INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
*(Volume 5, Issue 4)*
Available online at: www.ijariit.com

# Emotion recognition using Eigen Faces

*Prekshi Vyas*
*prekshivyas@gmail.com*
*Vellore Institute of Technology, Vellore, Tamil Nadu*

*Abhimanyu Saxena*
*abhimanyu.saxena2016@vitstudent.ac.in*
*Vellore Institute of Technology, Vellore, Tamil Nadu*

## ABSTRACT

***Human-computer interplay has numerous crucial fields of programs and expression detection is one among them. To evaluate the facial expression, we need to analyze the variability of human faces like colouration, posture, orientation, feeling, lights and so forth. Detecting and studying facial capabilities is a pre-needful to emotion recognition. That is frequently carried out through observation of components of the face, like eyes, lips motion and many others. These are then categorized and compared to pre-defined sets of data also called a training set. At a particular in this evaluation, a person's facial expression recognition gadget is modelled exploiting the Eigenface technique. The proposed technique uses Haar cascade classifier to discover the face in a photo. Fisher faces calculation has been employed for decreasing the excessive spatial property of the Eigen's face. The Euclidean separation between the test photograph and mean of the Eigen faces is hired to anticipate emotion expressed with the aid of test face. CK/CK+ data-set is hired for training purpose. The greyscale image of the face is employed by using the version to categorize 5 simple emotions like surprise, disgust, impartial, anger and happiness.***

***Keywords***— *Facial expression recognition, Fisher faces, Principal Component Analysis, Eigen faces, Euclidean distance*

## 1. INTRODUCTION

Facial expressions are important cues for non-verbal communication among human beings. Non-verbal communication takes place as humans are able to recognize emotions quite accurately and efficiently. Evaluation of human emotions has numerous applications in various contexts. The most common is the interaction of humans with the system and other applications like mental health monitoring of patients, studying a suspect for anti-social motives etc. using emotion recognition. It's also useful in e-commerce as one can analyze customer's reaction on seeing a certain product or advertisement or upon receiving a particular piece of information or message. Based on the feedback and reviews whether they are happy or sad or disgusted, etc., the organization can change its marketing strategy. A facial expression recognition system consists of a webcam generally for taking input/real-time data which obtains input image from a subject to communicate with the computer. After detecting the coordinates of the region that contains the face, features are extracted from the facial expression that pertains to the particular emotion. Once features are extracted they are pre-processed and sent to a classifier method that classifies them into a particular type of emotion. Numerous methods can be used for detection and classification of images. This paper presents a dynamic model for emotion evaluation with real-time input based on a comprehensive Eigen space-based approach. Eigen space is defined as a feature space that depicts variation in Eigen faces in encoded form and it characterizes the overall variations among face images.

Emotion recognition has been a fundamental part of life for a very long time. Hand gestures, body language, facial expressions are all ways to express emotions. Therefore, extracting these emotions and understanding them to produce relevant outcomes is important, in the system of emotion recognition, algorithms detect faces and work on the Euclidean distances between particular facial points to compare and classify them with a curated set of images for all types of emotion. Today we all use emoticons or as we call the emojis in our chats or texts. They are used to express emotions which we can't express through texts. Incorporating that idea into emotion analysis techniques, it can be made more interesting.

Emotion recognition and analysis are being used by many technological giants like Apple Inc., Google, Amazon, Microsoft, Facebook etc in understanding their customer needs through the emotions. Users can create their own emoticons using just their facial expressions. The recent developments in this field have been in marketing. Customer sentiments and emotions are targeted in order to make the brand reach the market. Successful markets and initiatives are majorly focused on emotion analysis. Many of the findings from consumer neuroscience studies of brands in the consumer goods market reveal that ads with the best emotional response generate a lift in sales, implying that emotional marketing can act as true support to increase profits in the business and yield better results for the companies. [4]

## 2. APPROACH

The approach followed in emotion recognition is as depicted in Figure 1 which involves the formation of face library followed

by face region detection from the given image, formation of Eigen faces of training dataset followed by projecting it on Eigen space and classification.

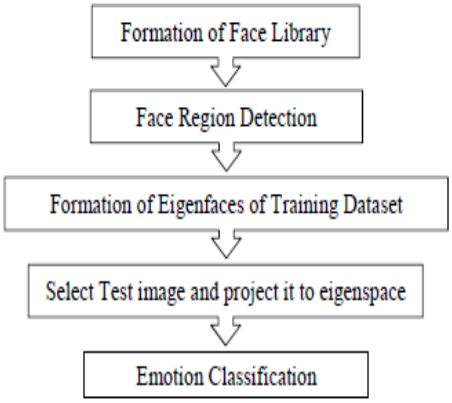



**Fig. 1: Proposed approach**

### 2.1 Formation of face library

It involves the preparation of dataset upon which the learning algorithm will work. In this research work, different datasets of faces available on CK+ dataset have been used. Data is trained using fisher face classifiers to recognize different emotions.

### 2.2 Feature Selection and Extraction

Various edge detectors like wavelet and wavelet packets, discrete cosine transformation and Gabor [3] filters including shape/colour features are widely used. The face space is usually computed by a principal components analysis or linear discriminant [6] analysis (Fisher's Linear Discriminant) of the face database. Both these analyses are classical methods for multivariate analysis. They can form Eigen faces or fisher faces.

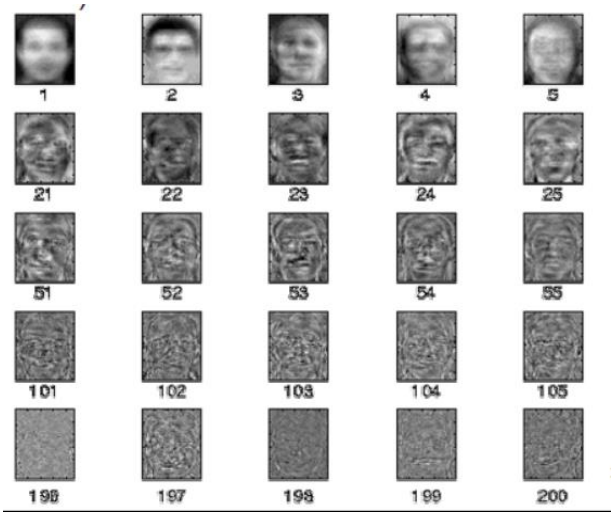



**Fig. 2: Some examples of Eigen faces (the number indicates the principal component number ordered according to eigenvalues)**

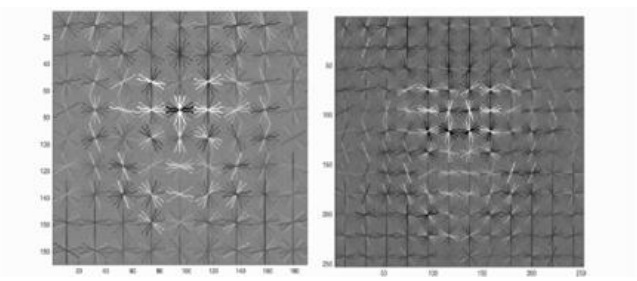


**Fig. 3: The Gabor wavelet responses at 3 spatial frequencies and 4 orientations (0, 45, 90, 135).**

Gabor Wavelet-based Features: Gabor Wavelet[3] filters are multi-scale and selective to specific directional changes in the image. They can, therefore, be used to obtain invariance to scale change and to investigate the effect of locally oriented image features. In addition, they achieve a certain amount of localized normalization for illumination.

### 2.3 Face Detection

Commonly Used Techniques involve finding faces in images with a controlled background which uses images with a plain mono-colour background or use them with a predefined static background and then removes the background always giving the face boundaries. Finding faces by colour is another method that uses the typical skin colour to find face segments. This method doesn't apply to all kinds of skin colours and is not very robust if lighting conditions vary. It can be combined with other methods such as motion and appearance-based face detection. Human skin forms a relatively tight cluster in colour space even when different races are considered.

Based on the above mentioned generalised techniques there are three main standardized techniques used for facial detection:

#### 2.3.1 Histogram of oriented gradient (HOG)

(a) The basic principle is that the distribution of native intensity gradients or edge direction which facilitates in characterizing the looks of the native object and its shape.
(b) This methodology is simple, quick and histogram can be calculated with ease.
(c) Orientation analysis is robust to lighting changes.
(d) It is very useful in cases of objects with texture and deformable shapes.
(e) Rarely used in face recognition and is usually used in intelligent video surveillance system like pedestrian detection.

#### 2.3.2 LBP (Local Binary Pattern)

(a) Images are divided into several small regions and each region is used to extract features through which one can evaluate the texture and shape of an image. [1]
(b) The surroundings of pixels in these regions are described with the help of features consisting of binary patterns.
(c) To form a representation of the image, the extracted features are concatenated into a single feature histogram.
(d) LBP method provides reliable results for face recognition. It is a fast technique and suitable for discrimination performance.
(e) Because of the way, the texture and shape of images are described, the method seems to be quite robust against face images with different facial expressions, different lighting conditions, image rotation and ageing of persons.

#### 2.3.3 Haar Cascade Classifiers [11]

(a) It uses a machine learning approach in which cascade function is put to training using a large set of positive and negative images.
(b) It is employed for the detection of objects present in images. The algorithm works on a lot of positive images i.e. images that contain faces and a lot of negative images that are images without faces.
(c) Sum of pixels under a white rectangle and sum of pixels under a black rectangle is calculated and the difference of both the sums is equivalent to the value of each feature.
(d) A threshold value which best suits for classification of an image as positive or negative is calculated by this algorithm.

Haar[11] was chosen out of all three methods for the present work. The first step in facial feature detection is detecting the face. The entire image needs to be analyzed for this purpose. This leads to isolation of faces for the detection of features. This isolated image is entirely used for feature detection which is smaller than the actual image that may contain a lot of noise or unwanted objects. Regionalization and isolation thus reduce the time taken for detection of all facial features, even less time than detecting the face itself and also increases the accuracy of detection.

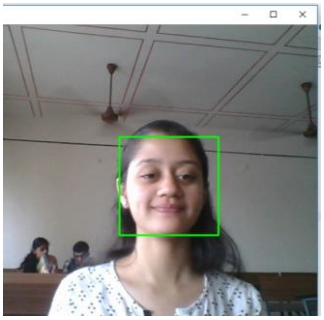


**Fig. 4: Output of face detection using HAAR**

### 2.4 Emotion Recognition

#### 2.4.1 Taxonomy

Before starting to recognize emotions, we focus on all the emotions that can be recognized by humans all over the globe. Universally displayed basic emotions to culture-specific complex ones, psychologists and emotion theorists have done several classifications of emotions. Out of the various models in emotion research, there are two that have dominated facial expression research: Ekman's basic set of emotions and Russell's circumflex model of effect.

Ekman and Friesen in 1971[14] were the first ones who proposed six prototypical emotions - anger, disgust, fear, happiness, sadness, and surprise - which are displayed universally among human beings and are recognized from human facial expressions.

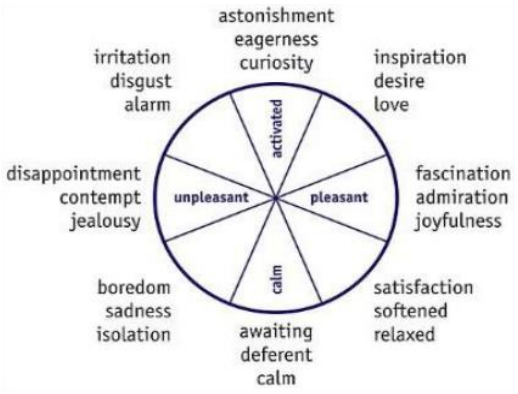



**Fig. 5: The Circumflex Model of Russell**

## 3. EXISTING WORK

The emergence of this knowledge has been over a few decades, it still remains an area of research and welcomes new techniques and algorithms each time. Identification of correct emotional state of the individual understudy from the measurements of physiological conditions is difficult. When mixed emotions are encountered, recognizing them becomes difficult.

In the present work, the facial features were extracted using different feature filters like Gabor wavelet filter and discrete cosine transformation. Another idea of 3D facial features was also used. This technique of facial expression detection uses 3D facial feature distances. The face was scanned and transformed to its 3D space, similar transform was done for expression training and prediction.

### 3.1 Popular algorithms

Training algorithms for emotion recognition:

**3.1.1 Convolutional Neural Networks:** are best suited for object detection and are therefore not used in human/facial analysis systems. Fisher face classifiers were used in present work and therefore the method has been described in detail for Fisher face classifier.

**3.1.2 Fisher Face Classifier:** This algorithm is based on Principal Components Analysis [2] (PCA). These Eigenfaces are the eigenvectors associated with the largest eigenvalues of the covariance matrix of the training data. It is a strong method through which one can represent data as it ensures the data variance and eliminates the existing correlations among the original features (dimensions) in the sample vectors.

First Eigenface is evaluated of the test image after which, its Euclidean distance is calculated with the mean of the Eigen faces of the training dataset. This Euclidean distance is compared with the eigenvalues of the eigenvector. The distances between the Eigenfaces of the training dataset and their mean image is calculated and stored. The labelling of different images into different emotion classes like happy, sad, fearful, disgust, all is done according to the distances of various images from the mean image. When the Euclidean distance between the test image eigen face and mean image matches the distances between the mean image and training dataset's eigen faces, the emotion is classified and named as per the labelled train images.

Steps followed in computing Eigen faces:

**Step 1:** Every face image is being transformed to vectors of dimension (hxw, l) where h and w are height and width respectively of the face image and value 1 represents a single face image.

**Step 2:** Computation of mean feature vector.

**Step 3:** Subtracting mean feature vector from each feature vector.

**Step 4:** The covariance matrix is estimated to find the Eigen directions in order to find the eigenvectors.

**Step 5:** K Eigen vectors representing the K largest Eigen values from each class are chosen.

The Equation to measure Euclidean distance between two points' p and q in Euclidean n-space is given by the equation:

$$\sqrt{\sum_{i=1}^{n}(Qi - Pi)^2}$$

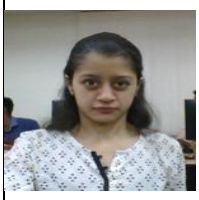
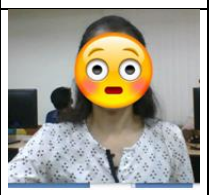
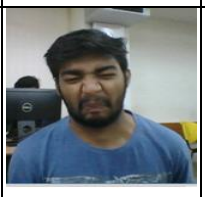
**Fig. 6: Eigen face generated for happy faces**

## 4. RESULT

Haar cascade classifier has shown good results for the images having a simple or mono colour background. Haar cascade can be considered suitable for providing speed and is a reliable method for large datasets. Accuracy of detection was not affected by Illumination on the image. The results remained consistent when the object under study had minor real life variations such as wearing spectacles. Fisher's face has provided reliable results even with the moderate dataset. Table 1 shows the results of the method applied to real webcam images. The program successfully superimposed the corresponding emoji on face images depicting the type of emotion.

**Table 1**: Output Images

| Emotion | Normal Image | Output Image |
|---|---|---|
| Neutral |  |  |
| Happy |  |  |
| Angry |  |  |
| Surprise |  |  |
| Disgust |  |  |

## 5. CONCLUSION

Emotion recognition has gained a lot of attention in the past few areas because of its applications in various fields and its complexities, challenges in the field of machine learning and image processing. This paper puts forth a human facial emotion recognition model that uses eigen face approach in which the various emotions are evaluated by calculating the Euclidean distance between the input test image and the mean of the eigenfaces of the training dataset. Further research and exploration can be carried out in the field of expression detection and its applications. This project focuses on directly transforming the dataset images to their eigen faces so as to depict a general sense in which these expressions are formed. The training is done by fisher face classifier and despite the small size of dataset an accuracy of 80% is achieved. In order to optimize the training, we omitted 3 emotions out of 7 namely fear, sadness and contempt. Greater accuracy can be achieved with detecting these emotions if a model is trained with a larger dataset and can be implemented as future work.

## 6. REFERENCES


[1] S. L. Happy, A. George and A. Routray, "A real time facial expression classification system using Local Binary Patterns," IEEE 4th International Conference on Intelligent Human Computer Interaction, 2012.

[2] C. Juanjuan, Z. Zheng, S. Han and Z. Gang, "Facial expression recognition based on PCA reconstruction" International Conference on Computer Science and Education, 2010.

[3] Liu, Chengjun, and Harry Wechsler. "Gabor feature based classification using the enhanced fisher linear discriminant model for face recognition." *IEEE Transactions on Image processing* 11.4 (2002), pp. 467-476.

[4] https://blog.hubspot.com/marketing/emotion-detection-technology-marketing

[5] De, Anurag, Ashim Saha, and M. C. Pal. "A human facial expression recognition model based on Eigen face approach." *Procedia Computer Science* 45 (2015), pp. 282-289.

[6] Zhao, Wenyi, et al. "Discriminant analysis of principal components for face recognition." *Face Recognition*. Springer, Berlin, Heidelberg, 1998, pp. 73-85.

[7] Cevikalp, Hakan, et al. "Discriminative common vectors for face recognition." IEEE Transactions on pattern analysis and machine intelligence 27.1 (2005), pp. 4-13.

[8] Martinez, Aleix. "Fisherfaces." Scholarpedia 6.2 (2011) 4282.

[9] Turk, Matthew A., and Alex P. Pentland. "Face recognition using eigenfaces." Computer Vision and Pattern Recognition, 1991. Proceedings CVPR'91, IEEE Computer Society Conference on. IEEE, 1991.

[10] Belhumeur Peter N., João P. Hespanha, and David J. Kriegman. "Eigenfaces vs. fisherfaces: Recognition using class specific linear projection." IEEE Transactions on pattern analysis and machine intelligence 19.7 (1997), pp. 711-720.

[11] Wilson, Phillip Ian, and John Fernandez. "Facial feature detection using Haar classifiers." Journal of Computing Sciences in Colleges 21.4 (2006), pp 127-133.

[12] Krizhevsky, Alex, Ilya Sutskever, and Geoffrey E. Hinton. "Imagenet classification with deep convolutional neural networks." Advances in neural information processing systems. 2012.

[13] Pushpaja V. Saudagare, D.S. Chaudhari, Facial Expression Recognition using Neural Network –An Overview, International Journal of Soft Computing and Engineering (IJSCE) ISSN: pp. 2231-2307, Volume-2, Issue-1, March 2012.

[14] P. Ekman and Friesen. Constants across cultures in the face and emotion. Journal of Personality and Social Psychology, 17(2), pp. 124-129, 1971

[15] Viola, P., & Jones, M. (2001, July). Robust real-time face detection. In *null* (p. 747). IEEE.

[16] Viola, P., & Jones, M. (2001). Rapid object detection using a boosted cascade of simple features. In *Computer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on* (Vol. 1, pp. I-I). IEEE.