Emotion Recognition using AI Techniques: A Review

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Abstract

The human face Emotion Recognition is an important & primitive element human interaction. To understand human behavior, it is essential to analyze human facial Emotion Recognition from image data. Various Artificial Intelligence based techniques are used for Facial Emotion Recognition and Facial Expression Evaluation. Facial Emotion Recognition can be used in domains such as health care, marketing, environment, security and Social media. In this paper includes introduction of Facial Emotion Recognition and comparative study of popular AI based Facial Emotion Recognition techniques.

Keyword

Optimization, Eigen face, Fisher face, LBPH, DNN & CNN.

Introduction

As are stepping forward from one generation to another, and this generation depend on technologies. Emotion Recognition is an advance AI technology, it impact on social intelligence like communication understanding, decision making and also help in understanding aspect of human. Emotion play important role during communication. Emotion Recognition is new way, which provides verbal or non- verbal communication. According to Mehrabian, a psychologist, verbal language convey 7% of the message in face to face communication, speech convey 38% and facial expression provide 55% of the message. Voice is a verbal form of communication and facial expression, body movement; action is non-verbal communication [1].Automated and real time non-verbal communication play important role in human and machine interaction. Automatically recognize the emotional state the challenging field of the human – robot interaction. And it'salso allows to human behavior and thinking transparencies, so it increase the level of technology acceptance. Emotion recognition technology can improve security, health sector, airport control and criminal investigations. In this paper, an evaluation of the Artificial Intelligence and Machine Learning algorithm performance for facial expression or emotion recognition will be carried out. This will

perform feature extraction and feature classification. And finally discusses about the future scope.

Related work in the relevant field

There are so many researchers in the field of facial Emotion Recognition some of them are as follows –

The American researchers Bledsoe et al 1964 studied facial recognition computer programming. They imagine a semi-automatic method and measure the size of the mouth or eyes. In 1977 by Goldstein adding 21 additional marks (e.g. Lip width, hair color). In 1978, Pal Ekman and Frisen reported that facial expression acts as a rapid signal that varies with contraction of facial features like eye's open and close, lips, eyebrow's distance, eye retina, mouth shape, cheeks and voice, there by affecting the recognition accuracy. Happy, sad, fear, disgust, anger and surprise also are basic expressions that are readily recognized across very different cultures. It wasn't until the late 1980 that we saw further progress with the development of FER as a biometric for business. In 1988 Sirvich and Kirby began applying linear algebra to the problem of facial recognition. In 1991 Alex Pentland and Methew Turk of the Massachusetts Institute of Technology (MIT) example of Facial Recognition technology, Eigenfaces, which uses the statical principal component analysis (PCA) method. In 2005 the Face Recognition Grand Challenge (FRGC) competition was launched to encourage and develop face recognition technology designed to support existent facial recognition initiatives. By InsafAdjabi et al. great contribution today Facial Emotion Recognition (FER) technology advancement has encouraged multiple investments in commercial, industrial, legal and governmental application. He presents many works on the FER, without his contribution the present research in completed.

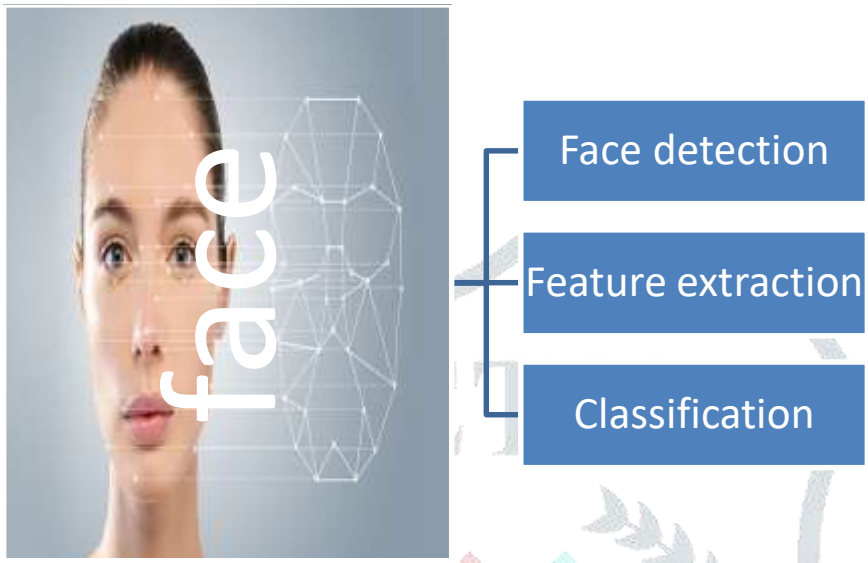
Emotion Recognition different approach and success

Reference and Year	Approach and Method	Performance
Dongshuang and Lei (2015)	Face Recognition Complex model based on developmental network and ANN.	-
Wei-Long Zheng and Bao- Lianglu (2016)	EEG based affective models without labeled target data using transfer learning techniques (TCA- based subject Transfer)	Positive (85.01%) Emotion Recognition rate is higher than other approaches but natural (25.76 %) and negative (10.24%) Emotions are often confused with each

		other.
Niveditachitra and GeetaNijhawan (2016)	Face emotion & recognition. Appearance base automated access control using LBP & SVM techniques.	Facial Emotion expression rate improve 90 % and provide positive result.
HakanBoz and Utkukose (2018)	Emotion Expression Recognition as- surprise, sad, happy, natural, anger etc. and using AI Techniques.	Positive rate 84 %, give Emotion expression better result.
Tim kretzmann (2019)	Inner working of the brain, experiment with network architecture and using DNN & NN techniques.	-
Jasmine kahphoolseng and Kenneth li- minnang (2019)	Multimodal emotion and sentiment modeling from unstructured big data challenges, and architecture, using CNN, DNN& KNN techniques.	Performance computing platforms and GPU clusters and its performance rate..
MinSeop Lee et al. (2020)	Emotion Recognition using Convolutional Neural Network (CNN) techniques. It's based on data set.	Dominance parameter.
jiaZheng Lim et al. (2020)	Using Eye tracking Taxonomy and SVM, KNN Techniques. Based on classification.	Subject Classification performance rate-

Emotion Recognition

There are three important levels of Emotion Recognition system as show in the figure 1-



(a) Face detection-

Face detection is the first step in facial Emotion Recognition. It is a computer technology being used in a variety of applications that identifies human faces in digital images [5].

(b) Feature extraction-

This step of transforms important content of images into various content features. It is a process that provide important feature to be used in the classification task [5].

(c) Classification-

Emotion classification or Facial Expression classification is the last step in facial analysis where the extracted features are recognized based on the action units. The recognizer identifies not only the basic emotions like anger, happy, surprise, sad [2] but also identifies the expression caused due to pain [3], temporal dynamics, Intensity expression, Spontaneous expression etc. [4], [5].

Overview of Emotion Feature Extraction System (Methodology)

This section provides brief review of few popular emotion feature extraction techniques. The paper proceeds with brief idea of few well known methods such as Optimization, Fisher face, LBPH, DNN & CNN.

Optimization

The term "linear programming" for certain optimization cases was due to George B. Dantzing, although much of the theory had been introduced by Leonid Kantorovich in 1939. Dantzing published the simplex algorithm in 1947, and John Von Neumann developed the theory of duality in the same year.

Given an algorithm **f(x)**, an optimization algorithm help in either minimizing or maximizing the value of **f(x).** In the content of deep learning, we use optimization algorithms to train the neural network by optimizing the cost function **J.** The cost function is defined as: $j(w,b) = \frac{1}{\mathrm{m}} \sum_{i=1}^{m} \mathrm{L}\left(\mathrm{y'^{i}}, \mathrm{y^{i}}\right)$

Cost function **j value** is the mean of the loss **L** between the estimated value y' and actual value y. the value y' is obtained during the forward propagation step & makes use of the weights **w** and bases **b** of optimization algorithms; we minimize the value of cost function **j** by updating the values of the trainable parameters. **W** and **b.** Optimization algorithm use in machine learning and deep learning. So we can improve facial emotion or expression recognition data analysis work by optimization algorithm. Because optimization provides toolkit of modeling/ formulation and algorithmic techniques [13].

EigenFace

An Eigenface is the name given to a set of eigenvectors when use in the computer vision problem of human faces recognition. The approach of using eigenfaces for recognition was developed by Sirovich and Kirby 1987 and used by Matthew Turk and Alex Pentland in face classification. The eigenvectors are derived from the covariance matrix of the probability distribution over the high – dimensional vector space of face images. The eigenfaces themselves form a basic set of all images used to construct the covariance matrix. Eigen face prepares a training set of images, in which it concentrates that all the parts of the image have normal light. And normalized the eyes, mouth and other parts of the face. Convert each image into a row and column and analysis the image at the base of original pictures, vector of length at the base of the

$$\mathrm{R} \times \mathrm{C}$$

1. Concatenate the rows of pixels of the original picture; the length is set to the vector of R × C.
2. If of picture is set of row, then they create the matrix.
3. Where no of Rows = N and each Row length R × C, and each Row is represented by an image vector. And this step represents the image A of the N means vectors.
4. For the next step A subtract by each Row M, which find to a matrix of M. S covariance is a matrix, which represents a transposed matrix T.

$$S = TT$$

5. We will calculate the S Eigen Vector and Eigen value. And achieve the highest value through by R × C. So that it can be identified by the face space [7].

Fisherface

In 1997, Belhumeur introduced the Fisherface method for face recognition. This method is a combination of PCA (Principal Component Analysis) & LDA (Linear Discriminant Analysis) methods. The PCA a method is used to solve singular problems by reducing the dimensions before used to perform the LDA process.

Fisher face algorithm is capable of taking information of 'e' Within – Class. This message reduces differences between classes. Fisher face maximizes the class variations in each class. And Eigen face construction process step first each (N × M) an image array, and provide a new reshape in ((N × M)× 1) vector.

Next, using the X_k values, calculate both the class mean μ_k and the mean of all the μ samples

$\mu_k \frac{1}{k} \sum_{R=1}^{N} X_K$ = Mean

$\mu_k = \frac{1}{N\,k} \sum_{m=1}^{N} X_k$

Where:

N = Total Number of image

N_k = Number of image in class K

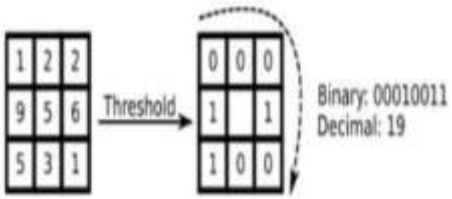
X_{km} = Image at index m of class K [6].

LBPH

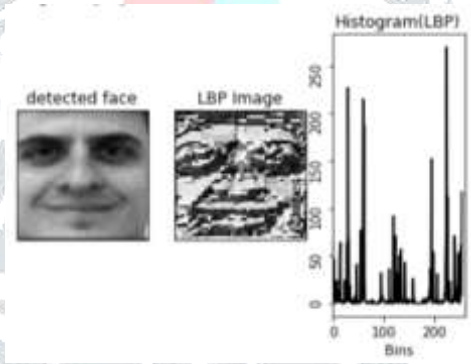
Local Binary Patterns Histograms (LBPH) is a type of visual descriptor used for classification in computer vision. LBP is the particular case of the Texture Spectrum model proposed in 1990. LBP was first described in 1994. It has since been found to be a powerful feature for texture classification; it has further been determined that when LBP is combined with the Histogram of oriented gradients (HOG) descriptor, it improves the detection performance considerably on some datasets. A comparison of several improvements of the original LBP in the field of back ground subtraction was made in 2015 by Silva et al. A full survey of the

different versions of LBP can be found in Boumans et al.LBP feature vector can be generated with the following type-

1. The window being tested will divide in to cells or split.
2. And compare each test of the cell than 8 pixels around it. (left – top, left – middle, left – bottom, right – top, right – middle, right – bottom etc.), and with these pixels, we will assume a circular path that move in the clock wise and anti-clock wise direction.



3. If the value of midpoint pixel is greater than the value of the nearest pixel, then it will mark from zero or mark 1, here one byte gives binary number and this number gets converted to decimal number.
4. Calculate the histogram for the regularity of the cells being created from each number.
5. Normalize the histogram.
6. Connect and normalize the histogram of each cell.



7. This provides a feature vector for the complete window.

Its classifiers can be used for face recognition or texture analysis [8] [12].

DNN & CNN

The first general, working learning algorithm for supervised, deep, feed forward, multilayer perceptron's was published by Alexey lvakhnenko and Lapa in 1967. Deep learning (also known as deep structure learning) is part of a broader family of machine learning methods based on artificial neural network with representation learning. Learning can be supervised, semi – supervised or unsupervised.Deep Learning requires large amount of labeled data and computing powers. Neural Networks have so much power that can approximate (Predict) any

continuous function. A n – layer NN having an input layer and N-1 hidden layer. Deep Neural Network (DNN) is widely used in computer vision. It is a powerful tool that uncovers or represents non – linear hidden information. The commonly used activation work sigmoid and Rectified Linear Unit (ReLU). Convolution Neural Network (CNN) or the births of the ConvNets were traced in 1988 to the concept of DNN [9]. CNN is widely used in a wide variety of applications such as image understanding, speech recognition, game playing, robotics etc [10]. CNN or ConvNet names Convolution Neural Network, are also called multilayer perceptions (MLPs). This Network's main objective is image Recognition and image classification, which are widely used in present generation. It starts with the reading of the input image where the computer will be in the form of vision pixels are and it refers it to the number of pixels that is called image resolution. Then it convert into three dimensional h*w*d (h – height, w – width, d – dimensional) with gray scale in 6×6×3 and RGB at 4×4×1 [11].

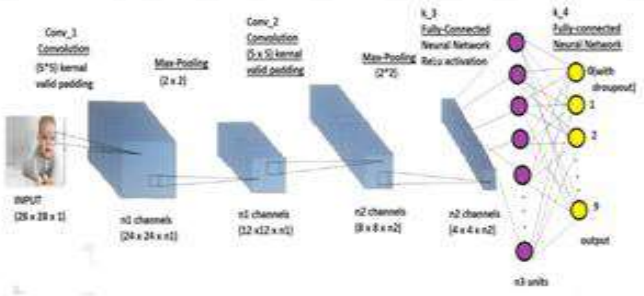


Fig 4: CNN Process.

Using CNN, classify facial expression or image by following type and achieve knowledgeable information.

Input – the expression or image will be converted to tensors and then passed into the CNN block.

CNN Block – it is the most important block in the neural network. These are following step.

- Input tenser are broken into basic channels and used for construct edges and gradients.
- Construct textures and patterns using the construct edges.
- And gradients & objects from them that are used to reconstruct object.

Conclusion

In this paper we conclude that different techniques are used for Facial Emotion Recognition (FER) system. Every technique provides better result, but every technique has some negative marks and limitation. For Emotion Extraction we can use Artificial Intelligence (AI) based

DNN & CNN algorithm methods. For classification and more accuracy we can use Convolution Neural Network (CNN), Artificial Neural Network (ANN) or AI based different techniques.

Future work

We will develop and improve the Facial Emotion Recognition algorithm for the knowledgeable result, and also we will improve security and other process automation. As health sector, airport control, criminal investigation.

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