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Identifying Human Facial Emotions by a Deep Neural Network

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Abstract

We are moving towards an era where every aspect of our life is getting automated. So, getting facial emotion analysis done by artificial intelligence is one of the steps towards automation. Facial expressions are of the means of identifying one's emotion. Facial emotion recognition is widely used in fields like psychology, forensics and social media as it is of vital importance to get reliable results in all of these fields. The proposed system will work towards identifying the seven common emotions- happy, sad, anger, fear, disgust, surprise, neutral. Neural Network based approach is commonly employed for this process and Convolutional Neural Network which is a Deep Neural Network method, is very popular. Haar cascade classifier is used for face detection. A publicly available database is used to test the architecture of the proposed Convolutional Neural Network.

Keywords— *Deep learning, Convolutional Neural Network, Facial expressions, Face recognition, Human emotions*

I. INTRODUCTION

Facial Emotion Recognition (FER) has attracted attention since the work of C. Darwin in 1872. In Charles Darwin's book "The Expression of the Emotions in Man and Animals", he said that each one humans and animals show emotion through remarkably similar behaviors. The first reported research project on the analysis of facial expressions is often traced back to as early as 1862 to Duchenne who wanted to work out how the muscles in the human face produces facial expressions. The first attempt to analyze facial emotion from image sequences was done by Paul Ekman and Wallace V. Friesen in 1978. They defined six basics' emotions (anger, fear, disgust, sadness, surprise and happiness), which are the same across cultures. Facial expression recognition system is one of the most important non-verbal channels through which machines can recognize human's internal emotions and intent. Facial expression recognition has brought much attention in the past years due to its impact in clinical practice, sociable robotics and education. According to diverse research, emotion plays an important role in education. The automatic expression recognition has significant meaning in many applications. With the advances in the robotics, the requirement of the robust real-time facial expression recognition system is urgent. It could improve the performance of human-computer interaction and help to construct more intelligent robots with the ability to understand human emotions. Apart from this, facial expression recognition system is also useful in other fields such as education software, animation, automobile system and behavioral science. In the field of education, existing virtual learning environments successfully simulate interaction

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at a cognitive level during traditional teaching processes. In the process of human-computer interaction, teachers naturally expect a face recognition system to possess the power to detect, analyze and process emotions so as to urge good teaching effect, such as perception, understanding and expressing emotions. Currently, a teacher uses exams, questionnaires and observations as sources of feedback but these classical methods often come with low efficiency. Using facial expression of students, the teacher can adjust their strategy and their instructional materials to help foster learning of students.

II. LITERATURE SURVEY

Developed a technique using deep neural network for human facial expression recognition. Kernel PCA is applied to feature before feeding them into the deep neural network that consists of 1 input layer,2 hidden layers and a SoftMax classifier. They have used the Extended Cohn-Kanade Dataset for training and testing. It is demonstrated that the network generalizes to new images fairly successfully with an average recognition rate of 96.8% for six emotion and 91.7% for seven emotions. In comparison with shallower neural Networks and SVM methods, the proposed deep network method can provide better recognition performance at [2]. Identifies some optimal parameters like Eyes features, Haar feature & Filter & edge detection for eyes and mouth using Support Vector Machine (SVM) classifier. platform used was Python 2.8, OpenCV and using JAFF database they showed that the proposed method has high classification performance. For their results they used Neural Network, Emotions recognized were Sad, surprise, happy, anger, disgust and fear. Overall, because the mouth was added as an identification of elements using Harr-like method, accuracy has improved at [3]. This paper used the Viola-Jones algorithm to detect the eye and lips region from a face and then with the help of the neural network. Also, Machine Learning techniques, Deep Learning models, and Neural Network algorithms are used for emotion recognition. This paper detected emotion from those features from the positioning of the mouth and eyes. They used Dataset from Kaggle.com results found is that the accuracy of the system can be raised to about 97% if adequate quantity of raw data is obtained at [4]. They present a new architecture network based on CNN for facial expressions recognition. They fine-tuned their architecture with Visual Geometry Group model (VGG) to improve results. Feature Extracted using Vector field Convolutional, Local Binary Pattern (LBP). To evaluate their architecture, they tested it with many largely public databases (CK+, MUG, and RAFD). Obtained results showed that the CNN approach is very effective in image expression recognition on many public databases which achieve an improvement in facial expression analysis [5]. Emotion detection is done using two-channel Convolutional Neural Network. Viola-Jones algorithm is used for feature extraction. Two datasets are used in this paper – JAFFE and CK+. In this paper MATLAB 2016 platform is used for the experimentation. The accuracy for JAFFE dataset is 97.71% and 95% for CK+ dataset at [7]. Deep Convolutional Neural Network is used for emotion detection. Haar cascade is used for feature extraction and SoftMax classifier is used for emotion classification. In this paper Python 3.5.3 platform is used. Yale-face dataset is used and average system accuracy is 97.05% [8]. The idea related to automated live facial emotion recognition through image processing and artificial intelligence (AI) techniques is presented in this paper. Convolutional Neural Network is applied using python. Haar cascade is used for feature extraction. 7 emotions are detected in the system with accuracy of 66% [10]. The Proposed system detects 6 emotions: happy, anger, disgust, fear, happiness, sadness,

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and surprise. Based on Convolutional Neural Networks. The Viola Jones Algorithm is used for feature extraction. Multi-class SVM based classifier is used. Two datasets are used to train and test model: CK+ benchmark and ImageNet. The accuracy of the model with face detection algorithm is 86.04% and without it the accuracy is 81.36% at [15]. Method for feature extraction is Haar Cascade. The emotions the proposed system will detect are Anger, happiness, surprise, neutral, fear and sadness. The method used is Convolutional neural network (CNN). The tools used are Keras, TensorFlow, OpenCV. It is found that better functionalities using Python as compared to when MATLAB used. The face should be at an angle of at least 45 degrees et al [18].

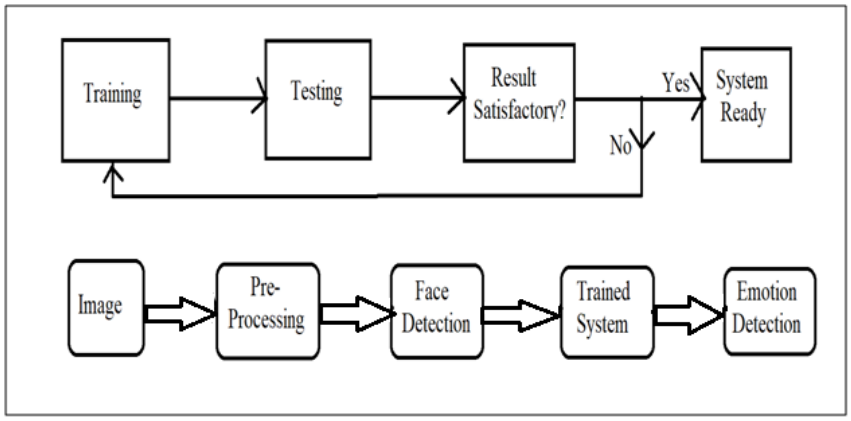

Fig 1: Block Diagram

III. PROPOSED METHODOLOGY

A convolutional neural network (CNN) is strong image processing, artificial intelligence (AI) systems that use deep learning approach to accomplish both generative and descriptive tasks, with image and video recognition, as well as recommender systems. The CNN employs a technology similar to a multilayer perceptron that is optimized for low processing requirements. An input layer, an output layer, and a hidden layer with several convolutional layers, pooling layers, fully connected layers, and normalizing layers make up a CNN's layers. The main advantage of CNN compared to its predecessors is that it automatically detects the important features without any human supervision. CNN is also computationally efficient. It uses special convolution and pooling operations and performs parameter sharing. This enables CNN models to run on any device, making them universally attractive.

Convolutional Layer – The initial layer and one of the fundamental building components of a Convolutional Neural Network is the convolutional layer (CNNs). They use the training image's raw pixel values as input and extract features from it. By learning visual attributes from small squares of input data, this layer assures the spatial link between pixels.

Max Pooling Layer --A Pooling Layer is usually applied after a Convolutional Layer. This layer's major goal is to lower the size of the convolved feature map in order to reduce computational expenses. This is accomplished by reducing the connections between layers and operating independently on each feature

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map. There are numerous sorts of Pooling operations, depending on the mechanism utilized. Largest element is obtained from the feature map in Max Pooling. The average of the elements in a predefined sized Image segment is calculated using Average Pooling. Sum Pooling calculates the total sum of the components in the predefined section. The Pooling Layer is typically used to connect the Convolutional Layer and the FC Layer.

Fully connected Layer -- Layer The weights and biases, as well as the neurons, make up the Fully Connected (FC) layer, which is used to connect the neurons between two layers. The last several layers of a CNN Architecture are usually positioned before the output layer. The previous layers' input images are flattened and supplied to the FC layer in this step. Later, the flattened vector is sent via a few additional FC layers, where the mathematical functional operations are normally performed. The classification procedure gets started at this point.

The proposed model consists of four convolution layer, four MaxPooling layers, four layer of batch normalization, flatten layer, dropout layer, three fully connected layers and output layer. Among four convolutional layer two layers are of 64 nodes and remaining two layers are of 128 nodes. All the three fully connected layers i.e., dense layers are of 128 nodes. Batch normalization is a layer that allows every layer of the network to do learning more independently. It is used to normalize the output of the previous layers. Using batch normalization learning becomes efficient also it can be used as regularization to avoid overfitting of the model. The activation function is one of the most crucial elements in the CNN model. They're utilized to learn and approximate any form of network variable-to-variable association that's both continuous and complex. In simple terms, it determines which model information should fire in the forward direction and which should not at the network's end. Activation function used for every layer is ReLu activation function. There are several commonly used activation functions such as the ReLu, tanH and the Sigmoid functions. Input image size given to the CNN model is 48×48.In categorical encoding, One-Hot encoder is used. Loss function used is categorical_crossentropy and Adam optimizer is used for optimization process. SoftMax classifier is used in the output layer to classify various emotions from the given input image. Haar cascade is used to detect the frontal face from the input image. Various libraries such as TensorFlow, Keras, OpenCV and other libraries is used in the project. The proposed system gives the accuracy of 64%.

Architecture of Convolutional Model is:
Model: "sequential"

Layer (type)	Output Shape	Param #

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conv2d (Conv2D)	(None, 48, 48, 64)	640
batch_normalization (BatchNo	(None, 48, 48, 64)	256
max_pooling2d (MaxPooling2D)	(None, 24, 24, 64)	0
conv2d_1 (Conv2D)	(None, 24, 24, 64)	36928
batch_normalization_1 (Batch	(None, 24, 24, 64)	256
max_pooling2d_1 (MaxPooling2	(None, 12, 12, 64)	0
conv2d_2 (Conv2D)	(None, 12, 12, 128)	73856
batch_normalization_2 (Batch	(None, 12, 12, 128)	512
max_pooling2d_2 (MaxPooling2	(None, 6, 6, 128)	0
conv2d_3 (Conv2D)	(None, 6, 6, 128)	147584
batch_normalization_3 (Batch	(None, 6, 6, 128)	512
max_pooling2d_3 (MaxPooling2	(None, 3, 3, 128)	0
flatten (Flatten)	(None, 1152)	0
dropout (Dropout)	(None, 1152)	0
dense (Dense)	(None, 128)	147584
dense_1 (Dense)	(None, 128)	16512
dense_2 (Dense)	(None, 128)	16512
dense_3 (Dense)	(None, 7)	903

Total params: 442,055
Trainable params: 441,287
Non-trainable params: 768

Dataset is taken from KAGGLE.com. This dataset is split into approximately 8:2 ratio, where 80% dataset is used for training the CNN model and the remaining 20% dataset is used to evaluated the model. As the system is supervised the training dataset is labeled into different emotions which we are going to detect

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(angry, surprise, happy, sad, disgust, fear and neutral). The Tables I gives information about number of images used for each emotion for training purpose

TABLE I
TRAINING DATASET

Emotion Label	Emotion Name	Number of images
1	Angry	3993
2	Surprise	3205
3	Happy	7164
4	Sad	4938
5	Disgust	436
6	Fear	4103
7	Neutral	4982

IV. CONCLUSION

Thus, the facial emotion recognition system proposed in this paper uses supervised learning method, the process starts with training the neural network with an open-source dataset from Kaggle.com. Training is followed by three major stages: image preprocessing, feature extraction and emotion classification. Reliable results are obtained for six emotions which are happy, sad, angry, fear, surprise and neutral. However, this model cannot be relied upon for the detection of the emotion disgust as the dataset for this emotion is too small. The model was trained with front-facing images. As an extension in future, we would like to make the model capable of dealing with faces facing at different angles.

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