. have proposed a method with the Viola-Jones object detection framework and ANN. With this method, the author recognizes happiness, anger, and neutral facial expression. For expression "happy", "angry" and "neutral" 60%, 55% and 80% accuracy is achieved respectively.

J. Jaya lakshmi et al. have proposed a method in which Viola-Jones algorithm is adopted for face detection and three methods Zernike moments, Local Binary Pattern and Discrete Cosine Transform used for feature point extraction which will take more time as compared to other methods. After extraction, all the feature points are combined together by means of Normalized Mutual Information Selection method. The whole system is trained and classified using SVM, RF and KNN classifiers.

III. PROPOSED METHOD

The proposed system consists of several states for face detection or face localization, feature extraction, and classification for the image.

1. Input Image (Database)

Seven basic facial expression images and one further Contempt facial expression images are used from Japanese Female Facial Expression (JAFFE) and Radboud frontal faces databases respectively.

2. Face Detection

Face detection or localization is an essential step for image classification since only the main component of the face such as nose, eyes, mouth are required for classification. Face detection algorithms can be broadly classified into feature, knowledge, template, and appearance-based methods. Our proposed system utilizes the Viola-Jones object detection algorithm for face localization which comes under feature-based classification.Viola Jones object detection algorithm uses Haar feature based cascade classifiers.

The Haar Cascade classifier is a much important component of face detection. The presence of the features in any of the input image is determined by the Haar features. Anchit et al. suggest that HAAR presents better results than the Skin colour method. To instruct the classifier, we require to implement several positive and negative images mean's images with faces and without faces respectively. After providing images, features are extracted. For extracting the feature values of white rectangle pixels are subtracted from the grey rectangle. The features with minimum error rates are classified into positive and negative images.

In the beginning, all images have the same weight. Misclassified images will have increased weight after every classification. This method is repeated until we reach the essential accuracy or error rate or the needed numbers of features. In conclusion, we get the final classifier. This is a weighted sum of all weak classifiers which cannot classify image on its own but requires other classifiers. Together with other classifiers, it formulates a

strong classifier. But, as we know when we see an image most of the area is non-face. Hence, to reduce the time we check if a window is facing or not using the Cascade of Classifiers. If it is not the face then we reject it.

3. DMMA Feature extraction During Training Phase most of the time only a single sample per person (SSPP) is available for discriminative feature extraction. For example ID card Identification etc, but conventional appearance-based face recognition usually need Multiple Samples per person (MSPP) for this work. Due to less number of representations for discriminant learning, most of the methods fail. Hence, we have implemented DMMA (Discriminative Multi-Manifold) analysis by learning discriminative features from image patches. Initially, we classify each face image into multiple non-overlapping patches to form an image set for each sample per individual. After that articulate the single sample per person face recognition as a manifold-manifold matching problem and learn multiple discriminative multi-manifold analysis feature spaces to maximize the manifold margins of different persons.

The discriminative multi-manifold analysis is used to isolate patches that are not of an individual person. And it fixed all patches of the corresponding person in one manifold. Using different manifolds for different persons makes it more reliable as it has a person-specific feature extraction method which is not present with generic methods as well as it optimizes the feature dimension for the individual as it uses the single manifold for all faces.

5. K-Nearest Neighbour (KNN)
KNN has basically used instances for learning purposes. When we want to classify a new record then we want to compare it with the current most similar record of the training set. For the classification of the new records, we need to first decide k. Now the nearest training samples are fetching as output depending on the distance. A generally used distance metric for continuous variables is Euclidean distance.

IV. ALGORITHM METHODOLOGY

Steps for Support Vector Machine Training and Classification: For classification we have used multiclass_svm_learn.exe and multiclass_svm_classification.exe

Step 1: Get features and make train file as per SVM format.
Step 2: Train system using svm_learn.exe.
Step 3: Get model file which is having kernel inside it.
Step 4: Make test file using feature.
Step 5: Use svm_classify.exe to generate prediction file.
Step 6: Output of image in the form of expression.

V. EXPERIMENTAL RESULTS

We have used standard JAFFE database for seven basic facial expressions for contempt expression. Figure 9 shows snap shot of Expression detection. Total 80 images are used for test, 10 for each expression for testing.

Fig.1 Different facial expressions.

The proposed system recognized eight expressions happy, sad, anger, surprise, fear and disgust with Neutral and Contempt perfectly. It has 96.7% recognition accuracy for Zernike Moment order 7, 90% accuracy for Zernike moment order 3 and 84.84% accuracy for Zernike Order 1 and 92.8% accuracy for HU Moment.

VI. CONCLUSION

We propose a human facial expression identification technique with Zernike moment to identify human facial expressions. We have also shown comparison of Hu moment with Zernike. For better classification of extracted features with Zernike moments and HU moment, we have used Support Vector Machine Classification algorithm which provide high accuracy as compare to other classification methods. Facial Expression and Emotion accuracy can be additional explored to make system identify whether person's emotion are in accordance with facial expressions or not.

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