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Comparison Between Facial Expression Recognition Algorithms - For Effective Method

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ABSTRACT

Facial expression is an ancient element for identifying humans. Human behavior, thinking or mood can be easily understood through facial expression. At present, facial expression can be evaluated by algorithm based on facial expression AI. In this paper, comparative studies have been done in methods related to facial recognition and an attempt has been made to evaluate it. Previous and recent research paper has been investigated to find out the related effective method.

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

I. INTRODUCTION

We all know that all of us are completely depend on technology. This technique is developed according to our requirements. In current time, we are using human interaction technology based on our requirements. Which is based on facial recognition .We knows that facial expression has an important role in understanding thoughts, feelings or its reaction. Through which we can know the happiness, fear, disgust, anger, resentment, surprise of humans by doing facial expression evaluation. Facial expression evaluation system compares the facial features from multidimensional datasets. Object can be segregated by creating the difference among the distributions of pixels. Improve security & other process automation. As airport control, police care with facial recognition cameras and criminal investigations. This paper will explore the application of deep neural network, and algorithms the context of emotion evaluation from large datasets of facial expression. In this paper, we will evaluate facial expressions based on AI techniques. And this Paper objective to work human thinking, through facial expressions. So that the Security can be incremented by human thinking. This paper is organized in the fifth sections. Second section explains a major role of facial emotion recognition. Third section it is being explained which problem can be solved by different methods. Fourth section explained about algorithm comparison for the best algorithm. In the fifth section describe about facial expression related conclusion and future calculation.

II. METHODS AND MATERIAL

Feature for emotion recognition.

Emotions play a major role in understanding human's decision and feeling. Emotions are a most attractive research field. It's related to current IT marketing. It

is very difficult to measure emotion because emotion is both abstract and hidden. But through emotion difficult or hidden human thinking, feeling and behavior can be transparent. Different types of data are used to measure emotions.

And to detect the emotion well, the facial expression plays an important role. Facial emotion expression recognition involves three steps. Face detection, feature extraction and classification of expression [1] [18].

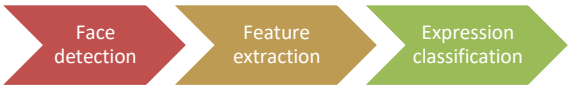


Fig 1. FEER innovation steps.

Algorithm

Optimization

The optimization algorithm is related to a mathematical branch used to solve a mathematics problem at the base of the minimize and maximize functions. And it acts as at importance stems for engineering and machine learning problems [2].

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: $j(w,b) = \frac{1}{m}\sum_{i=1}^{m} L\left(y'^{i}, y^{i}\right)$

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 [15].

Feature extraction by optimization algorithm:-

Feature extraction method is associated with the row-sum and column-sum of white pixels of edge identified image. The pattern of row-sum (Mh) along the column and the pattern of column-sum (Mv) along the row of white pixels are defined as the feature of each region. These patterns are known as projection profiles. f (m, n) represents a binary image of m rows and n columns. Then the vertical profile are defined as the sum of white pixels of each column perpendicular to x-axis which is represented by the vector Mv of size n by (1)

$$Mvj \sum_{i=1}^{m} f(i,j) \qquad j = 1, 2, 3, \ldots\ldots$$

The horizontal profile is the sum of white pixels of each row perpendicular to the y-axis which is represented by the vector Mh of size m is calculated by (2).

$$Mhi \sum_{i=1}^{m} f(i,j) \qquad i = 1, 2, 3, \ldots\ldots$$

The human eye shape is more like an ellipse (we call this as a regular ellipse), as shown in Fig. The minor axis is a feature of the eye that varies for each emotion. The major axis of the eye is more or less fixed for a particular person in varied emotions. The ellipse is parameterized by its minor and major axes, respectively, as "2a" (fixed) and "2b" (to be computed) is described by (3).

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

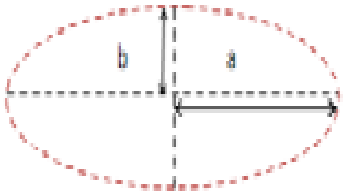


Fig 2. The regular ellipse.

The shape of human lip is towards a combination of two ellipses which is called an irregular ellipse, as shown in Fig. The word 'irregular' means that the ellipse has two different minor axes wherein the major axes remains the same. The edge detected lip image is considered as an irregular ellipse. Lengths of minor axes of the lip feature for each emotion are computed. The major axis is ''2a'' (considered to be fix) and two minor axes are ''2b1'' and ''2b2'' (to be computed). The suitable values to b1 and b2 are substituted for top and bottom portions respectively. The spirit state on a Picture or Image strongly depends on the facial expression b1, b2 as expression of lip and b as expression of eye. In the next section pso algorithm adopted to optimize these expressions [A. Habibizad navin1+ , Mir Kamal Mirnia2][15] [18].

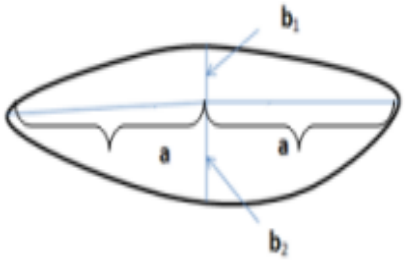


Fig 3. The irregular ellipse.

Eigen face

Eigen face method is an algorithm used for general facial recognition. It's based on Eigen face techniques. This uses principal component analysis (PCA) [4]. Mathematically the principal components of Eigen face divide the face feature vector. And the Eigen face matrix creates a multidimensional model, so that the face expression can be easily understood. The idea of the Eigen face is to convert the face feature to the mathematic form instead of the mathematic meaning, for the mathematic features and the changes [5]. 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

$$R \times C.$$

1. Concatenate the rows of pixels of the original picture; the length is set to the vector of $R \times C$.
2. If of picture is set of row, then they create the matrix.
3. Where no of Rows = N and each Row length $R \times C$, 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 $R \times C$. So that it can be identified by the face space [6].

Fisher faces

Fisher face algorithm gives a successful result for face recognition. LDA (Linear Discriminate Analysis) method demonstrated in (Belhumeur etal , 1997 , zhau etal.1999, chen etal,2000 Yu and Yang, 2001 ,Liu and Wechsler,2002, Lu etal. 2003 a,b; Ye and Li , 2004). Everyone has used LDA to search a set of images, which shows the maximum ratio between different class scatter. LAA's loss is that class

scatter matrix always single, because the number of pixels in the image is larger than the number of images. So it can easily detect the error in the image. Many algorithms are designed for this. The fisher face class takes advantage of scatter and reduces the difference within this scat, so it can solve conditions like lighting and difference in pose conditions. And helps identify the image [4]. The fisher face algorithm by Belhumeur etal, uses both Principal Component Analysis and Linear Discriminate Analysis to create a sub space projection matrix. 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 [5].

LBPH

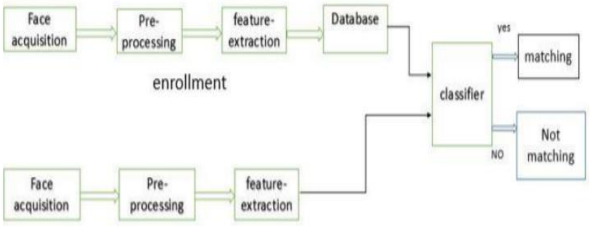
Local Binary Pattern Histogram (LBPH) many techniques are used for extraction. Those who provide important steps in recognition of face, Local Binary Pattern are one of the methods used for feature extraction. It was brought to a new approach by Ojala etal, in 1996. Shape and texture are achieved through LBPH. Separate the image into several small parts. And its feature includes a binary pattern to express the space and pixel of the image. Images in LBPH can be separated by evaluate based on the distance between their histograms. LBPH operator works between eight neighbors of pixels. This means that the center pixels value holds them. When the gray center pixels are higher than the center pixels value, the neighbor pixels becomes one. This condition occurs when value are same. LBPH is then made by concatenation of a binary code to zero [7].

This is an instance of texture spectrum photo type, which is used to classify image texture. When the LBP merges with the histogram of oriented gradients (HOG) descriptor, it increases enactment in data base Recognition [8].

Following steps involved to achieve this are –

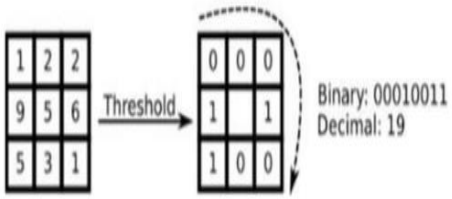
- Creating data set
- Face acquisition
- Feature extraction
- Classification

The LBPH algorithm is a part of open CV.

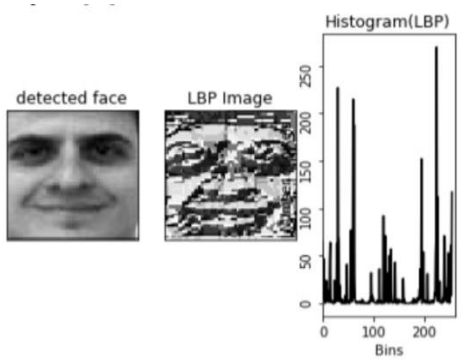


LBP feature vector can be generated with the following type-

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] [14].

DNN & CNN

Deep Learning is a machine learning approach and is made up of multiple processing layers. The concept of Deep Learning was first given in 1980, 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 grayscale in 6×6×3 and RGB at 4×4×1 [11].

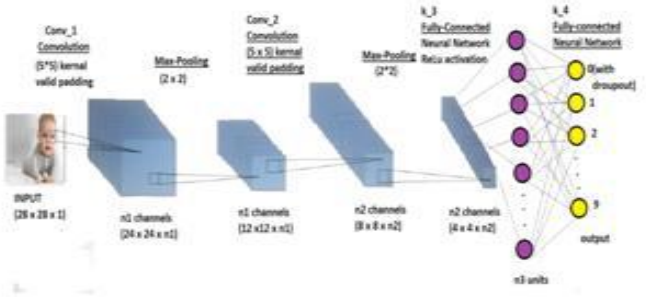


Fig 4 : CNN Process.

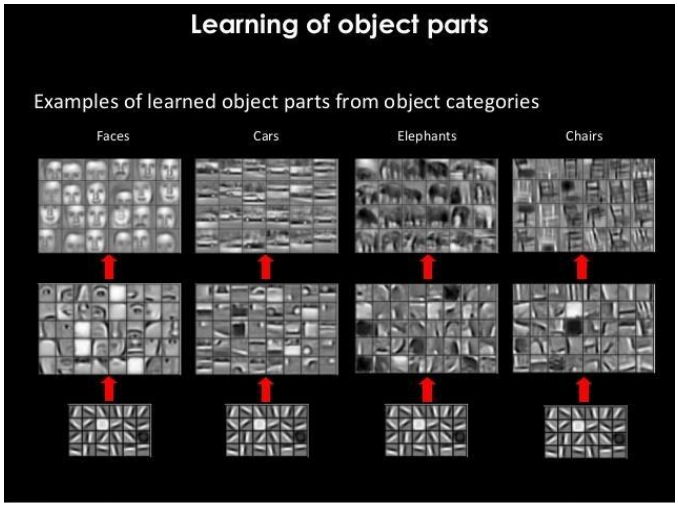
Using CNN, classify facial expression or image by following type and achieve knowledgeable information.

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

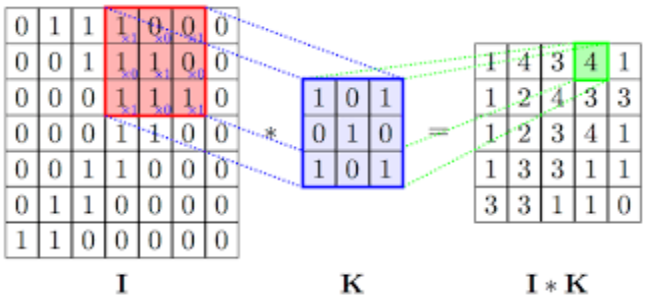
CNN Block – it is the most important block in the neural network. These are following step.

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. The below image show these steps

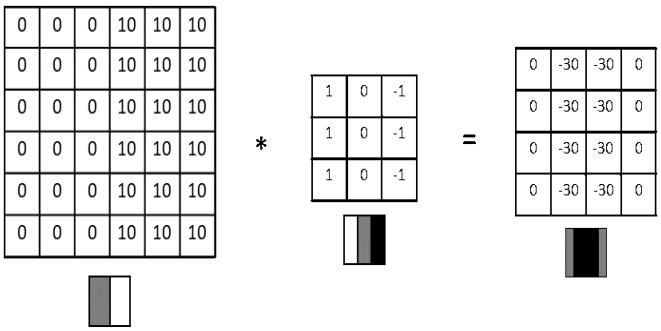


Do the above step with the help of a mathematical operation called convention. Input tensors which derived from CNN block represent numerical values; kernels are used to represent the pixel amplitude from the original image and to extract the feature from the input channel. An example of the conventional operation performed on 7 × 7 input channel (1) using 3 × 3 kernel to find 5 × 5 feature (1 × k) below. The value shown in the output is the sum of each – convolution.

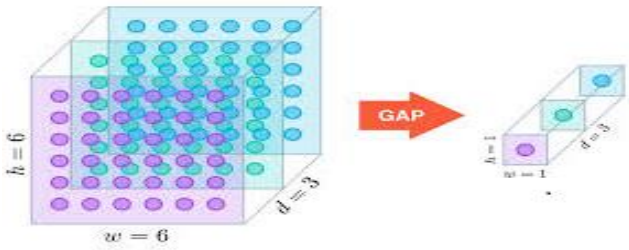


CNN block will have multiple convolution layers stached one after another with the objective of extracting edges and gradients - > texture & patterns - > parts of object - > object.

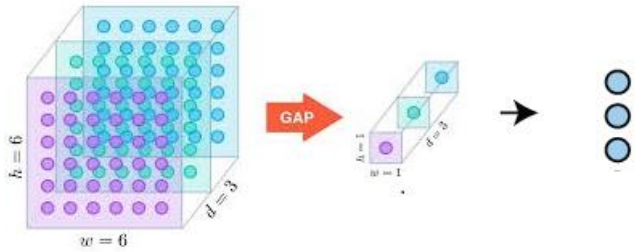
Of the final convolution layers and we can expect the channels to be the resemble original object that we are trying to classify & these channels will be multidimensional. We need to flatten this to a 1 – D array to make it compatible for a logistic regression classifier. Which is called Global Average Pooling (GAP), here we are reading the size 6 × 6 × 3 to 1 ×1 × 3 channel as show below.



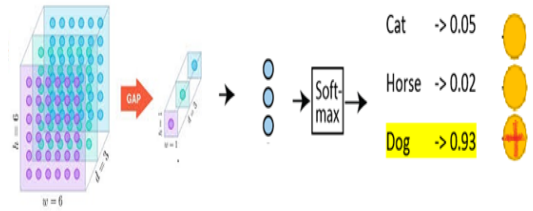
Next we will flatten our 1 × 1 × 3 channel in one dimensional array with three elements; we use 1 × 1 Conventional operations to achieve this or a function like nn linear in the pytorch. In the step forwarding flow is shown as Dense 2. The image below show this operation-



The number image classification of 1 D array elements must be exactly the same as the involve classes in the problem. For example, if we are trying to predict digits, the number of elements in many classes and one dimensional area will be 1 0 to accommodate (adjust) the digits from 0-9.



Output as one – hot vector - > in the final state we will feed the flattened 1- D array for a logistic regration classifier to predict the image class. The most commonly used classifier for this is softmax, softmax gives probability distribution list of class. In which the class with the highest probability softmax is selected as the predicted class. In the below example, the Dog will be predicted. We call the output as one – hot vector because only one of the nodes will have a value [16] [17].



Finds features from an input image from a conventional layer extract data set, where there is a small part of the input image for kernel feature classification. It does some mathematic work on Rectified Linear Units (RELU) such as image matrix and kernels. Which refers to the rectifier unit to classify the object as 1 (Yes) or 0 (with no able). This has a probabilistic value located between 0 and 1 that we use the activation function to avoid negative pixels. Pooling is the next layer, its generates for the input. And classifies the object through a maximum pooling, average pooling and global pooling. Flat layer is used to manipulate 3D from 2D and is placed between the fully connected layers in the convolution. Flattening is a two dimensional layer, which is converted from vector to fully connected neural network [11].

Comparison

On comparing all the algorithms above the Facial Expression Recognition ratio, we can say that the CNN and Optimization algorithm provides better results for Facial Expression and Facial Emotion Recognition. Optimization algorithm performs mathematical processing for facial expression or image processing and provides results by converting image pixels to binary and creation a perpendicular graph for each access to the image. This allows easy to perform feature analysis of image or expression and provides up to 99% accuracy using the Optimum CNN concept [12].

Eigen Face and Fisher Face get free space based on the characteristics of the image, based on the training set image. Both Eigen Face and Fisher Face are a global approach that creates 2D array pixels for face recognition. Both methods use linear projection and generally help to find the identified suitable results in the face space. The accuracy of the Eigen Face is more than 90 % based on the frontal face and the Fisher Face is also similar to that of the Eigen Face, but it provides results with better approval in the different class of the image in the comparison of the Eigen Face.

LBP presents the best facial feature on the Facial Expression Recognition and it performs an easily analysis of the face representation, feature extraction and classification. This analysis is done on the basis of store image data in the database and presents the results with about 90% accuracy in face reading or analysis [13].

DNN and CNN Facial Expression Recognition or image analysis it takes various hidden layer and pooling. Used for classification, so that the expression and classification can be easily analyzed. DNN &

CNN Network is the base approach that gives more effective results for facial image recognition and instructions. That is, DNN and CNN provide not only the data of the data base but also the network concepts by providing high accuracy results. CNN architectures work as rich feature extractors that are used for image classification, object detection, image segmentation and many other advanced functions. Due to which it can be called to be the best or effective algorithm in comparison to the other algorithm for Facial Expression Recognition.

III. CONCLUSION AND FUTURE WORK

In this paper we have discussed about face recognition, we have examined face recognition from theoretical as well as different statically perspectives and finally compare the algorithm. And after understanding the techniques related to this method, we can conclude by using the DNN and CNN technology of AI. Important information can be obtained from the face recognition or face reading database. Although 90% security and other problems can is solved using the algorithm related to express facial expression, because facial expression can work on human thinking behavior. We can transmit human thinking with face readings. It allows sharing of its information. All the muscles in our body are infected by nerves that enter the back bone and brain all the way, and we can evaluate the thinking of human brain by facial expression.

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