International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Emotion / Facial Expression Detection

Harshada Chapre[1], Lopita Choudhury[2], Manoj Kamber[3]

[1]PG Student, MCA, Parul Institute of Engineering and Technology - MCA, Parul University, Vadodara, India
Email: *harshadachapre1[at]gmail.com*

[2]PG Student, MCA, Parul Institute of Engineering and Technology - MCA, Parul University, Vadodara, India
Email: *lopitachoudhury[at]gmail.com*

[3]Assistant Professor, MCA Faculty of IT and Computer Science, Parul Institute of Engineering and Technology - MCA, Parul University, Vadodara, India

Abstract: ***Facial Expression conveys non - verbal cues, which plays an important role in interpersonal relations. The Facial Expression Recognition system is the process of identifying the emotional state of a person. In this system captured image is compared with the trained dataset available in database and then emotional state of the image will be displayed. A face recognition system is one of the biometric information processes its applicability is easier and working range is larger than others, i. e., Fingerprint, iris scanning, signature etc. An algorithm that performs detection, extraction, and evaluation of these facial expressions will allow for automatic recognition of human emotion in images and videos.***

Keywords: Facial expression recognition (FER), Local Binary pattern (LBP), Support Vector Machine (SVM)

1. Introduction

A Facial expression is the visible manifestation of the affective state, cognitive activity, intention, personality and psychopathology of a person and plays a communicative role in interpersonal relations. It has been studied for a long period of time and obtaining the progress recent decades. Though much progress has been made, recognizing facial expression with a high accuracy remains to be difficult due to the complexity and varieties of facial expressions. The system is growing attention because this could be widely used in many fields like lie detection, medical assessment and human computer interface. The Facial Action Coding System (FACS), which was proposed in 1978 by Ekman and refined in 2002, is a very popular facial expression analysis tool. On day - to - day basics humans commonly recognize emotions by characteristic features, displayed as a part of a facial expression. For instance, happiness is undeniably associated with a smile or an upward movement of the corners of the lips. Similarly other emotions are characterized by other deformations typical to a particular expression. Research into automatic recognition of facial expressions addresses the problems surrounding the representation and categorization of static or dynamic characteristics of these deformations of face pigmentation.

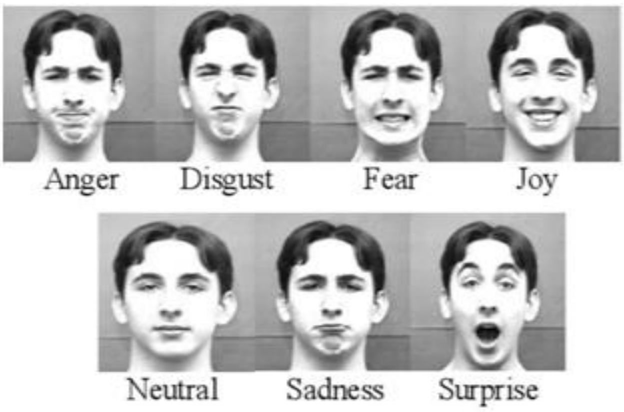


Figure 1: Seven basic human emotions

2. Methods and Material

1) Algorithms / Techniques

Over the last few of years, face recognition researchers have been developing new techniques. These developments are being fueled by advances in computer vision techniques, computer design, sensor design, and interest in the field of face recognition systems.

Principal Component Analysis: Principal component analysis (PCA) was invented in 1901 by Karl Pearson. PCA is a variable reduction procedure and useful when obtained data have some redundancy. This will result into reduction of variables into smaller number of variables which are called Principal Components which will account for the most of the variance in the observed variable. Problems arise when we wish to perform recognition in a high dimensional space. Goal of PCA is to reduce the dimensionality of the data by retaining as much as variation possible in our original data set. The stages involved in the suggested method for steganography utilising dynamic pixel mapping are as follows:

2) Eigen Face Approach:

It is adequate and efficient method to be used in face recognition due to its simplicity, speed and learning capability. Eigen faces are a set of Eigen vectors used in the Computer Vision problem of human face recognition. They refer to an appearance based approach to face recognition that seeks to capture the variation in a collection of face images and use this information to encode and compare images of individual faces in a holistic manner. By comparing a set of weights for the unknown face to sets of weights of known faces, the face can be identified. If the image elements are considered as random variables, the PCA basis vectors are defined as eigenvectors of the scatter matrix ST defined as ST

$$= (x – \hat{A}\mu) (x – \hat{A}\mu) T \quad (1)$$

3) Independent Component Analysis:
PCA considered image elements as random variables with Gaussian distribution and minimized second - order statistics. Clearly, for any non - Gaussian distribution, largest variances would not correspond to PCA basis vectors. Independent Component Analysis (ICA) (Bartlett et al., 2002; Draper et al., 2003) minimizes both second - order and higher order dependencies in the input data and attempts to find the basis along which the data (when projected onto them) are statistically independent. The INFOMAX algorithm was proposed by Bell and Sejnowski and used by Bartlett et al. (2002).

4) Linear Discriminant Analysis:
LDA encodes discriminatory information in a linear separable space of which bases are not necessarily orthogonal. Researchers have demonstrated that the LDA based algorithms outperform the PCA algorithm for many different tasks [7, 8]. However, the standard LDA algorithm has difficulty processing high dimensional image data. PCA is often used for projecting an image into a lower dimensional space or so - called face space, and then LDA is performed to maximize the discriminatory power.

Sb = (Âμj Âμ) (Âμj Âμ) T (2) Sw = (x j Âμ) (x j Âμ) T (3)

3. Tools & Technologies

1) Programming Language and Coding Tool

a) C+
C++ is a general - purpose programming language. It has imperative, object - oriented and generic programming features, while also providing facilities for low - level memory manipulation. It was designed with a bias toward system programming and embedded, resource - constrained and large systems, with performance, efficiency and flexibility of use as its design highlights.

b) IDE CLion for C+
CLion is a cross - platform C/C++ IDE which is more than just an editor as it offers intelligent C make support. CLion helps in knowing codes through and through and can boost the productivity with smart and relevant code completion, instant navigation and reliable refactoring.

2) Framework

a) OpenCV
OpenCV (Open - Source Computer Vision Library) is an open - source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception in the commercial products. Being a BSD - licensed product, OpenCV makes it easy for businesses to utilize and modify the code. The library has more than 2500 optimized algorithms, which includes a comprehensive set of both classic and state - of the - art computer vision and machine learning algorithms.

4. Results and Discussion

The aim of this project work is to develop a complete facial expression recognition system. Two datasets, COHN_KANADE and JAFFE were used for the experimentations. First of all, system was trained using different random samples in each dataset by supervised learning. In each datasets the data were partitioned into two parts for training and testing. Every dataset has completely different samples which are selected randomly in uniform manner from the pool of given dataset. The COHN_KANADE datasets included 585 directories of both subject and session where there were 97 subject directories and 8795 image files in total and partitioned was made in the ratio of 8: 2 i. e., 6481 (80%) for train and 1619 (20%) for test. Similarly, JAFFE dataset included 213images which was partitioned in the ratio of 7.5: 2.5 i. e., 160 (75%) for train and 53 (25%) for test. The confusion and accuracy evaluation results of

COHN - KANADE and JAFFE datasets are as below:

Labels	Angry	Disgust	Fear	Happy	Neutral	Sad	Surprise
Angry	259	0	0	0	0	1	0
Disgust	1	182	0	0	0	0	0
Fear	2	1	219	0	0	0	1
Happy	25	40	173	98	1	19	0
Neutral	1	1	12	0	111	0	0
Sad	1	1	1	1	0	228	0
Surprise	12	15	141	1	0	11	60

In the above table, row shows the actual classes and column shows the predicted classes. The classifier made a total of 1619 predictions where the classifier predicted angry for 300 times, disgust for 239 times, fear for 545 times, happy for 99 times, neutral for 112times, sad for 259 times and surprise for 61 times. Whereas in reality 260 cases was angry, 183 was disgust, 223 was fear, 356 was happy, 125 was neutral, 228 was sad and 240 was surprise.

Evaluation Types	Results Percentage
Precision	83.6412
Recall	95.0822
F-Score	88.9955

The above table shows that 83.6412% of the expressions were predicted 95.0822% of the expressions were correctly assigned. The harmonic mean of precision and recall was 88.9955%.

Labels	Angry	Disgust	Fear	Happy	Neutral	Sad	Surprise
Angry	4	1	0	0	0	1	0
Disgust	0	6	0	0	0	0	0
Fear	0	0	10	0	0	0	0
Happy	0	0	0	10	2	0	0
Neutral	0	0	0	0	6	0	0
Sad	0	0	0	0	0	10	0
Surprise	0	0	0	0	1	0	2

In the above table, row shows the actual classes and column shows the predicted classes. The classifier made a total of 53 predictions where the classifier predicted angry for 4times, disgust for 7 times, fear for 10 times, happy for 10 times, neutral for 9 times, sad for 11 times and surprise for 2 times. Whereas in reality 6 cases were angry, 6 was disgust, 10 was fear, 12 was happy, 6 was neutral, 10 was sad and 3 was surprise.

Evaluation Types	Results Percentage
Precision	91.8986
Recall	98.3649
F-Score	95.0218

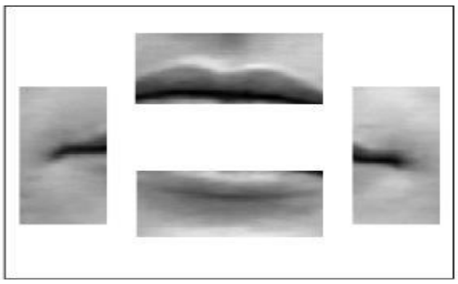
The above table shows that 91.8986% of the expressions were predicted, 98.3649% of the expressions were correctly assigned. The harmonic mean of precision and recall was 95.0218%

5. Conclusion

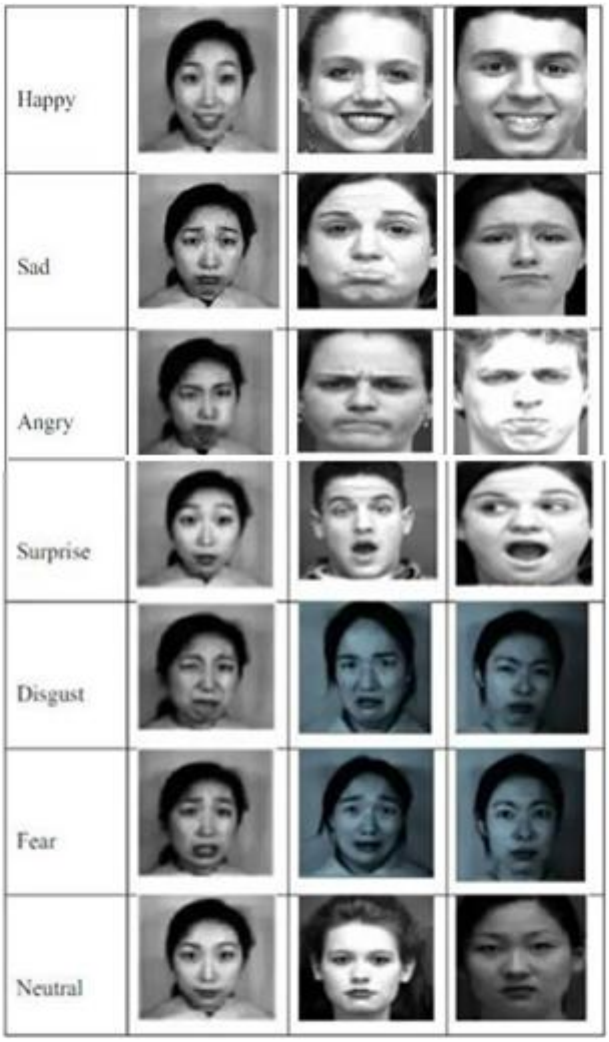
In this paper we have proposed to combine feature detection and extraction and recognition of facial expression into one system. We proposed a new method of feature detection and statistical approach is introduced in an attempt to improve the recognition rate. The proposed feature detection using multi - stage integral projection is simple, robust and efficient. Using integral projection, we were able to locate the eyebrows and lips. Then using a statistical approach on the optical flow field, we found the overall movement of the features in the window detected earlier without the need to pinpoint the exact location of the feature. The main advantage of this approach is that it does not require any initial manual settings such as location of head. The initial settings are predetermined using normalized coefficients obtained using a facial image database. Second, Kalman filtering is applied on the resultant optical flow value to calculate the recognition rate. From the recognition rate we can see that directly feeding in the Kalman filter to the neural network lead to a recognition rate of 70%. However, by applying the proposed statistical approach on the optical flow results and feeding it to the neural network lead to an improvement to 80%. This is because of the facial movement due to expressions consists of sudden changes and it is difficult to model a facial expression system. In Kalman filtering the system model has to be defined beforehand in the case of expression, the amount of movement need to be known. However, the amount of movement of the facial features varies from person to person and to some people for example, happiness is only a slight movement of the lips while to others, the movement can be very large. Therefore, the use of Kalman filtering lead to poor performance because of the difficulty in designing a suitable system model.

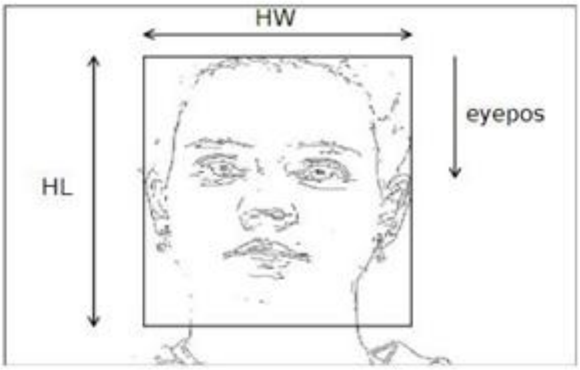
6. Demonstration (If applicable)

1) Datasets Collection

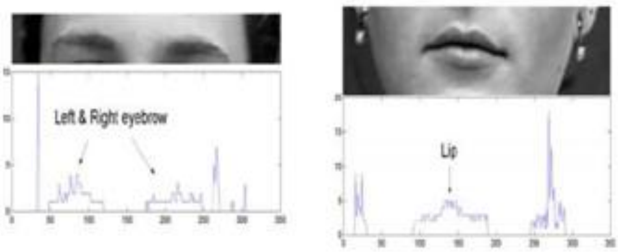


Lips Partition





Result of head area estimation



Vertical Projection of eyebrows and lips

Final Result of Projection

References

[1] Bettadapura, V. (2012). Face expression recognition and analysis: the state of the art. arXiv preprint arXiv: 1203.6722.
[2] Shan, C., Gong, S., & McOwan, P. W. (2005, September). Robust facial expression recognition using local binary patterns. In Image Processing, 2005. ICIP 2005. IEEE International Conference on (Vol.2, pp. II - 370). IEEE.
[3] Bhatt, M., Drashti, H., Rathod, M., Kirit, R., Agravat, M., & Shardul, J. (2014). A Study of Local Binary Pattern Method for Facial Expression Detection. arXiv preprint arXiv: 1405.6130.
[4] Chen, J., Chen, Z., Chi, Z., & Fu, H. (2014, August). Facial expression recognition based on facial components detection and hog features. In International Workshops on Electrical and Computer Engineering Subfields (pp.884 - 888).
[5] Ahmed, F., Bari, H., & Hossain, E. (2014). Person - independent facial expression recognition based on compound local binary pattern (CLBP). Int. Arab J. Inf. Technol., 11 (2), 195 - 203.
[6] Happy, S. L., George, A., & Routray, A. (2012, December). A real time facial expression classification system using Local Binary Patterns. In Intelligent Human Computer Interaction (IHCI), 2012 4th International Conference on (pp.1 - 5). IEEE.
[7] Zhang, S., Zhao, X., & Lei, B. (2012). Facial expression recognition based on local binary patterns and local fisher discriminant analysis. WSEAS Trans. Signal Process, 8 (1), 21 - 31.
[8] Chibelushi, C. C., & Bourel, F. (2003). Facial expression recognition: A brief tutorial overview. CVonline: On - Line Compendium of Computer Vision, 9.
[9] Sokolova, M., Japkowicz, N., & Szpakowicz, S. (2006, December). Beyond accuracy, F - score and ROC: a family of discriminant measures for performance evaluation. In Australasian Joint Conference on Artificial Intelligence (pp.1015 - 1021). Springer Berlin Heidelberg.
[10] Michel, P., & El Kaliouby, R. (2005). Facial expression recognition using support vector machines. In The 10th International Conference on Human - Computer Interaction, Crete, Greece.
[11] Michel, P., & El Kaliouby, R. (2003, November). Real time facial expression recognition in video using support vector machines. In Proceedings of the 5thinternational conference on Multimodal interfaces (pp.258 - 264). ACM.