Detection of Facial expression recognition using modified Firefly Algorithm with CNN for multi model optimization

1Vaishali A Damor,2 Prof. ShikhaMaan

[1]Student, [2]Assistant Professor

[1]Department of Computer Engineering, [2]Information Technology

[1,2]Silver Oak College Of Engineering and Technology, Ahmedabad,Gujarat, India

Abstract:Facial emotion recognition is one of the rational theory-practical study that takes attention in the field of both machine learning and deep learning. For many years multiple emotions have been labeled based on different datasets of different region's faces. People infer the emotional states of other people, such as joy, sadness, and anger, using facial expressions and vocal tone. Many Hybrid techniques have been evaluated for better accuracy. The proposed research is aimed to detect 3 novel emotions. The algorithm is divided into 3 parts. The first phase of algorithm is to construct a unique representation of each emotion with firefly algorithmfor feature optimization, while the second phase is using a convolutional neural network (CNN) for feature extraction and 3rd phase is using PCA for feature selection. These methods were Trained on the posed-emotion dataset CK+, and to test their robustness. The results show that with more fine-tuning and depth, our proposed model can perform better than the other existing methods for emotion recognition. The parameters to prove our point will be accuracy, precision and recall.New emotion can be : confused & contempt,frustrated.

***Keywords*: Modified firefly Algorithm, PCA, Deep learning approach, Facial expression Recognition.**

I .INTRODUCTION

Nowadays, image processing is among rapidly growing technologies. It forms core research area within Engineering and computer science disciplines too.The article introduced here has mainly concentrated on the creation of smart framework with the inherent capabilities of drawing the inference for emotion detection from facial expressions. Recently, the notion of emotion recognition is attaining mostly the researcher's mind in the area of exploration on smart system and interaction between human and computer. Facial emotion recognition is one of the rational theory-practical study that takes attention in the field of both machine learning and deep learning. For many years multiple emotions have been labeled based on different datasets of different region's faces. People infer the emotional states of other people, such as joy, sadness, and anger, using facial expressions and vocal tone. According to different surveys, verbal components convey one-third of human communication, and nonverbal components convey two-thirds. Many hybrid techniques have been evaluated for better accuracy. The proposed research is aimed to detect 3 novel emotions. The algorithm is divided into 3 parts. The first phase of algorithm is to construct a unique representation of each emotion, while the second phase is using a convolutional neural network CNN for feature extraction and 3rd phase is using PCA for feature selection.. The results show that with more fine-tuning and depth, our proposed model can perform better than the other existing methods for emotion recognition. The parameters to prove our point will be accuracy, precision and recall . Increasing Efficiency of time by reducing process of Image processing. FER has many applications such as Human-Robot interaction, surveillance, Driving-safety, Health-care, intelligent tutorial system, music for mood, etc.

I.I. IMAGEPROCESSING

Imageprocessingis a method to perform some operations on an image and get an enhanced image or to extract some useful information from it.Nowadays, image processing is rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. The two types of methods used for Image Processing are Analog and Digital Image Processing. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst. Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing.**Image processing technique**:Image pre-processing (2) Image Enhancement. (3) Image segmentation .(4) Feature extraction. (5) Image classification. Image processing basically includes the following three steps (1)importing the image via image acquisition tools; (2) Analysing and manipulating the image; (3) Output in which result can be altered image or report that is based on imageanalysis.

Purpose of Image processing:The purpose of image processing is divided into 5 groups. They are:1. Visualization - Observe the objects that are not visible. 2. Image sharpening and restoration - To create a better image.3. Image retrieval - Seek for the image of interest.4. Measurement of pattern – Measures various objects in an image.5. Image Recognition – Distinguish the

objects in an image. The Output of Image processing is givenbelow.

Fig (1) Output of Image processing.

I.II.FACIAL EXPRESSIONRECOGNITION

Facial expression recognition is a process performed by humans or computers, which consists of: (1). Locating faces in the scene (e.g., in an image; this step is also referred to as face detection) (2). Extracting facial features from the detected face region (e.g., detecting the shape of facial components or describing the texture of the skin in a facial area; this step is referred to as facial feature extraction), (3). Analyzing the motion of facial features and/or the changes in the appearance of facial features and classifying this information into some facialexpression-interpretative.FER has three steps as follow (fig 1) Simple Example is given below.

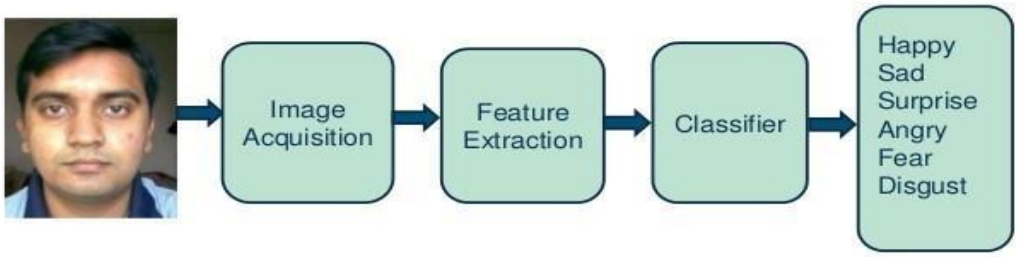
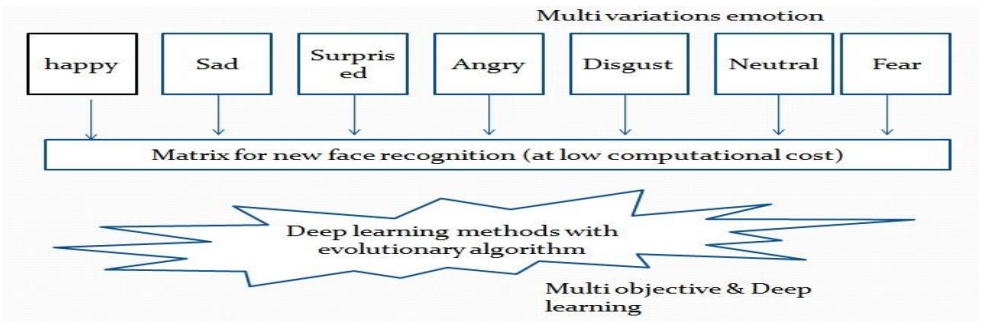


Fig (2) Steps of FER

II.PROBLEMSTATEMENT

The limitations of base paper is efficiency of time is reduced while recognizing facial expressions. The proposed flow will increase the time efficiency with introducing new facial emotions &other hybrid or multi-objective FAs will also be explored to solve optimization problems with multiple criteria.



III.LITRATURESURVEY

In this paper [1] Automatic facial expression recognition plays an important role in various application domains such as medical imaging, surveillance and human-robot interaction. This research proposes a novel facial expression recognition system with modified Local Gabor Binary Patterns (LGBP) for feature extraction and a firefly algorithm (FA) variant for feature optimization. First of all, in order to deal with illumination changes, scaling differences and rotation variations, we propose an extended overlap LGBP to extract initial discriminative facial features. Then a modified FA is proposed to reduce the dimensionality of the extracted facial features. This FA variant employs Gaussian, Cauchy and Levy distributions to further mutate the best solution identified by the FA to increase exploration in the search space to avoid premature convergence. The overall system is evaluated using three facial expression databases (i.e. CK+, MMI, and JAFFE). The proposed system outperforms other heuristic search algorithms such as Genetic Algorithm and Particle Swarm Optimization and other existing state-of-the-art facial expression recognition research, significantly.

In this paper [2] The Process of the proposed work comprises of 3 phases: Threshold Generation with Dynamic Modified Region Growing phase, Texture feature generation and Region Merging phase. For optimize the thresholds used FA algorithm. In the second phase, the texture feature can be extracted using entropy based operation from the input image. In Region Merging phase, the results obtained from the texture feature generation phase are combined with the results of Dynamic Modified Region Growing phase and similar regions are merged by using a distance comparison between regions. The performance of the proposed work is evaluated using the metrics Sensitivity, Specificity and Accuracy. The results show that the proposed algorithm provides very good accuracy for the segmentation process inimages.

In this paper [3] we introduce an approach to classify gender and age from images of human faces which is an essential part of our method for autonomous detection of anomalous human behavior. Automatic detection can help to recognize human behavior which later can assist in investigating suspicious events. Central to our proposed approach is the recently introduced transfer learning. It was used on the basis of deep learning and successfully applied to image classification area. This paper is a continuous study from previous research on heterogeneous data in which we use images as supporting evidence. We present a method for image classification based on a pre-trained deep model for feature extraction and representation followed by a Support Vector Machine classifier. Because very few data sets with labels of gender and age exist of face images, we build one dataset named GA Face and applied our proposed method to this dataset achieving excellent results and robustness (gender classification: 90.33% and age classification: 80.17% accuracy) approaching humanperformance.

In This Paper [4] Gender classification and emotion detection plays an important role in the areas security. Gender classification and emotion detection aids in identification of a person by recognizing its gender (male/female) with their emotions (happy/sad) from the face image only. Individual works has been done in the Gender classification and emotion detection fields but not together. In this paper, we proposed a system to do detection of emotion and gender simultaneously for a specific face image. In this paper AIGLBP (Approximation image Gabor local binary pattern) is applied for feature extraction and SVM is used for classification. The number of experiments is initiated on a standard face image databases taken in controlled (FERET and INDIAN FACE) environment. The experimental results demonstrate that the proposed system is effective enough to give high performance in terms of speed and accuracy.

In this paper [5] The human face plays a Different role for automatic recognition of emotion and for identification of human emotion and the define interaction between human and computer for some original application such as driver state surveillance, personalized learning, health monitoring etc. In this paper we have tried to design an automated workflow for emotion detection using facial expression. A non-verbal communication, as a platform for human computer interaction facial expression. The human face having multiple variability such as color, orientation, expression, posture and texture require to overcome by the facial expression recognition. In our work we have taken frame from live streaming and processed it using Gabor feature extraction and neural network. To detect the emotion facial attributes extraction by PCA is used and a cauterization of different facial expression with related emotions. Finally to decide facial expressions separately, the processed feature vector is channeled through the already learned patternclassifiers.

IV.THE PROPOSED FACIAL EXPRESSION RECOGNITION SYSTEM

A. Modify Firefly Algorithm:Firefly algorithm has been used in various application and proved to be very accurate and efficient. Inspired by behavior of fireflies.There are basic rules: 1. All fireflies are unisex and are attracted towards brighter ones regardless of their sex.2.Attractiveness is proportional to the brightness, and they both decrease brightness as their distance increase. 3. The fitness function define the brightness of a firefly (light intensity).The firefly algorithm contains two important steps: light intensity& calculating the attractiveness.
Modify in FA:(1)Multiple objective based on FA variance (Work on) (2) Add classification through CNN. (3) Group wise Image taken for testing.

B. Convolutional Neural Network: A convolutional neural network (CNN) is a type of artificial neural network used in image recognition and processing that is specifically designed to process pixel data.CNNs are powerful image processing, artificial intelligence (AI) that use deep learning to perform both generative and descriptive tasks, often using machine vision that includes image and video recognition, along with recommender systems and natural language processing (NLP). CNN have their "neurons" arranged more like those of the frontal lobe, the area responsible for processing visual stimuli in humans and other animals. The layers of neurons are arranged in such a way as to cover the entire visual field avoiding the piecemeal image processing problem of traditional neural networks.A CNN uses a system much like a multilayer perceptron that has been designed for reduced processing requirements. Convolutional Neural Network (CNN) architecture is inspired by mammalian visual cortex. Visual cortex processes images in hierarchical manner, first low level features and then high level features. CNN also works same as visual cortex, it first processes low level features of an image, such as curves, edges, then bit higher features like small part of an image and this hierarchy is continued layer by layer and in last whole image is processed. The layers of a CNN consist of an input layer, an output layer and a hidden layer that includes multiple convolutional layers, pooling layers, fully connected layers and normalization layers. Convolution layer takes an image as input and convolute it with feature vector or weight matrix and output more meaningful image. This image imported to other layer. Pooling layer of CNN is used to extract most meaningful feature from each section of an image. ReLU rectifies the image, it simply applied to check whether image gives some information or not. If image pixels are 0, the ReLU discards it. Fully connected layer is used to sum up all learned features by connecting all neurons of previous layer to the next layer. It is usually used in later part of CNN architecture. Loss layer in CNN, is used to apply different loss functions. For each attribute, a loss function can be applied. For example, softmax loss function is useful in multi-class classification and gives output a label with probability. The removal of limitations and increase in efficiency for image processing results in a system that is far more effective, simpler to trains limited for image processing and natural language processing.

B.1 LENET5 :The architecture is straightforward and simple to understand that's why it is mostly used as a first step for teaching Covolution neural network. The LeNet-5 architecture consists of two sets of convolutional and average pooling layers, followed by a flattening convolutional layer, then two fully-connected layers and finally a softmaxclassifier.The figure is given below Fig(3)

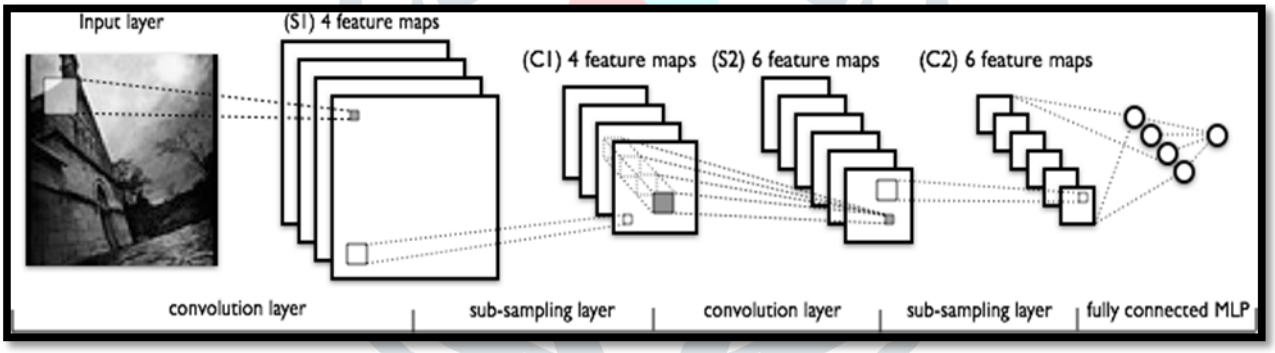


Fig (3) Lenet 5 Architecture.

C. Principle component analysis:Principal component analysis (PCA) has been widely applied in the area of computer science. It is well-known that PCA is a popular transform method and the transform result is not directly related to a sole feature component of the original sample. However, in this paper, we try to apply principal components analysis (PCA) to feature selection. The proposed method well addresses the feature selection issue, from a viewpoint of numerical analysis. The analysis clearly shows that PCA has the potential to perform feature selection and is able to select a number of important individuals from all the feature components. Our method assumes that different feature components of original samples have different effects on feature extraction result and exploits the eigenvectors of the covariance matrix of PCA to evaluate the significance of each feature component of the original sample. When evaluating the significance of the feature components, the proposed method takes a number of eigenvectors into account. Then it uses a reasonable scheme to perform feature selection. The devised algorithm is not only subject to the nature of PCA but also computationally efficient. The experimental results on face recognition show that when the proposed method is able to greatly reduce the dimensionality of the original samples. PCA can be described by orthogonally projecting the data onto a lower dimensional linear space called as principal subspace in order to maximize the variance of projected data [18].For maximum variance formulation we consider a data set of observation {xn} where n=1, 2, 3 …… N, and xn is a Euclidean value with dimensionality D. We need to project the data onto a space having dimensionality M < D while maximizing the variance of the projected data. The value of M is assumed. For the projection we have only considered the space having one dimension (M = 1). The direction of this space is defined by a vector u1 dimension D, then we have considered a unit vector so that u1Tu1=1. Each data point xn is then projected onto a scalar valueu1Txn.The mean of the projected data is where x is the sample set mean given by

$$y = A(x - mx) \quad (1)$$

This point of view enables to form a simple formula but it is necessary to keep in the mind that each row of the vector x consists of K values belonging to one input. The vector mx in Eq. (1) is the vector of mean values of all input variables defined by relation

mx = E{x} = 1 K K k=1 xk (2)

Matrix A in Eq. (1) is determined by the covariance matrix Cx. Rows in the A matrix are formed from the eigenvectors e of Cxordered according to corresponding eigenvalues in descending order. The evaluation of the Cx matrix is possible according to relation

Cx = E{(x − mx)(x − mx) T} = 1 K K k=1 xkxT k − mxmT x (3)

As the vector x of input variables is n-dimensional it is obvious that the size of Cx is n x n. The elements Cx(i, i) lying in its main diagonal are the variances

Cx(i, i) = E{(xi − mi) 2} (4)

(i, j) determine the covariance between input variables xi, xj.

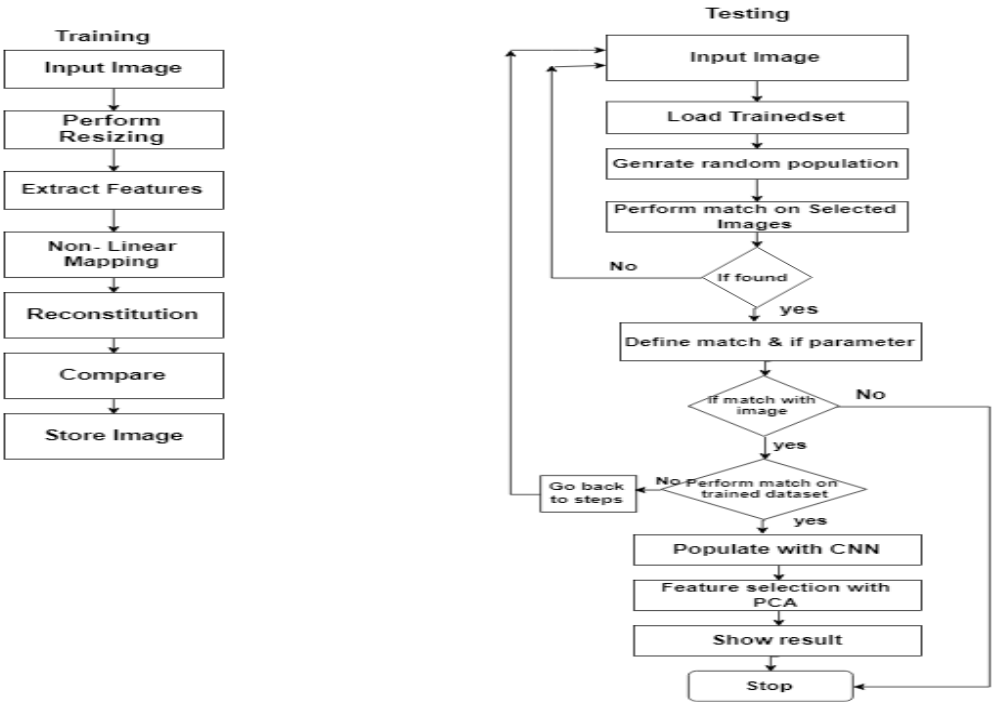
Cx(i, j) = E{(xi − mi)(xj − mj)} (5)

between input variables xi, xj . The rows of A in Eq. (1) are orthonormal so the inversion of PCA is possible according to relation

x = ATy + mx (6)

The kernel of PCA defined by Eq. (1) has some other interesting properties resulting from the matrix theory which can be used in the signal and image processing to fulfill various goals as mentioned below.

V.PROPOSED ALGORITHM



Flowchart of proposed flow

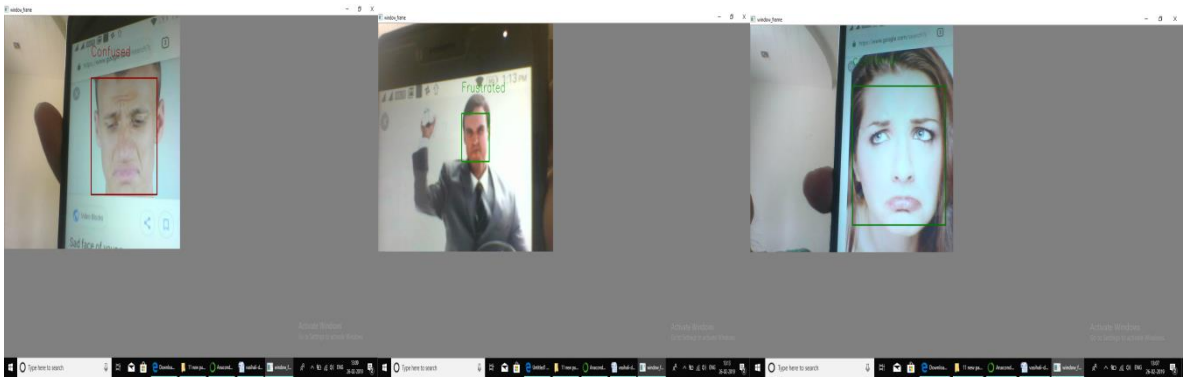
Explanation of Proposed flow:

Step 1: load document (image). Step 2: process for random population - selection of random pixels. Step 3: determine parameters call algo_fa() (based on FA criteria) Step 4: generate chaotic map (CNN based feature extraction). Step 5:Convert to haarcascade to generate new emotions (mix of two emotions based on feature extraction process).Step 6: populate with CNN. Step 7: repeat step 4 .Step 8 : determine image with feature selection process .Step 9: match criteria to determine the emotion. Step 10: result.

VI. ANALYSIS OF PROPOSED ALGORITHM

In this proposed method we used Python language for implementation and Used CK+ dataset for Trained Images for whole Process to detect Emotion. Modified Firefly algorithm used for feature optimization. In CNN , We take LENET 5 Architecture for Feature Extraction for better result and PCA is used for Feature selection which is provide best result of taken testing Images. First we capture an image from the webcam then Resized the image and convert into grayscale and optimized the image using Modify FA.Then matched the feature with the trained images then Extract the facial expression using LENET 5 process and PCA selects the best image which is provide higher result better than other. As per used proposed method, provide good result of precision process, recall process and accuracy. Got new emotion with the help of Hybrid-or Multi objective Method. The main aim was to detect new emotion and try to got good result with Recall and Precision Process which is got from using proposed method .The experimental results shown in below.

Result : Detected New Emotion



Emotion captured –"confused" **Emotion captured –"frustrated"** **Emotion captured –"contempt"**

A confusion matrix is a technique for summarizing the performance of a classification algorithm. Classification accuracy alone can be misleading if you have an unequal number of observations in each class or if you have more than two classes in your dataset.Calculating a confusion matrix can give you a better idea of what your classification model is getting right and what types of errors it is making.

Global results (N=251)

Label	Picture					
	angry	*fearful*	*happy*	*neutral*	*sad*	*surprised*
angry	**89,6***	2,0	0,8	3,2	6,4	0,8
fearful	2,4	**61,4***	0,4	0,8	1,6	0,8
happy	0,0	0,4	**96,8***	0,4	0,0	2,0
neutral	0,4	3,6	0,4	**81,7***	1,2	0,0
sad	2,8	12,7	0,4	11,2	**79,3***	0,0
surprised	0,4	8,8	0,0	0,4	0,0	**94,0***
none	4,4	11,2	1,2	2,4	11,6	2,4

* above chance level of 14.8%

Table 1.Confusion Matrix

a	b	c	d	e	f	g	h	
56.67	3.33	3.33	10	6.67	10	6.67	3.33	a
10	**40**	13.33	10	0	13.33	3.33	10	b
6.67	3.33	**50**	6.67	6.67	10	16.67	0	c
10	6.67	10	**53.33**	3.33	6.67	3.33	6.67	d
3.33	0	13.33	16.67	**53.33**	10	0	3.33	e
6.67	13.33	6.67	0	6.67	**53.33**	13.33	0	f
6.67	3.33	16.67	6.67	13.33	20	**33.33**	0	g
3.33	6.67	3.33	20	0	13.33	6.67	**46.67**	h

Table 2.Confusion Matrix result with New emotion

	tp	tn	fp	fn	precision
pleasant	96	2	35	2	73.28244
contempt	214	1	8	80	96.3964
confused	90	2	12	12	88.23529
neutral	250	68	84	84	74.8503
frustrated	83	7	7	2	92.22222
sad	72	5	6	6	92.30769
surprise	66	7	5	9	92.95775

Table 3. Precision result

	tp	tn	fp	fn	Recall
pleasant	96	2	35	2	97.95918
contempt	214	1	8	80	72.78912
confused	90	2	12	12	88.23529
neutral	250	68	84	84	74.8503
frustrated	83	7	7	2	97.64706
sad	72	5	6	6	92.30769
surprise	66	7	5	9	88

Table 4. Recall result

	tp	tn	fp	fn	accuracy
pleasant	96	2	35	2	72.59259
contempt	214	1	8	80	70.9571
confused	90	2	12	12	79.31034
neutral	250	68	84	84	65.4321
frustrated	83	7	7	2	90.90909
sad	72	5	6	6	86.51685
surprise	66	7	5	9	83.90805

Table 5.Result of Accuracy

VII.CONCLUSION

According to all research paper, the techniques how facial recognition processes and how it requires in future work to improve the techniques for more accurate facial emotion recognition is explained and demonstrated. The proposed flow is based on the evolutionary algorithm and convolution neural network. The limitations of base paper is efficiency of time is reduced while recognizing facial expressions. The proposed flow will increase the time efficiency with introducing new facial emotions.I am planning to make it more precise and clear with all possible techniques and equations. I am also planning to check the expected results based on available datasets. Future work will benew emotions to detect different moods of human being by capturing face emotions multiple times.

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