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International Journal for Modern Trends in Science and Technology, 7(10): 79-83, 2021

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0710012
Available online at: http://www.ijmtst.com/vol7issue10.html

Classification of Facial Expressions using Convolutional Neural Networks

Dr. P. Sumithabhashini[1] |Ramesh Alladi[2] |Dr. ChiranjeeviPandi[3]

[1]Professor ECE, Holy Mary Institute of Technology & Science (Autonomous), Hyderabad,
[2]Associate Professor CSE, ACE Engineering College (Autonomous), Hyderabad.
[3]Associate Professor CSE, ACE Engineering College (Autonomous), Hyderabad.

To Cite this Article
Dr. P. Sumithabhashini, Ramesh Alladi and Dr. ChiranjeeviPandi. Classification of Facial Expressions using Convolutional Neural Networks. *International Journal for Modern Trends in Science and Technology* 2021, *7*, pp. 79-83. https://doi.org/10.46501/IJMTST0710012

Article Info
Received: 06 September 2021; Accepted: 30 September 2021; Published: 05 October 2021

ABSTRACT

We can recognize the emotion of a human by seeing their facial expression and it is an efficient way of human communication. It is the easiest way and essential technology for realizing the human and machine interaction. Facial expression recognition task can be able to classify the face images into various categories of emotions such as happy, sad, angry, fear, surprise, disgust and neutral. In this paper, we are analysing and efficiently classifying each facial image into one of the emotion category. There are numerous approaches to address and solve this problem, out of them convolutional neural network (CNN) is the best approach. Here, we are proposing a novel technique called facial emotion recognition using convolutional neural networks. It is based on the feature extractor to extract the feature and the classifier to produce the label based on the feature. The extraction of feature may be imprecise by variance of location of object and lighting condition on the image. The feature of image can be extracted without user defined feature engineering, and classifier model is integrated with feature extractor to produce the result when input is given. In this way, the CNN approach can produces a feature location invariant image classifier that achieves higher accuracy than conventional linear classifier and our model classified the emotions with 66.62 accuracy.

KEYWORDS: CNN, facial expression Recognition, emotions, classification.

I.INTRODUCTION

The human beings can be able to communicate with one another in various ways like with speech, actions and also with emotions [1]. The key technology for identifying the human computer interaction is the facial expression recognition (FER) in the computing system. Recently this FER technology is in more demand in many fields. With respect to Artificial Intelligence (AI), a computer will be able to interact with humans much more naturally if they are capable of understanding human emotion [2], Automatic recognition of facial expressions can be an important component of natural human machine interfaces, and the FER may also be used in behavioral science and in clinical practice. Like this, for real time purposes, facial emotion recognition has a number of applications. FER could be used in combination with other systems to provide a form of safety. For instance, ATMs could be set up such that they won't dispense money when the user is with the emotion fear. Although humans recognize facial expressions virtually without effort or delay, reliable expression recognition by machine is still a challenge.

There have been several advances in the past few years in terms of face detection, feature extraction mechanisms and the techniques used for expression classification, but development of an automated system that accomplishes this task is difficult [3]. In this paper, we are analyzing and efficiently classifying each facial image into one of the emotion category by using an approach based on Convolutional Neural Networks (CNN) for facial expression recognition. The input into our system is a facial image; we use CNN to predict the facial expression label which should be one of the following labels: happy, sad, angry, fear, surprise, disgust and neutral. The fig.1 shows the examples of different facial emotions are used for the classification.

Fig.1: Examples of different facial emotions

In terms of facial expression recognition, the major advantage for this one is dataset collection, there are various facial expression detection related datasets are available online like FER-2013, Lifespan, CMU MultiPIE, CK and etc. Most datasets contain labeled images which are generally posed. This generally involves photos taken in a stable environment such as a laboratory. While it is much easier to precisely predict the emotion in such scenarios, these systems tend to be unreliable in predicting emotions in the uncontrolled environment. Another issue is that most datasets are from these controlled environments and it is relatively harder to obtain labeled datasets of emotions in the wild. Furthermore, most datasets have relatively lesser training data for emotions such as fear and disgust when compared to emotions such as happiness. Another factor to take into account is a person's pose. It is considerably harder to decide the emotion of a person when only half of their face is visible. In addition, lighting plays a major role in facial expression recognition. Machines may fail to identify an emotion that it usually would identify if the lighting conditions are poor. Finally, one must keep in mind that a user's emotional state is a mixture of many factors; a smile does not always mean that a person is really happy. The objective of this paper is to classify human faces into one of the six universal emotions or a seventh neutral emotion. In recent years, many papers have been published that use deep learning for facial emotion recognition. In this paper we use the CNN approach; it can produce a feature location invariant image classifier that achieves higher accuracy than conventional linear classifier.

STRUCTURE OF PAPER

The paper is organized as follows: In Section 1, the introduction of the paper is provided along with the structure, important terms, objectives and overall description. In Section 2 we discuss related work. In Section 3 we have the complete information about facial expression recognition. Section 4 shares information about the flexible YAML templating system created for it, its advantages and disadvantages. Section 5 tells us about the methodology and the process description. Section 6 tells us about the future scope and concludes the paper with acknowledgement and references.

OBJECTIVES

There have been several advances in the past few years in terms of face detection, feature extraction mechanisms and the techniques used for expression classification, but development of an automated system that accomplishes this task is difficult

In this paper, we are analyzing and efficiently classifying each facial image into one of the emotion category by using an approach based on Convolutional Neural Networks (CNN) for facial expression recognition.

II. RELATED WORK

Since 1971 many researchers are doing the considerable research on Facial expression recognition classifiers. P. ekman et al. [4] defined seven basic emotions, irrespective of culture in which a human grows with the seven expressions (happy, sad, angry, fear, surprise, disgust and neutral). Several facial expression recognition systems classify the face into a

set of classical emotions such as happy, sad and anger. Other facial expression recognition systems identified the muscle movements that the face image can produce in order to provide the description of the facial expression.

III. FACIAL EXPRESSION RECOGNITION

There are various FER techniques, in this work we have surveyed some of the works: First one is based on the statistical movement [5], it presents the detection of all the universal emotions based on statistical movements i.e. Zernike movements. The features extracted by Zernike movements are further classified through Naïve Bayesian classifier, rotation invariance is also experimented, it is one of the important properties of Zernike movements. Second one is identification of driven based visual emotion recognition system for a social robot [6]. The proposed modification includes identification step prior to emotion classification in order to provide personalized emotion recognition. The facial detection and parameterization is done by FaceTracker application. The feature extraction step is based on authorial feature set definition, which will work on any given model, which guarantees ease of modification. The evaluation of the system uses two discriminant classifiers, decision tree and four variants of nearest neighbor classifier. The system is able to recognize 7 emotion classes. Third one is to improve the accuracy facial image recognition, a new technique has been proposed and presented based on Fuzzy Support Vector Machine (FSVM) and K-Nearest Neighbor (KNN)[7]. At first, the feature of the fixed facial expression image is extracted by the Principle Component Analysis (PCA), then, the algorithm divide the region into different types, and combine with the characteristic of the FSVM and KNN, switch the classification methods to the different types. The results of the experiment show that proposed algorithm can reach good recognition accuracy.

IV. METHODOLOGY

The convolutional neural network (CNN) takes this name from mathematical linear operation between matrixes called convolution. CNN has multiple layers including convolutional layer, non-linearity layer, pooling layer and fully connected layer. The convolutional and fully-connected layers have parameters but pooling and non-linearity layers don't have parameters. Especially the applications that deal with image data, such as largest image classification data set (Image Net), computer vision, and in natural language processing (NLP) and the results achieved were very amazing [7].

To classify the facial expressions, we developed the model using CNNs with variable depths to evaluate the performance of these models for facial expression recognition. We considered the following network architecture in our investigation:

Here, we first approached this project by specifying out clearly our primary purpose--classify provided grayscale pictures into one out of six labels. The facial expression image classification task can be efficiently classified using CNN among different classification algorithms. To perform this task we have used the publicly available dataset FER2013 from kaggle website of FER challenge[8]. All the images of the dataset are of size 48*48; some of the images are plotted in fig.2.

Fig.2: Training dataset

To classify the emotions we can use various phases which are shown in fig. 3.

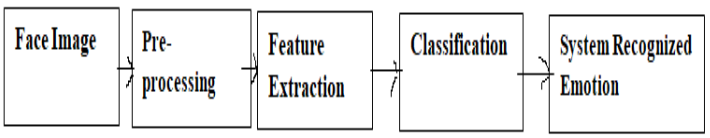

Fig. 3: phases of classification

Here we are discussing the three essential phases[9] such as preprocessing, feature extraction and classification.

a) Preprocessing

Preprocessing can be used to enhance the FER performance and can be done before the feature extraction process. Image preprocessing will have the various processes which are face detection,

illumination, pose of the image, alignment of faces and data augmentation. The face FER2013 dataset has group of images with train and validation. The shape of the loaded data is (28709, 48, 48, 1) of training data, (3589, 48, 48, 1) of testing data and (3589, 48, 48, 1) of validation data,

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(1, 48, 48, 1)
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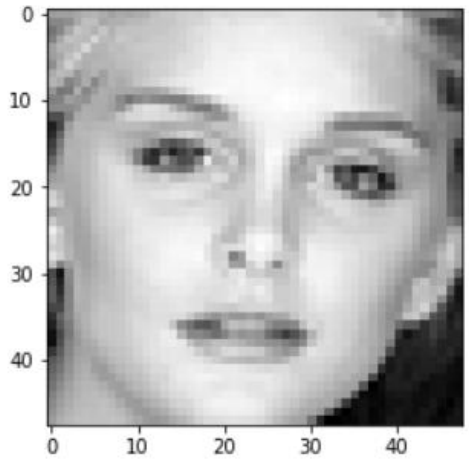

Fig.4: Feature extraction phase

b) Feature Extraction

The facial expressions can be extracted by translating the input data into a group of features. By utilizing the feature extraction the researchers can able to reduce the huge amount of data down to a relatively small set, which allows the computation very speed with that the resultant feature extraction facial image can be shown in fig.3.

c) Classification

To classify the emotions CNNs have been widely used in different computer vision applications. Here we had plot different emotions with the labels as shown in fig.4.

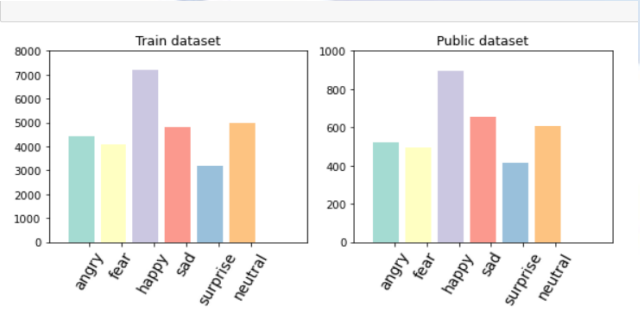

Fig.5: Plotting of different emotions from FER2018 dataset

In FER2013 we have a group of gray scale images, in our practical CNN approach we have decided to start the task from three sequential convolutional layers which are increased from 32 to 128 and it is suggested to use the such hierarchical structure with increasing number of layers it gives best performance in CNN, used same padding pattern, common activation function relu in all layers with input shape (48, 48, 1) and followed by a maxpooling layer. Finally, the convolutional layer is first flattened and after that, we used two more dense layers to reach the output layer in which softmax activation function is used for classification of facial expression recognition and the emotions are classified with the accuracy and loss of the training and validation data are shown in the fig.6.Our model classified the emotions with accuracy of 66.62.

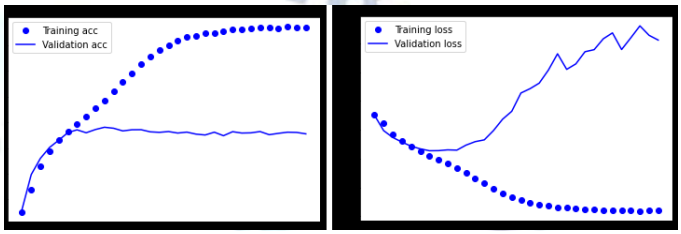

Fig.6. accuracy and loss of training and validation

V. FUTURE SCOPE AND CONCLUSION

The classification of facial expression recognition using convolutional neural network approach has been done using FER2013 dataset. For the activation we have used the relu activation function in our work. In the future we are planning to do it with the hybrid classification algorithms to achieve high accuracy to identify the correct emotion for real time facial images.

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About Authors:

Dr.P.Sumithabhashini received herB.Tech Degree in the Department of Electronicsand Communication from Sri Venkateswara University in 2001 and M.Tech Degree fromSri Venkateswara University in 2005. Shecompleted PhD Degree from Sri VenkateswaraUniversity, Tirupatiin the yearof 2010. She is having 17 years of teaching experience . She has performed as a chair for the Various International Conferences and a Reviewer & Editorial Board Member for various journals. Shehas published 27 research papers at National and International level journals and conferences and accepted as aResearch Supervisor by JNTUK and JNTUH and working as a research supervisor to one Ph.D Scholar under JNTUH .Presently, She is working as a Professor in theDepartment of Electronics and Communication Engineering, Holy Mary Institute of Technology and Science(A),Hyderabad. HerresearchinterestsincludeSignal Processing AL&ML IOT and 5G & 6G Communications .

Mr. Alladi Ramesh received his B.Tech Degree in the Department of ComputerScience and Engineeringfrom Jawaharlal Nehru Technological University, Hyderabad in 2005 and M.Tech Degree from JNTU Hyderabad in 2008. He is having 14 years of teaching experience. He is working as a Associate Professor in the Department of Computer Science and Engineering, ACE Engineering College (A), Hyderabad.His research interests include AI&ML, Adhoc Networks and Wireless Sensor, CNN.

Dr. P Chiranjeevireceived his B.Tech Degree in the Department of ComputerScience and Engineeringfrom Jawaharlal Nehru TechnologicalUniversity,Hyderabad in 2006, M.Tech Degree from JNTU Hyderabad in 2009 and Ph.D (CSE) from JNTUH, Hyderabad in 2019.have been working as associate professor in Computer science and Engineering department at ACE Engineering College. He had published 20 Research papers in reputed journals and conferences his research interests include Sentiment Analysis and Deep learning.