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# Hybrid Deep Learning Model for Emotion Recognition using Facial Expressions: Channelizing Employee Productivity

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***Abstract:***
Purpose – This paper aims to examine and predict various types of emotions in the humans using their facial expressions.
Design approach – The model developed in this work consists of two Convolutional Neural Networks (CNNs). The first CNN is used to analyse the primary emotion of the image as happy or sad. The second CNN is used to predict the secondary emotion of that image.
Findings – The overall results show that the proposed model is capable of predicting emotions using facial expressions better than the existing state of the art approaches.
Originality – The paper discusses a critical issue of predicting emotions as it can have potentially significant relevance in identifying an individual's mental wellbeing in life in general and at workplace in particular. Organizations can also get benefitted as it can channelize employee productivity in right manner at work place.
***Keywords:****Emotions, CNN, Facial Expressions.*

## I. INTRODUCTION

Facial expressions are major components of nonverbal communicationto express human emotions. The main aim of thisstudy is to recognize the mood of a person by analysing his/her facial expressions. As a human, by seeing one's face, mood of that person can be analysed easily with some reasonable accuracy. Sometimes the expressions are so visible and prominent that it does not require much analysis to predict one's mood whereas other times it is difficult to analyse the same due to less or blurred expressions (Jain et. al, 2019). It is indeed challenging task to train a computer to recognize correct emotion through facial expression from an image. Due to a variety of facial features and expressions, it is challenging to train a computer. From the several studies done by various researchers (Lu et. al, 2012., & Borth et. al, 2016), the existing methods of emotion recognition for images can be categorized into two categories- dimensional method and categorical method. In the dimensional method, the range of emotions is mapped into two-dimensional space. In the categorical method, the emotions are categorized in different classes such as – sadness, happiness, angry, etc.(Lu et. al, 2012). The proposed method is also using the categorical method to recognize emotions. As very little research work is done in the way of image emotion recognition, therefore very less literature is available regarding feature extraction from image for emotion recognition. In most of the previous work, conventional image features are used such as - colour, shape, and texture, etc. (Valdez et. al, 1994) found the relation of different colours on emotions and behaviour. Although these above traditional methods were good and quite popular for emotion recognition but were generally time-consuming. This paper proposed an improved deep learning model for analysing facial expressions and prediction of emotions using Convolutional Neural Networks(CNN). This research work holds a lot of significance to academicians as well practitioners as the results could be used to identify and channelize

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the emotions of employees at work place for achieving higher productivity. Moreover, the issues of stress and depression that are generally experienced by humans in general life and workplace, can be addressed if it could be possible to predict one's emotions through their facial expressions.

## II. PROPOSED WORK

### *2.1 Methods and Materials*

#### *2.1.1 Dataset and Pre-processing*

For the proposed model the FER2013 and JAFFE dataset are used (Minaee et al, 2019). There are seven emotions recorded in the data set – anger, disgust, fear, happy, sad, surprise and neutral. For creating a model, two sets of images have been created – the first set was happy and sad. After that under each category, two more categories are made. The surprise and neutral categorieshave been created under happy emotion. Anger and fear have been created under sad. The proposed model also have been tested for predicting emotions in real-time images using the live camera.

### *2.2 Proposed Model Structure*

In the proposed CNN model with each convolution layer, a relu activation function is used for using stochastic gradient descent with back-propagation of errors to train proposed CNN. First, P-CNN model architecture has been designed to classify the image on the basis of two primary emotions as happy or sad. The model is used to predict a particular image whether it is showing happy or sad emotion. The proposed CNN contains three convolution layer and three fully-connected layers with 1024 neurons each. The last layer contains two neuron with softmax function for the final classification of happy or sad emotion.The other S-CNN model is designed to do classification based on secondary emotions under the results of the first CNN used for primary emotions. The network is designed with five 2D-convolution layers each is attached with the max-pooling layer. After all the convolution layer three fully connected layers with 1024 neurons are connected. To avoid the over-fitting and reduce the training time two dropout layers with the rate of 0.2 are introduced in the network after the first dense layer and second dense layer. The last dense layer with four neurons created for the final prediction of the secondary emotions surprise, neutral, anger, and fear. The proposed model is shown in Fig.1

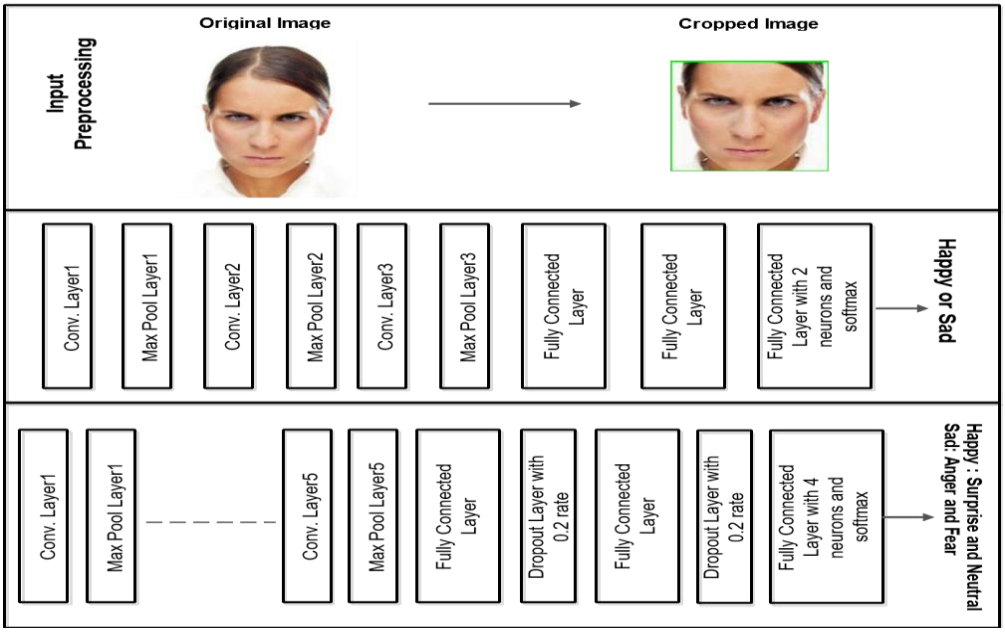


**Fig. 1** The Proposed model architecture with pre-processing on input image

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## III. Experimental Results and Comparisons

The model has been implemented on Intel core i7 8th generation laptop with 16 GB RAM, 256GB SSD with NVidia GeForce GTX 1050 Ti 4GB graphics. The performance of the proposed models was evaluated after the training on the basis of accuracy, loss and confusion matrix. The model strategy is quite straight, first the P-CNN model has been trained to classify whether an image is showing happy emotion or sad. In the training dataset, all the images are labelled as either happy or sad. The overall train accuracy of the model is 97.07% and loss is 0.094 when evaluated with the FER2013 dataset and with JAFFE the training accuracy is 94.12%.

## IV. Conclusion and Future Scope

The hybrid deep learning model for emotion recognition has been proposed in this paper. A proposed CNN model is able to detect two categories of emotions, primary and secondary. In primary emotions two categories have been considered in the model happy and sad. For the secondary emotions, two types of emotions under each primary category have been considered in the model. In the model concept of the dropout layer with a 0.2 drop rate has been introduced so that optimal accuracy can be obtained. The model has been evaluated using two datasets FER2013 and JAFFE. The accuracy of the model in the case of FER2013 is 97.07% and in the case of JAFFE, it is 94.12%. The model has also been tested for real-time images by placing the camera. In the future, the model can be modified by extending P-CNN for multiple primary emotions and S-CNN for more secondary emotions on real-time video data.

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