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A Novel Approach for Facial Emotions Detection

Akash Vishwakarma
Research Scholar M.Tech.
Computer Science and Engineering
Takshshila Institute of Engineering and Technology
Jabalpur (M.P.), India
Email: aaksh3252@gmail.com

Neha Khare
Assistant Professor
Department of Computer Science and Engineering
Takshshila Institute of Engineering and Technology
Jabalpur (M.P.), India
Email: nehakhare@takshshila.org

ABSTRACT

Depression is a prevalent mental health disorder that can significantly impair an individual's well-being. Early detection is crucial for effective treatment, yet traditional diagnostic methods are often time-consuming and reliant on subjective self-reporting. Using advanced machine learning techniques, particularly Principal Component Analysis (PCA), the system identifies subtle emotional patterns that correlate with depressive symptoms from facial expressions. The proposed model analyzes a dataset of facial images, extracting key emotional features—such as sadness, anger, and happiness—based on micro-expressions, asymmetries, and intensity variations. These features are then classified to predict the likelihood of depression

Keywords:*—Image, facial emotion, accuracy, data set, pca, depression..*

I. INTRODUCTION

Facial expression is one of the primary non-verbal communication methods for expressing emotions and intentions. Ekman et al. identified six facial expressions (viz. anger, disgust, fear, happiness, sadness, and surprise) as basic emotional expressions that are universal among human beings. Automatizing the recognition of facial expressions has been a topic of study in the field of computer vision for several years. Automated Facial Expression Recognition (FER) has a wide range of applications such as human computer interaction, developmental psychology and data driven animation. Despite the efforts made in developing FER systems, most of the existing approaches either have poor recognition rates suitable for practical applications or lack generalization due to the variations and subtlety of facial expressions. The FER problem becomes even harder when we recognize expressions in videos.

Numerous computer vision and machine learning algorithms have been proposed for automated facial expression recognition. It perform fine on classifying facial expressions collected in controlled environments and lab settings. However, these traditional approaches mainly consider still images independently and do not consider the temporal relations of the consecutive frames in a video. In recent years, due to the increase in the availability of computational power, neural networks methods have become popular in the research community. In the field of FER, we can find many promising results obtained using Convolutional Neural Networks. While in the traditional approaches features were handcrafted, the CNNs have the ability to extract more appropriate features from the training images that yield in better visual pattern recognition systems. Therefore, it has been concluded that the CNNs are able to extract features that generalize well to unseen scenarios and samples. Due to uniqueness of expressions for each person and insufficient number of examples in available databases, oneshot methods have received attentions in recent years. In these methods, information about different categories are learned from one or very few samples.

II. Face Detection Methods

Face detection methods have evolved from traditional techniques to more advanced, technology driven approaches. We'll explore these methods, ranging from the basic knowledge-based to the latest appearance-based techniques..

1. Knowledge-Based :

This method relies on predefined rules about what constitutes a face (e.g., a face must have two eyes, a nose, and a mouth in specific arrangements).

2. Feature-Based :

This approach locates faces by extracting key facial features. It uses algorithms trained as classifiers to distinguish facial regions from non-facial regions.

3. Matching of Templates:

Template matching uses pre-defined or parameterized face templates to find faces. It compares input images with these templates to detect faces.

4. Appearance-Based

These algorithms learn from a set of training images what a face looks like, combining statistical analysis and machine learning to identify facial characteristics

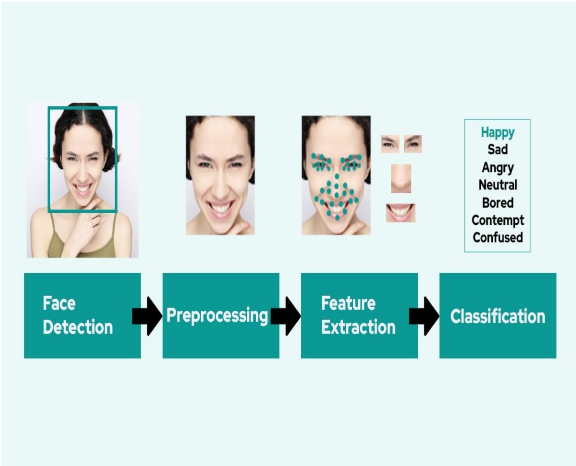

Figure 1: Basic steps

III. Problem Statement

In Existing system the module uses three different channels, increasing the diversity of extract feature. Then, the feature maps of the three channel outputs are cascaded together. Finally, use this module to build Expression Net. Compare Expression Net to the classic AlexNet and others algorithm in the FER2013 dataset. The results show that the accuracy of Expression Net is significantly improved, and the parameters are greatly reduced. It proves that the module can effectively improve network performance and control model size..From above review we drawn a following shortcoming:

- No comparison is made between the accuracies of several algorithm
- The overall classification accuracy was found to be the same irrespective of the kernel types.
- Occurrence of errors are more in single Feed Forward Neural Network with large no. of hidden neurons
- Processing building the model requires fast and efficient processors which is cost consuming

IV. Proposed Method

The proposed model is introduced to overcome all the disadvantages that arise in the existing system. This system will increase the accuracy of the system results by classifying the fer2013 face expression image dataset using principal component analysis. The data augmentation is used to generate the image samples for train and test dataset. It enhances the performance of the overall classification results. Predict the facial expression and to find the accuracy more reliable. We have created a basic facial recognition system using a technique called principal component analysis (PCA) by projecting the face images on the feature space (face space) which best represents the variations among distinct faces. The face space is defined as the “Eigen faces", which are the eigenvectors of the set of faces. The goal of implementing this system is to recognize a person's face by comparing it to a pre-existing database of faces, and identifying the closest match.

Steps for Implementation of PCA Algorithm :

- Standardize the data: PCA is sensitive to the scale of the input data, so it is important to standardize the data to have zero mean and unit variance.
- Compute the covariance matrix: Calculate the covariance matrix of the standardized data. This matrix shows how the different features of the data are related to each other.
- Compute the eigenvectors and eigen values of the covariance matrix: The eigenvectors are the principal components, and the eigen values indicate the amount of variance explained by each principal component.
- Select the principal components: Sort the eigenvectors by their corresponding eigen values in descending order, and select the top k eigenvectors to form the new lower-dimensional space. This new space will have k dimensions, where k is less than the original number of dimensions.

Flow Diagram:

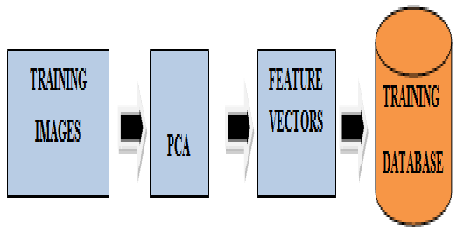

Figure 2: Training Process

Training Process:

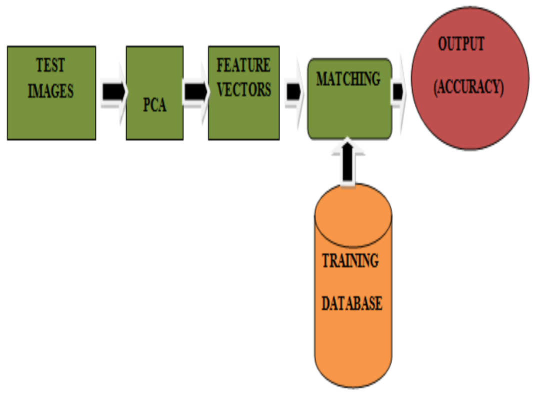

Figure 3: Testing Process

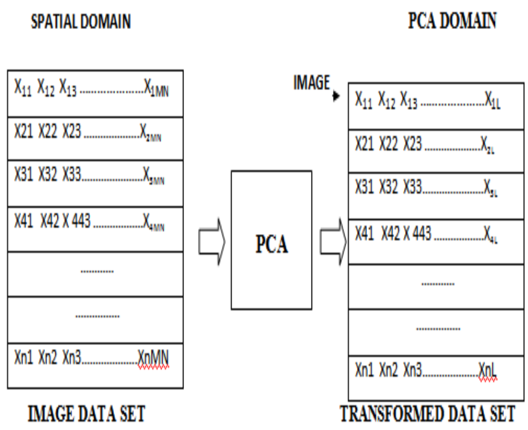

Figure 4 : PCA Algorithm

Mathematically:

Xcentered=X−μX_{\text{centered}} = X - \muXcentered=X−μ

where XXX is the data matrix, and μ\muμ is the mean of all image vectors.

After mean centering, compute the **covariance matrix** CCC, which captures the relationships between the pixel values (or features) in the images. This matrix is typically large and square with dimensions d×dd \times dd×d, where ddd is the number of pixels per image.

The covariance matrix CCC is given by:

C=1k−1XcenteredXcenteredTC = \frac{1}{k-1} X_{\text{centered}} X_{\text{centered}}^TC=k−11XcenteredXcenteredT

where kkk is the number of images, and XcenteredX_{\text{centered}}Xcentered is the mean-centered data matrix.

Alternatively, for computational efficiency (if kkk is smaller than ddd), you can compute the covariance matrix using the following:

C=1k−1XcenteredTXcenteredC = \frac{1}{k-1} X_{\text{centered}}^T X_{\text{centered}}C=k−11XcenteredTXcentered

This produces a matrix of size k×kk \times kk×k, which can be smaller and more manageable. Calculate the eigenvalues and eigenvectors of the covariance matrix CCC. The eigenvalues represent the amount of variance captured by each principal component (PC), and the eigenvectors represent the directions of maximum variance in the data.

To compute the eigenvalues and eigenvectors of the covariance matrix, use the decomposition:

Cv=λvC v = \lambda vCv=λv

where λ\lambdaλ is the eigenvalue and vvv is the eigenvector.

Alternatively, if you're using the data matrix directly, you can perform a Singular Value Decomposition (SVD) on the centered data matrix:

Xcentered=UΣVTX_{\text{centered}} = U \Sigma V^TXcentered=UΣVT

IV. Comparative Result

S.No	Parameter (Accuracy)	Dhvanil Bhagat, Abhi Vakil[1]	Result Obtained
1	Training Data	82.56%	91%
2	Testing Data	65.68%	78%

V. Conclusion

In this study, fer2013 image dataset is used to find the facial emotion expression using deep leaning algorithm. In first step import the facial expression train and test dataset as input image and resize the image, then augment the image using data image generator and convert the images into array by dividing default dimension using 255. Finally the Conventional Neural Network algorithm is applied and find the prediction result of facial expression, and the result is based on accuracy.

VI. Future Work

In future, to predict the emotion expression using live cams, text, audio and video file. It will find the facial emotion from facial feature extraction method. The trained model is used to predict the facial expression easily and it will enhanced as web application like flask.

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