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Facial Expression Detection Using Convolution Neural Networks

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***Abstract*: Facial expression recognition systems has been attracted much research that interest within the field of artificial intelligence. Many established facial expression recognition (FER) systems they apply standard machine learning to extract image features, and these methods generalize poorly to previously unseen data. This project referred recent research paper to classify images of human faces into unique emotion categories using Convolutional Neural Networks (CNNs).**

Facial expression detection has become a required system because of its immense applications in artificial intelligence such as human computer collaboration, data driven animation, human-robot communication etc. Since it has an interesting problem and demand in computer vision, several works had been conducted regarding this topic. The aim of this research is to develop a facial recognition system based on CNN. This approach enables to classify seven basic emotions consists of disgust, angry, fear, happy, neutral, sad and surprise from image data.

***Keywords*: Facial expression recognition, Convolution Neural Networks, Facial parts.**

1. Introduction

Human will communicate with each other in the form of speech. Sometimes Humans can express their feelings through

Facial Expression. Facial expression is the movement of facial muscles that express the emotions made by Humans. It provides information about what emotion that person is going

through. Emotion is a mental condition that the person express. person's mental condition can be identified by his/her facial expression.

The motive of this research is to advance a facial expression recognition system which can categorize an image into seven different classes of emotion and compute accuracy, precision, recall.

2. Problem Statement

Human facial expressions are often easily classified into 7 basic emotions like happy, sad, surprise, fear, anger, disgust, and neutral. Our facial emotions are expressed through activation of specific sets of facial muscles. These sometimes subtle, signals in an expression often contain an abundant amount of data about our state of mind. Through facial emotion recognition, it is possible to use the system by audience/users through a simple and low-cost procedure. For example, retailers may use these metrics to guage customer interest. Healthcare providers can provide better service by using additional information about patient's emotional state during treatment.

3. Literature Survey

There are various researches on this subject, a number of papers that we've referred for this paper are listed below: Tan Nguyen, Luy Tan Nguyen [1] proposed an algorithm during this work, they propose an easy solution for countenance recognition that uses a mixture of Convolutional Neural Network and specific image pre-processing steps. CNN achieve better accuracy with big data.

Tawsin Uddin Ahmed, Mohammad Shahadat Hossain, Raihan Ul Islam, Karl Andersson [2] the aim of this research is to develop a countenance recognition system supported CNN with data augmentation. This approach enables to classify seven basic emotions contains angry, disgust, fear, happy, neutral, sad and surprise from image data. CNN with data augmentation results in higher validation accuracy than the opposite existing models (which is 96.24%) also helps to overcome their limitations.

Deepesh Lekhak [3] during this paper countenance recognition system is implemented using Convolution Neural Network (CNN). CNN model of the project is predicated on LeNet Architecture. Kaggle countenance dataset with seven countenance labels as happy, sad, surprise, fear, anger, disgust, and neutral is employed during this project. The proposed model achieved 56.77% accuracy and 0.57% precision on testing dataset.

4. Methodology

The facial expression recognition system is implemented using convolutional neural network. The block diagram of the system is shown in following figures:

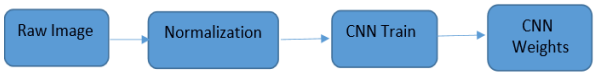

Fig. 1. Training phase

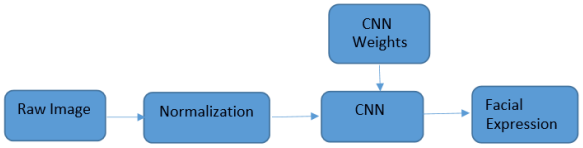

Fig. 2. Testing phase

During training, the system received a training data comprising grayscale images of faces with their respective expression label and learns a group of weights for the network. The training step took as input a picture with a face. Thereafter, an intensity normalization is applied to the image. The normalized images are used to train the Convolutional Network. To make sure that the training performance is not affected by the order of presentation of the examples, validation dataset is employed to settle on the ultimate best set of weights out of a set of trainings performed with samples presented in different orders. The output of the training step is a set of weights that achieve the best result with the training data. During test, the system received a grayscale image of a face from test dataset, and output the anticipated expression by using the final network weights learned during training. Its output is a single number that represents one of the seven basic expressions.

A. Dataset

The dataset from a Kaggle Facial Expression Recognition Challenge (FER2013) is used for the training and testing. It comprises pre-cropped, 48-by-48-pixel grayscale images of faces each labeled with one of the 7 emotion classes: anger, disgust, fear, happiness, sadness, surprise, and neutral. Dataset has training set of 24,710 facial images with countenance labels. The dataset has class imbalance issue, since some classes have sizable amount of examples while some has few. The dataset is balanced using oversampling, by increasing numbers in minority classes. The balanced dataset contains 35,888 images, from which 24,710 images are used for training, 6,178 images are used for testing, and 5000 images are used for validation.

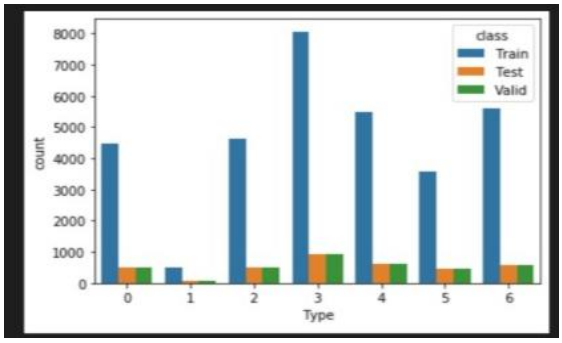

Fig. 3. Training, testing and validation data distribution

B. Model Architecture

The proposed model takes 48x48 pixels images in gray-scale as input. It has four convolutional layers of which second convolution is of 5x5 and others are 3x3 convolutional layers with single striding. Four 2x2 max pooling layers are included one after each convolutional layer. Additional batch normalization and dropout layers are used for increased performance. Relu activation is used along with Adam activation function. The model is extended with 3 dense layers of which the final dense layer has seven units in it. Final output is predicted based on the maximum score of the output unit in the final dense layer.

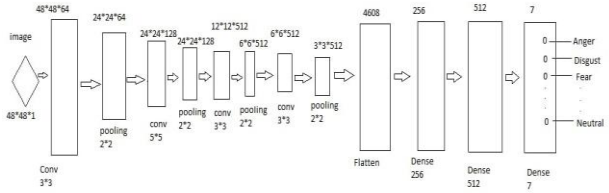

Fig. 4. Model architecture

5. Results

CNN architecture for facial expression recognition is implemented in Python. Along with Python programming language, Numpy, Python Imaging Library(PIL), OpenCv, Tensorflow, Pandas and Keras libraries were used.

The testing of the model is carried out using 6,178 images. The classifier provided 66.51% accuracy on Test set and 94.26% accuracy on Train set. As a performance measure precision and recall are considered in this paper. In spite of the imbalance in the dataset the system has shown precision of 0.66518, which signifies that good number of true positives predicted among total positive prediction. At the same time the recall achieved is 0.66518, indicates that the classifier has lesser number of false negatives predicted.

The confusion matrix for seven facial expression classes is shown below:

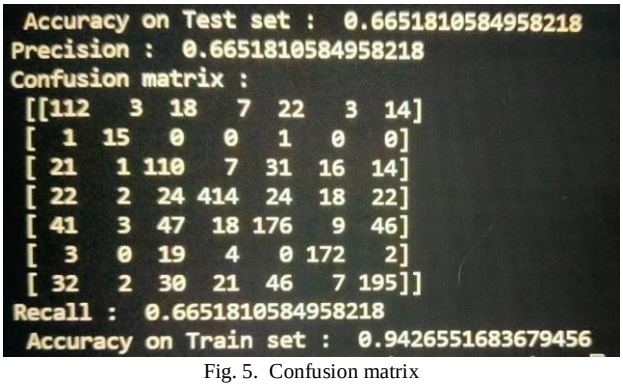

Fig. 5. Confusion matrix

6. Conclusion

Convolution neural network is implemented to classify human facial expressions. We have considered seven discrete

and unique emotion classes (angry, disgust, fear, happy, neutral, sad and surprise) for emotion classification. So, there is no overlapping among classes. The system has been evaluated using Accuracy, Precision, Recall. The classifier achieved accuracy of 66.66 % on test sets, 94.26% accuracy on train set, precision of 0.66, recall 0.66.

References

[1] Tan Nguyen, Luy Tan Nguyen, "Facial Expression Recognition with Convolutional Neural Networks: Coping with Few Data and the Training Sample Order", September 2013.
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