

Review Article

The Field of Facemask Expressions Recognition Using PCA Classifier

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A B S T R A C T

Many computer vision and machine vision researchers are working towards the direction of making HCI (Human-Computer Interface) systems, which can behave similarly to HHI (Human-Human Interface) systems. To make all these systems realistic the computer system has to understand the logic behind the power of humans to identify the emotions present on other's faces during any kind of communication. The main challenges in the field of emotion detection are illumination conditions; pose variations, facial accessories, etc. In this paper, the main focus is on various steps which must be followed by the users to identify the emotion present on the face of the person whose image is under observation. The main emphasis is given to the sequence of steps followed to get the emotion from the face by using various concepts of image processing. These sequential steps are Face recognition to confirm that the image under consideration has a facial data or not, Detection of the face region from the image, Extraction of Region of Interest (ROI) from facial data, at the end the identification of the category of the emotion present on the detected face from the image supplied as input.

Keywords: Illumination, Pose variation, ROI, HCI, HHI

Introduction

Researchers are working very hard these days to make the different tasks of human beings as easy as possible. The advent of a computer system in past was the biggest achievement of researchers in this direction. They replaced the manual task with the automatic one by preparing some executable codes for different tasks to increase the speed of the task and efficiency of the process. Nowadays, almost 100% accuracy is achieved for these automated tasks with the help of the latest technologies. But in the case of tasks like manual human-to-human interaction, the computer systems have some restrictions to deal with the situations. They interact with humans in general conversations, firstly

there is a need to build an automated system that can be able to identify the expressions present on the face of the person during conversation and the system can reply to humans according to the category of emotion present on the face of the person. Various emotion categories like Happy, Anger, Disgust, Sad, etc. are mentioned in Figure 1. For performing this task of expression identification, the system has to follow some technical sequential steps. The first step in this direction is to capture the facial image. Then this image is supplied as an input to the system under consideration. After that, there must be the requirement of a system to again check whether the image supplied as input to the system contains facial data or not. After the verification that the input image contains a human

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face, the next process is to detect the portion of the image which contains facial data. This process is known as face detection. This process needs the support of some segmentation algorithm to extract facial data from input images. This process may be completed by considering the structural behavior of the facial images like edges, contours, boundaries, etc. or other features like skin color, distance and existence, distance between various facial components like eyes, nose, lips, etc.¹ After getting the facial area next process is to apply the knowledge gain from Facial Action Coding System (FACS). This system provides various features to identify the exact emotional state present on the face under consideration. The Facial Action Coding System consists of total 44 action units. These Action Units are actually the parts of the face or the activities done by the various components of the face. These action units consider eyes, lips, nose, nose wrinkles, lip up, lip down moments etc. By observing the behavior of Action Units (AU) further decisions can be made about the presence of emotion categories. These emotion categories may be happy, sad, disgust, anger, fear or normal.²

Further in this paper the different portions consider the work done in the field of facial expressions and emotion recognition, Then the next part of the paper highlights the various challenges in this field of research, after that some objectives are proposed which show the step-by-step approach to deal with the problem. At the last conclusion section of the paper will conclude the need and requirement which attract towards the researchers to work on this area.

Literature Review

Jain and Sahu [2016], presented a methodology for face recognition by using the method of principal component analysis (PCA). Principal component analysis method was performed on a set of training and testing images. They compared ORL and JAFFE database by using PCA. Here the PCA algorithm gave 94% recognition rate for ORL database and 96.24 recognition rate for JAFFE database.¹ Dongcheng et al. [2010], proposed a method for facial expression recognition using the PCA technique along with Discrete Wavelet Transform and Linear Discriminate Analysis. DWT was used to decompose the input image and LDA was used to extract required features. PCA was further used for classification process. They found a low rate of recognition for emotion categories like normal, Happy and Surprised. The experimental studies were performed on the JAFFE database which gives a recognition rate of 78.77%.² Jain and Sahu [2016] investigated the possibility to detect the emotions by applying two algorithms i.e PCA and 2DPCA. The techniques were implemented on four different standard databases. One of the JAFFE databases which gave recognition rate as 93.5% by applying PCA technique also gave 95.71% recognition rate by applying 2DPCA technique.³

January et al. [2013], used PCA approach for three training images and six testing images. They selected different PCA components for each class separately. The dataset used by them contained images of 30 different persons with different facial expressions. The accuracy achieved by them were 92.62%.⁴ De et al. [2015], proposed a human facial expression recognition model based on eigen face approach. Euclidian distance was used to found emotion categories. Mean of the eigen faces of training images was used for the purpose of comparison. The accuracy achieved by them were 85.36%.⁵ Georganas et. al. [2009], suggested the use of multi-model ways to deal with the problem of automatic feature extraction. They used the part based PCA method for emotion detection. They considered the division of training set into seven different classes. The recognition rates achieved by them were 76.67%.⁶ Rani et al. [2014] proposed a system, where they take an input of facial images from video frames. Euclidean distance and PCA was used for emotion detection.⁷ Besinger et al. [2010], utilized following calculation for recognizing the three feelings cheerful, irate and pitiful. In which analyst utilized Optical stream-based examination to bargain with the issue of feeling discovery. They utilized a highlight point following strategy to identify the feeling show within the confront. This strategy is connected on five facial parts. They utilized the database in which 60 diverse faces of distinctive sexes and they are not wearing glasses and they don't have facial hair. The normal exactness accomplished by the creators was 83%.⁸



Figure 1. Different emotion categories⁹

Singh et al. [2011], proposed a strategy utilizing optical flow-based examination and highlight-based strategy to distinguish the state of the feeling show on the facial parcel of the input picture. They compared their work with the template-based investigation to demonstrate the truth that feature-based strategy is a more secure, speediest and less complete strategy as compared to template-based approach.¹⁰ Michel et al. [2003] found from their ponder that Irish acknowledgment is exceptionally basic in human distinguishing proof and it too gets more consideration in confront acknowledgment. A number of frameworks were created utilizing Irish filter that works in unmistakable wavelength and was less compelled. The creators proposed a division strategy that can handle debase pictures procured

in less obliged conditions. In their think firstly they consider the Sclera portion of the eye, at that point a modern sort of highlight that degree the extent of Sclera in each heading and at long last to run the strategy of feeling discovery. Their strategy created lower computational fetched.¹¹ Luo et al. [2007], proposed a question following demonstration with the assistance of optical flow-based examination. There were two methodologies in their experimentation. First, for the following of both inflexible and deformable objects. Another portion was the following of both settled camera and moving camera. Authors displayed the comes about of different objects in genuine time video.¹² Renjie and Songyu [2008], examined the plausibility of progressing the exactness of visual-facial feeling acknowledgment through the utilization of extra keyboard-stroke data. The examination was based on two observational considers that they had conducted including human subjects and human eyewitnesses. The considers were concerned with the acknowledgment of feelings from a visual-facial methodology and keyboard-stroke data, separately. They were motivated by the relative deficiency of such past inquiries in experimental work concerning the qualities and shortcomings of each methodology so that the degree can be decided to which the keyboard-stroke data complements and makes strides the feeling acknowledgment of exactness of the visual-facial methodology. Specifically, the inquiry centered on the acknowledgment of six fundamental feeling states, to be specific joy, pity, astonish, outrage, nauseate as well as the emotionless state which we allude to as impartial. They found that the visual-facial methodology may permit the acknowledgment of certain states, such as unbiased and shock, with adequate precision. However, its exactness in recognizing outrage and bliss can be made strides essentially on the off chance helped by keyboard-stroke data.¹³

- Challenges within the field of Facial Expression Recognition
- Various Illumination conditions
- Camera Quality and limitations
- Pose variations
- Facial Accessories
- Similarities among faces
- Age Effect on Faces

Above mentioned challenges attract various research towards this field of research. Figure 2 shows the challenges as per the above discussion. The input required to the systems which are meant for face recognition is considered as an image containing a face or facial data. These images are acquired using Digital cameras. The picture clicking quality of the camera affects the input image which may be given as input to the face recognition or expression identification systems. The quality of the camera may depend on a number of factors like the number of pixels

used, zooming capability, focus etc. Another effect is the lighting condition at the time of clicking the photograph. This also adds some properties on the clarity of images. Pose variations by persons at the time of picture clicking also affect the entire process. Sometimes facial accessories like spectacles, facial jewelry, makeup, etc. make the process of recognition and identification difficult. Nature contains a number of hidden facts and suspense which always gives a mesmerizing feeling. As we see twins' similar appearance or parents and children having the same facial features also makes the processing power of systems quite difficult in some cases at the time when there is a need to distinguish among them.

Aging effects also affect the facial features of same person over time. So, all these are some difficulties that one has to consider when it is time to make an automated system Table1. shows the work done by the researchers using the PCA algorithm for facial expression recognition. Mainly, the PCA technique was used in combination with other techniques like DWT and Euclidian Distance calculations. This table reflects the maximum accuracy as 92.62% in the field of facial expression recognition using the PCA approach.

Proposed Algorithm

To make a successful framework for facial expression acknowledgment, in this paper a few targets are proposed in a successive way for the reason of execution.

- to create calculations for confront reorganization, highlight extraction, feeling classification utilizing Skin Color Segmentation, Knowledge-Based Approach, PCA separately
- to realize the proposed framework utilizing the actualizing environment
- to test and approve the proposed framework on the premise of a few parameters like reorganization rate, division precision, ROI extraction exactness

To seek after work in this inquire about the field in this paper primary center is given on the advancement of each step which must be taken after amid facial expression acknowledgment approach.

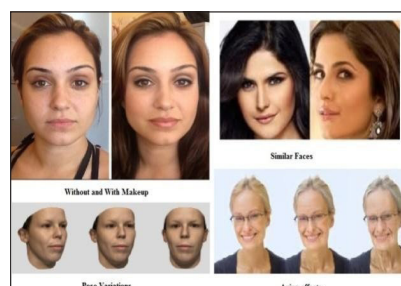


Figure 2.Challenges during Facial Expression Recognition⁹

Table I.A Survey on Emotion Detection Current status

S. No.	Research Paper	Year	Technique	Accuracy
1.	A Human Facial Expression Recognition Model based on EigenFace Approach	2015	PCA, Euclidian Distance	85.36%
2.	Implementation of Emotion Detection System Using Facial Expressions	2014	PCA, Euclidian Distance	-----
3.	Human Emotional State Recognition Using Facial Expression Detection	2013	PCA	92.62%
4	The Method of Facial Expression Recognition Based on DWT-PCA/ LDA	2010	DWT-PCA/ LDA	78.77%
5.	Part-based PCA for Facial Feature Extraction and Classification	2009	Part-based PCA	76.67%

Before the detection of facial component from the image, the first part is to verify that the input image contains face or not here the concept of skin color segmentation is proposed in this paper. Then after this verification the next step is to identify the region from the image which contains the facial data. After this identification, next part is segmentation based on the region of interests which may help in finding the emotional category present in the face. After the segmentation process there is the turn of classification method to identify the emotion state present of the facial data reflected by the input image. In this paper Principal Component Analysis (PCA) approach is proposed along with Knowledge-based approach to deal with this issue. Figure-3 shows the step-by-step procedure explained above. The emphasis given on the minute steps may prove to be good for the overall recognition and identification system.

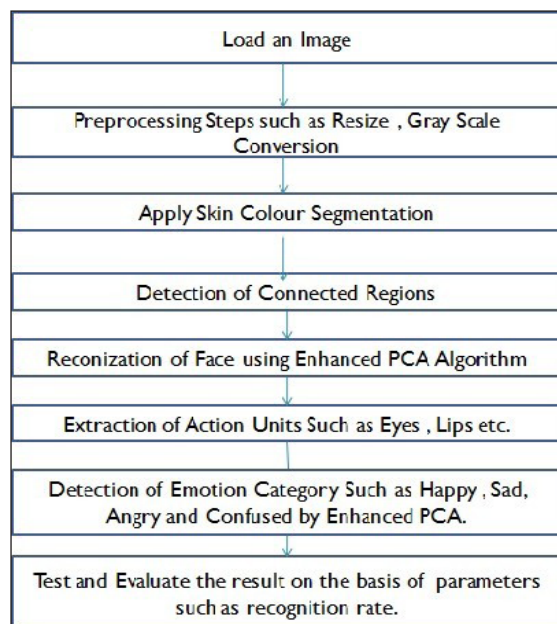
**Figure 3. Proposed Steps for Feature Extraction**

Figure3. represents the step by step working of the proposed system for facial features extraction. The system will take a facial image as input. Then to enhance the quality of the input image various preprocessing operations like resizing, gray scale conversions have to perform. After that, the enhanced image has been further passed through a skin color segmentation approach. This step will help to find the connected regions in the input image. This step is necessary for finding facial region form the input image. Enhanced PCA approach is further proposed to recognize facial expressions.

Conclusion

Many researchers are currently working in the field of emotion detection and recognition. There are a number of challenges present in this area as per the above discussion like aging effects, pose variations, illumination conditions etc. All these challenges create a scope to do work in this direction. In this paper a step-by-step idea is proposed to handle the issue.

Face recognition has been considered as the first step in the proposed system. This step is used to check the fact that input image contains a face or not. The use of the approach of skin color segmentation helps to locate the facial region in the image for further processing. Knowledge-based approach extracted from the Facial Coding System (FCS) is proposed to identify the region of interest (ROI). Finally, the use of a PCA classifier will help in the final identification of emotion categories. The proposed system can be used for the purposes like surveillance, criminal identification, person identification, HCI expert system applications.

References

1. C. Jain and R. Sahu, "Study and Comparison of Face Recognition based on PCA," vol. 3, no. 2, pp. 37–41, 2016.
2. S. Dongcheng and J. Jieqing, "The method of facial expression recognition based on DWT-PCA/LDA," 2010

- 3rd Int. Congr. Image Signal Process., pp. 1970–1974, 2010.
3. C. Jain and R. K. Sahu, "Study and Comparison of Face Recognition based on PCA and 2DPCA," vol. 4, no. Vi, pp. 128–131, 2016.
 4. V. I. January, G. B. Vasani, P. R. S. Senjaliya, P. V. Kathiriya, A. J. Thesiya, H. H. Joshi, "Human Emotional State Recognition Using Facial Expression Detection," vol. 2, no. 2, pp. 42–44, 2013.
 5. A. De, A. Saha, M. C. Pal, "A human facial expression recognition model based on eigen face approach," *Procedia Comput. Sci.*, vol. 45, no. C, pp. 282–289, 2015.
 6. N. D. Georganas and E. M. Petriu, "Part-based PCA for facial feature extraction and classification," 2009 IEEE Int. Work. Haptic Audio Vis. Environ. Games, pp. 99–104, 2009.
 7. J. Rani and K. Garg, "Implementation of Emotion Detection System Using Facial Expressions," vol. 2, no. 4, pp. 348–350, 2014.
 8. A. Besinger, T. Szynda, S. Lal, C. Duthoit, J. Agbinya, B. Jap, D. Eager, G. Dissanayake, "Optical flow based analyses to detect emotion from human facial image data," *Expert Syst. Appl.*, vol. 37, no. 12, pp. 8897–8902, 2010. "Facial Expression images." [Online]. Available: https://www.google.co.in/search?q=facial+expression+images&dc=0&source=lnms&tbm=isch&sa=X&ved=0ahUKEwji5q-O2onXA h V H P 4 8 K H c - R B G g Q _ A U I C i g B &biw=1280&bih=603. [Accessed: 23-Oct-2017].
 9. G. Singh and B. Singh. Feature Based Method for Human Facial Emotion Detection using Optical Flow Based Analysis *Int. J. Eng. Sci.*, vol. 4, no. 1, pp. 363–372, 2011.
 10. P. Michel and R. El Kaliouby, "Real time facial expression recognition in video using support vector machines," *Proc. 5th Int. Conf. Multimodal interfaces - ICMI '03*, p. 258, 2003.
 11. X. Luo and S. M. Bhandarkar, "Tracking of Multiple Objects Using Optical Flow Based Multiscale Elastic Matching," pp. 203–217, 2007.
 12. L. Renjie and Y. Songyu, "Confidence based optical flow algorithm for high reliability," 2008 IEEE Int. Conf. Acoust. Speech Signal Process., pp. 785–788, 2008.