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Facial Expression Recognition and Gender Detection Using CNN

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Abstract
The very popular method for Facial Recognition and Classification is Deep Learning. There are different types of deep learning algorithms such as Deep Belief Network (DBN) and Convolutional Neural Network (CNN). In this paper we present a new architecture network based on CNN for building a facial recognizer model which detects the emotion and gender of a person in real-time and classify accordingly. We will be using Convolution Neural Network to implement this model which is the best algorithm for Facial Emotion Recognition (FER) and Gender Detection. To evaluate our network architecture we will test the model with large databases that are publicly available. Obtained results show that the CNN approach is an effective expression and gender detection model.

Keywords: *Convolution Neural Network(CNN), Facial Expression Recognition(FER),Gender Detection.*

1. Introduction

Feelings play a vital role not only in our relationships with people but also within the way we use computer and other systems. Emotional state of an individual influences his decision making skills, problem or task solving and also his/her concentration. Affective computing vision is to create systems that are able to recognize and influence human emotions is as to reinforce productivity and effectiveness of working with computers[4].As a result of increasing amount of applications, particularly since the rise of social platforms and social media, automatic gender classification has become relevant. Gender classification focuses on the efforts of understanding human visual processing and identifying key features used to categorize between male and female individuals. It is very easy for human to acknowledge the emotions and gender but for machines emotion and gender recognition and classification could be a challenging task[4]. In recent years many techniques and mechanisms are used for emotion and gender recognition but to develop an automated system to accomplish this task is difficult. In this project we have developed a Deep Convolution Neural Network to accomplish this task. This project aims at using CNN (Convolution Neural Network), LSTM (Long Short Term Memory), and LRC (Logistic Regression Model) for gender classification and Face Expression Recognition (FER).

Image is given as input to our network which then predicts the gender and emotion. Gender is classified into Male and Female. Whereas the emotions are classified into seven classes such as anger, happiness, fear, sadness, surprise and neutral.

2. Related Work

In the recent years, researchers are successful in developing many automatic face recognition models which can classify expressions, gender and many other features.

1. R. Pathar et.al [1] proposed a paper work that aims to categorize a facial image into one of the seven emotions which they are considering in this study, by building a multi class classifier. They are using Convolutional Neural Networks (CNNs) for training over gray scale images obtained from fer2013 dataset. They experimented with different depths and max pooling layers to achieve an accuracy of 89.98%.
2. Y. Zhou et.al [2] proposed a paper work which consists of two components: one is face recognition module and other is gender recognition module which uses pre-trained CNN to extract face and gender features

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in image. They use public dataset Adience to train CNN and get an accuracy of 93.22%.

3. Mane. S et.al [3] proposed a scholar work where they use CNN to build a model that can recognize faces and classify them based on expressions and gender. In case of gender identification they have ~500k images ,the accuracy is 96% whereas they have only 1200 images for training facial expression recognition, the accuracy is significantly lower at 66%. This case proves that, more the model is trained with a larger dataset better the accuracy of the system.

4. C. M. M. Refat et.al [4] proposed a paper that aims to build a network model using CNN that detects facial expression. The model is designed by 3 max pooling layers and 1 full connected layer which follows deep convolutional neural network model. They have tested the algorithm using JAFFE (Japanese Female Facial Expression) datasets which consists of 213 facial expression images (grayscale) .This deep neural network with JAFFE dataset gives a significant accuracy.

5. Verma et.al [5] proposed a paper on Facial Expression Recognition, in which they have built their own CNN architecture called Venturi architecture which resembles the shape of venturi tube. The architecture consists of 6 layers in the hidden layer. They train and test the model using Karolinska Directed Emotional dataset and the accuracy is compared with existing Rectangular and Triangular CNN architecture.

The two things that make a huge difference between all these models are the hidden layers they used to build the neural network models and the dataset that they used to train those models.

3. Implementation Methodology

We use the following methodology to build our network:

A. Data Set for Training, Valiging, testing the network

We need huge amount of image data to train our model to recognize expression. We are going to use the data set available on Kaggle which is an online community of data scientists and machine leaners, owned by Google, Inc. It allows users to search out and publish data sets, explore and build models in a web-based data-science. Another method which we thought of using is to download the image using python script.

B. Preprocessing the Data

Preprocessing of image data is required for getting better results while training the neural network. We will be using following preprocessing steps:

1. Classifying the image data as training, validating, testing set.
2. Vectorization: All inputs and targets in a neural network must be tensors of floating-point data. This process of converting inputs of any format into tensors is called data vectorization.
3. Value Normalization: We normalize the data by rescaling the pixel values between 0-255.
4. Data Preprocessing: Data should be formatted into appropriately preprocessed floating point tensors before feeding into network.

C. Building and Training the Network model

Designing the network architecture is the most challenging part while developing any neural network. Here we discuss following method:

1. Neural Network Architecture: The network architecture consists of:

a. Type of neural network model used: The convolutional base of our network consists of Convolution 2D model and Convolution LSTM-2D. Convolution Neural Networks use kernels, or filters, to find patterns in smaller parts of an image.

b. Number of Layers Used: The numbers of layers we are initially using are:

3 Convolution Layers
2 Max Pooling Layers
2 Fully connected Layers

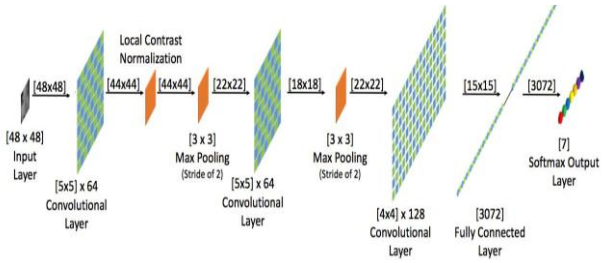

Figure 1: Network layer [10]

c. Pooling Layer: Pooling Layers are used to down sample the features extracted in each layer. We are using Maxpooling Layer but this isn't the only layer available we can also use average pooling.

d. Fully Connected Layer: After the convolution base we use fully connected layers to classify the output features generated by the convolution base. We feed this network with one dimensional vector of values; it can be done by flattening operation.

e. Output Layer: The output layer gives the probability of each class on which the model was trained. We can use python data visualization tools to view the outputs while testing the trained network.

f. Activation Functions And Loss function: The activation functions which we have used are:

- Softmax activation function for output layer

Loss functions are used to compute the loss which we get in each step of the epoch.

2. Specifying the Hyper Parameters: Hyper parameters are the variables which determine the network structure. Hyper-parameters are set before training. We use Validation data to configure the hyper-parameters so that network will perform well on the testing data.

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3. Training the network: Training the model includes fitting the training set into the designed network; here we use training image data set. We have to be careful not to include any data from validation or training data set because a phenomenon like over fitting may occur in the network.

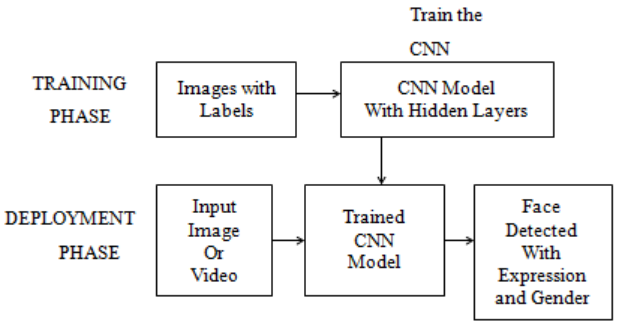

Figure 2: System Design

D. Validating

We evaluate the performance of our trained model based on the validation data which we had kept separate from training data. The two main goals of evaluation is to know that whether the model is capable of generalizing to all the data or whether it is over fitting to training data. Over fitting is the worst thing that can happen to a neural network.

E. Testing

Testing is basically done by using the testing data set which we had separated from the training data set, here we check for the metrics such as total loss and total accuracy of the model, better the accuracy and lesser the loss the model is ready to be deployed.

F. Improvement

The model which we have designed now is prone to overfitting and less performance so we are going to use the following methods to improve performance:

1. Dropout.
2. Fine Tuning.
3. Feature Extraction.

G. Deployment

In Deployment method we save the Model/Network which we have successfully trained and tuned the hyperparameters and we save the model as an hd5file (Hierarchical Data Format File).

This File is used to load the network model as it contains all the parameters the model had learned during its training process. We can use this model to develop applications in the backend if the application which we are developing needs to classify the images or data which the network knows how to classify.

4. Results

Our current model gives us O/P for six emotions -neutral, happy, sad, angry, fearful, surprised and it recognizes gender as man and woman accordingly.

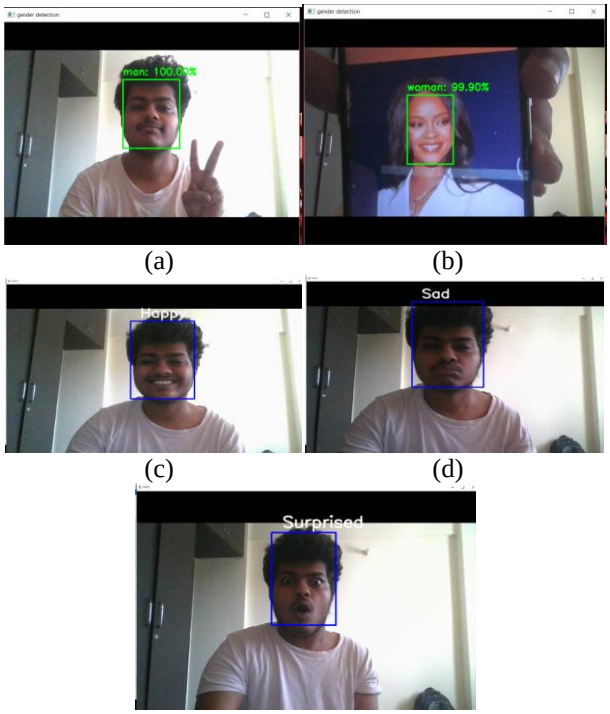

Figure 3: (a) Gender-male, (b) Gender-Female, (c)Emotion- happy, (d)Emotion-sad, (e)-Emotion-Surprised.

5. Conclusion

In this particular model which we have chosen to develop comprises of existing and optimized deep learning algorithms which are for different purposes. We have integrated the current algorithms to create a new improved algorithm for facial expression recognition and gender detection. Our model can detect and predict emotion and gender in real time using webcam. This model has a practical use in the field of market analysis.

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