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Face detection and emotion recognition system

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ABSTRACT

Recognizing Human facial expressions and emotions by computer is an interesting and challenging problem. Recently there has been an increasing interest in improving the interaction between humans and computers. The face is a feature that can differentiate from person to person. Emotion is expressed through face, body gestures, and speech. Emotions through faces vary from situation to situation and person to person. The Face Detection and Emotion Recognition System automatically recognizes the faces and emotions of the persons accurately in an image. Convolutional neural network concept applied with machine learning and image processing is used in classifying the universal emotions such as Happiness, Sadness, Anger, Disgust, Surprise, Fear, and Neutral. Color images that are showing the human faces are given as input to the detection system. This face emotion recognition system mainly consists of four steps. They are Image Pre-Processing, Face Detection, Facial Feature Extraction, and Emotion Recognition. Image Pre-Processing is a step to change the image in Binary or Grayscale format and resizing the image in 48x48 pixels. Face detection is a method and that is capable of verifying or identifying and capturing the frames of the faces from an image. Feature extraction is a method to identify the characteristics of the person's face captured in the image and comparing the faces in the image whether the faces of the persons are the same or not. In the final step, Emotion recognition is trying to acquire the various expressions of emotions that a person can make through their faces to communicate with each other. In emotion recognition step it can predict the emotion of the person in any kind of images or videos. This system can detect the faces and recognize the emotion of the person accurately by considering the live feed camera images and pre-existing image and video clues.

Keywords: Face Detection, Emotion Recognition, Convolutional Neural Networks

1. INTRODUCTION

Automatic recognition of facial emotions plays a crucial role in artificial intelligence and robotics and thus it is important to the present and future generations. Recently there has been increasing interest in enhancing the interaction between humans and computers.

In the present technology, human-machine interaction is an increasing challenge and the system needs to understand human gestures and emotions. If a system can relate to human emotions, it can understand human nature better. Human emotions can be identified by seeing and observing their facial expressions and it can lead to better communication between humans or machine and a human. Facial emotions are expressed through the changes in facial muscles and body language. Human facial expressions are differentiated into 7 basic emotions are Happy, Sad, Surprise, Fear, Anger, Disgust, and Neutral. These facial expressions are important keys to recognize human emotions and they are important cues for non-verbal communication among human beings. Facial Expression Recognition system needs to perform detection and to locate the faces in an image or video, after that it has to extract the features of the faces and identifying the emotion of the person in an image or video. Face detection and emotion recognition system is implemented using three-layered Convolution Neural Networks. This system also works in real-time by considering the live feed videos or webcam images as input to recognize and identifying the faces and emotions of the persons on the screen. Facial expression analysis can be done in four main steps:

- (1) Image Pre-Processing,
- (2) Face Detection,
- (3) Facial Feature Extraction and,
- (4) Emotion Recognition.



Fig. 1: Facial Expressions

By following all these steps, this system can automatically recognize the emotions represented on a face. The existing system can identify the emotions of the person in an image with less accuracy. In this emotion recognition is identifying by using the different algorithms like k-nearest neighbor, or viola-Jones algorithms but we did not get the accurate results and it cannot identify all faces in an image that have all characteristics to identify the faces in that image. The proposing system can detect all faces in an image and recognize the emotions of the person with more accuracy than the existing one. But if any person or an automated system can realize their needs by noticing their facial expression then it can make the other people or automated systems can understand and making the decisions based on that.

2. LITERATURE SURVEY

In paper [1] the author used the K Nearest Neighbour and Sparse Representation Classifier to detect the faces and to recognize the emotion they use Convolutional neural network concept. In paper [2], the author explained the Viola-Jones technique to detect the faces and Fisher LDA method to recognize the emotions.

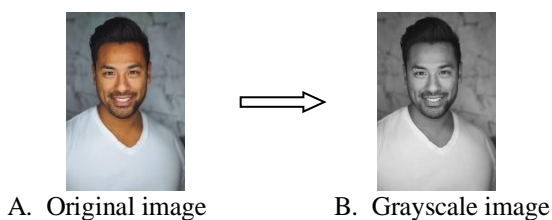
In paper [3], the author presented the Viola-Jones classifier method to detect the faces, select the non-skin area, Morphological functions are implemented to the selected image to taken out the facial features to recognize the facial emotion.

3. METHODOLOGY

A. Preprocessing

Pre-processing is a technique to perform operations on images and this can improve the quality of the image from input to the output image. This step will always be used to get useful and helpful images to the system from the crude images. It consists of various operations that apply to images. Most of the pre-processing operations are applied to an image are –

- a. Removing the noise
- b. Converting the Image in a Binary or Grayscale form.
- c. Changing the Brightness of the pixels
- d. Transforming the Geometric features.



If the system considered an image as an input then it can develop that in the form of a grayscale image and it will be resized because the image should in the size of 48x48 pixels. If video is given as input then the results are in the form of gray color frames in this step.

B. Face Detection

The Face detection step is used to detect the faces in an image or the frames acquired from the video and then locate the faces of the persons in that image. The result of this step will be the input to the next step and it can decide the entire result of the system that is recognizing the emotion of the person.

It can be implemented with the help of different techniques like Haar Cascade Classifier, relating pre-trained HOG + Linear SVM object detector, or applying the deep learning algorithm to detect faces.

In this step, we use the Haar Cascade Classifier method. This method has been trained from the source to detect the faces from the input. Haar Cascade Classifier consists of two types of classifiers. They are Frontal Face Classifier and Profile Face Classifier.

C. Facial Feature Extraction

Facial feature extraction step will begin after getting the results from the previous step. The Facial feature extraction process is defined as locating the specific positions, points, landmarks, or regions. This step can be done by applying the dlib face landmark facial detection library that considers points from all the points on the face. All points that are detected in this step other than the points on the mouth, eyes, and eyebrows are not used to produce the output from the input that is recognized from the previous step.

The points obtained from all these points are the values of the location of the point based on the detected face distance with the right, left, top, and bottom edges of the frame so it is important to normalize the points to generalize the value. In this process, it can compare the faces whether that any of the faces that are detected can be the same or not by considering the characteristic points or facial landmarks.

D. Emotion Recognition

Emotion Recognition is a process in which the system can recognize or identify the emotion of the person in 7 basic emotions like Anger, Fear, Disgust, Happy, Sad, Surprise, and Neutral by considering the preprocessed detected faces based on the trained model. The model is created by collecting the datasets that consist of different emotion image datasets and after that datasets can be trained by using deep convolution neural networks. If we use the supervised learning technique then the model automatically tries to adapt itself in a way that can map every input with the corresponding output.

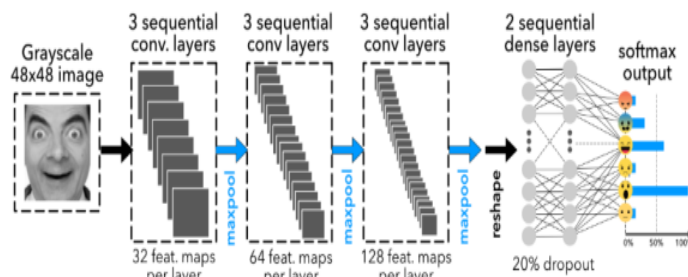


Fig. 2: Convolution neural network layers

From the previous step we can get the detected faces with a square box as a result and that will become an input to this step. In this step, the system can recognize the emotions of the faces by considering the trained model.

4. PROPOSED APPROACH

In this paper, we can detect the faces and recognize the emotions of the persons in an image by following 4 basic steps. They are

- Pre-Processing,
- Face detection,
- Facial feature extraction, and
- Emotion recognition

These steps follow one by one in order because from the previous step output is taken as input to the present and future steps. These steps are represented in the below figure.

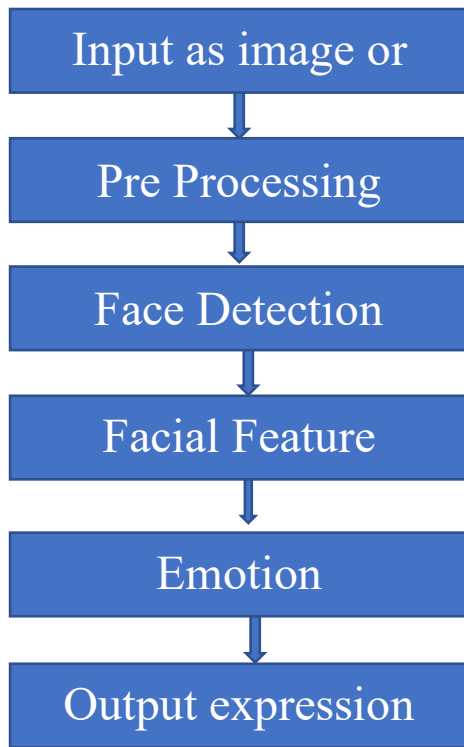


Fig. 3: Basic steps

In Pre-processing step the system can modify the images, especially in size and color. After doing that it can detect the faces in an image by using Haar Cascade Classifier. It can compare the Detected faces that we get an output from the previous step whether the faces of the persons same or not. Comparing the faces means that the detected faces have similar characteristics or not. If the two faces have similar characteristics then the two are same, otherwise not. After that, it can recognize the emotion in an image by using the trained model. This model we can get by applying the convolution neural network concept to train the datasets we have gathered

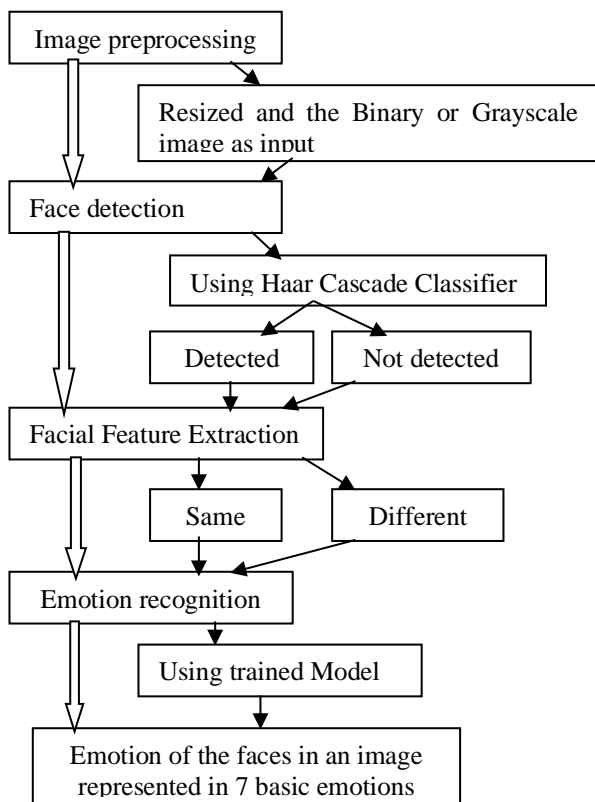


Fig. 4: Face detection and emotion recognition sequence

5. OTHER FACIAL DATASETS ACCESSIBLE IN ONLINE

1. Facial Expression Recognition2013
2. Emotic
3. JAFFE
4. Wild Dataset
5. Kaggle
6. CK
7. CK+

These datasets are useful for emotion recognition. In this paper, we collected the FER dataset to train the model. The dataset consists of anger, disgust, fear, happiness, sadness, surprise, and neutral classes. These classes comprise 35887 cropped, 48x48 pixel grayscale images of faces each labeled with one of the 7 emotions.

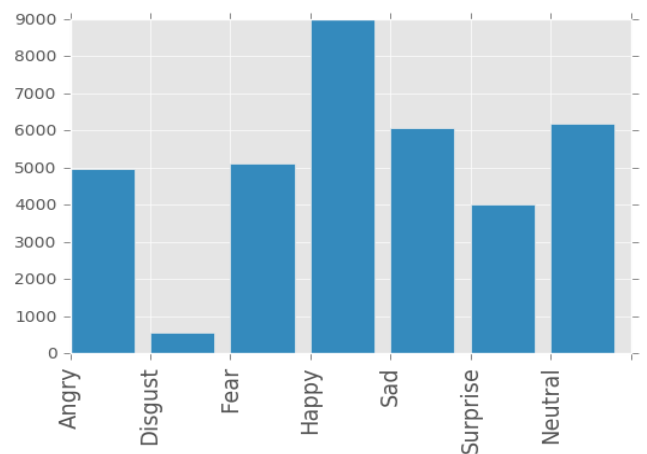


Fig. 5: Emotions Overview

In this dataset, we can get the images in the form of CSV file format. If we can change this CSV format to image format it will be very easy to identify. For best outcomes, the images should be of similar properties for example size.

The dataset is divided into the Training and Classification sets. The training set uses to relate the type of emotions by seeing the set of images from several images and the classification set is used to evaluate the classifier performance.

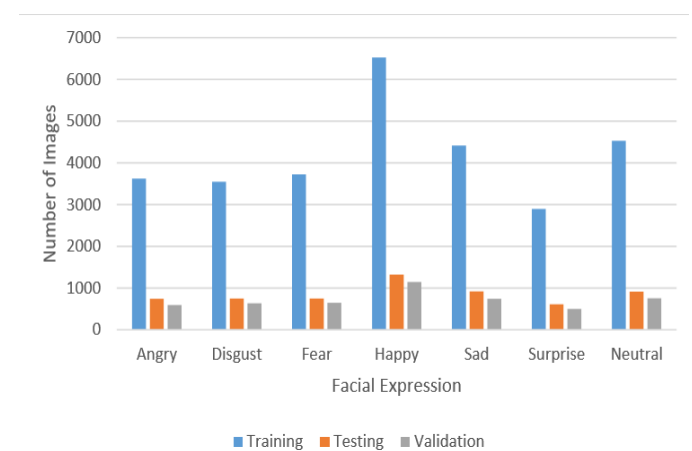


Fig. 6: Training, Testing, and validation data distribution

At last, we aggregate the training set utilizing 80% of the test information and characterize the excess 20% on the classification set. Repeat a similar process to enhance efficiency. By doing this again and again we can the best model through that we can get the best results.

6. ALGORITHM FOR FACE DETECTION AND EMOTION RECOGNITION SYSTEM

1. Given the input to the proposed system as images or live-feed/ previously-stored videos.
2. The system can convert the images to Binary or Grayscale.
3. If it is a video then it can convert the video into frames and it can resize the images/frames in the preprocessing process.
4. In the face recognition step, the Haar Cascade classifier is used to specify the faces with a square box in an image or frame.
5. By considering all the face feature positions or muscular positions on the face, the system can differentiate and compare the faces in the image whether the persons same or not.
6. After viewing all these it can recognize the emotion by observing the model.
7. The trained model can be created by collecting the emotion-related image datasets from FER or other sources.
8. In the dataset, the images are stored in CSV format. So we need to convert the CSV file images in the form of Jpg format.
9. The dataset should be trained to provide a model by using three-layered convolutional neural networks.
10. After this, the trained model can identify the emotion of the faces in an image based on the emotion class.
11. By using this trained model, the emotion can be detected with more accuracy in an image or webcam/pre-existing video.

7. EXPERIMENTAL RESULTS

If we were given input as a video or image to the system then it can follow all the implementing steps to produce an output as a frame with a square box represented on the faces in the face detection step and representing the emotion.



Fig. 7: Input Image

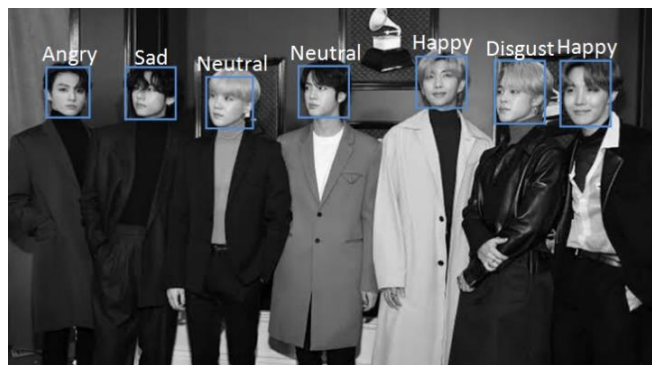


Fig. 8: Output Image

Comparison of Cost function and error function in Training and Validation. This is shown in the below figures.

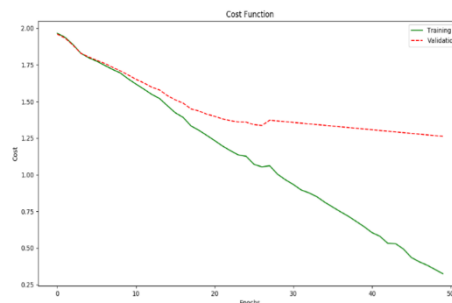


Fig. 9: Cost function in Training and Validation

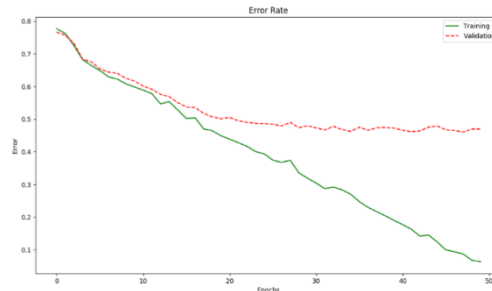


Fig. 10: Error Rate in Training and Validation

8. CONCLUSION AND RELATED WORK

The Face detection and emotion recognition system can identify the faces and recognize the emotions of the persons in an image or video and also on live web feed images or videos in a very efficient way and accurately. This face detection and emotion recognition system can be implemented in different categories like:

- This system can be used for security purposes like authorities can utilize for further investigation efforts to concern someone at some point in an interview or interrogation.
- This system is used by different companies to gauge consumer moods towards their product and brand. This will be used in market research analysis and digital advertising.
- This system can be used in the automobile industry to make things automated.
- This emotion detection system is used in video games also to gain the attention of the gamer.
- “Lack of supervision” is a most challenging problem in an E-learning or distance learning environment. This system can be very useful in this E-learning platform. Emotion recognition can be very helpful in online education at this time where we can only depend online.

9. REFERENCES

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