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Sentiment Analysis using Convolutional Neural Networks

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Abstract: Facial emotions help in effective communication among the individuals as it conveys emotional state or feeling of a person. Facial expression recognition is a wide application of human-computer interaction which is not an easy task as there are a lot of variations and complexity in the face. Machine learning algorithm uses extracted features for modeling the face for emotion recognition since these features depend on prior knowledge and the achieved accuracy has constraints. YOLO (You Only Look Once) algorithm along with a convolutional neural network (CNN) are used for face recognition and classifying the emotional expression of the face into seven basic categories. CNN calculates features by learning by its own. This paper focuses on use of feature points of the face from the CNN model and recognize them into seven basic emotion state.

Keywords — Convolutional Neural Network, Facial emotion recognition, Feature points, Machine learning algorithm, YOLO.

I. INTRODUCTION

Facial expressions, in general, tend to be different among individuals. For example, a smiling face or a person talking or giving any other emotional expression as it appears may have different emotional implications for different persons. In order for facial expression recognition, the algorithm must have good ability in dealing with the variability of facial appearance. The most algorithm, so far, has addressed only a part of these problems. Emotions are an important property of humans and are essential for effective interactions among society. Humans communication can be either verbal or nonverbal. In nonverbal communication, emotion plays an effective role because it conveys humans feeling about the subject, and it is proven that facial expressions are more effective than spoken word in a conversation.[1]

Feature extraction for emotion recognition can be divided into two approaches: Geometric feature-based methods and Appearance-based methods. In the first method, location and shape of parts of the face such as eyes, mouth, eyebrows, and nose are considered, while in the second method, particular regions or whole of the face is considered. Because of differentiating expressions' feature space is a difficult problem, so expression recognition is still a challenging task for computers. Some problems are due to t extracted features from two faces with same expression may be different, while extracted features from one face with two expression may be equal, or some expression such as "fear" and "sad" are very similar.

The main aim of the proposed system is to extract the features of the face from the image, classify that image according to their facial expression into seven basic emotion categories such as Happy, Sad, Angry, Surprise, Fear, Disgust, Neutral and train the CNN. A classifier is used for obtaining the sentiment analysis. This analysis is done by continuously monitoring using a monocular camera and predicting the situation hence disaster can be avoided.

II. LITERATURE SURVEY

Many researchers has contributed in recognizing facial emotions and classifying them into seven basic categories using Convolutional neural networks (CNN) [1]. Facial Action Coding System (FACS) is used for recognizing Action Units (AUs) which are used for classification and final emotional state is determined by a combination of (AUs). Deep CNN is able to learn facial expression characteristics and increase facial emotion recognition accuracy.

Some researchers has used EEG (Electroencephalogram) along with CNN [2]. The EEG signals are pre-treated and appropriate parameters of CNN are chosen. Comparison of 2-category and 3-category ERA is performed. It is observed that the highest accuracy of the 2-category ERA is 98.8% and for 3-category ERA is 68.8%.ERA-CNN gives the highest classification accuracy.

Rule-based algorithm for robust facial expression recognition is combined with robust face detection using a CNN is developed [3]. Rule-based analysis of facial expressions using local features is detected by CNN. This model which is developed for the facial expression recognition system with subject independence combined with robustness with variations in face images in terms of appearance and location is the first developed model.

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CNN model for classification of emotions in real time.CK+, JAFFE and Own (home-brewed) dataset were used which consists of 5 images each. VGG-S network was implemented for image classification [4]. After this newly trained VGG-S was obtained a video stream was connected to the network using a standard webcam. This network classifies an arbitrary number of faces per image simultaneously in real time, whereas appropriate images were superimposed over the face. It was observed that the JAFFEE dataset gave less training accuracy than CK+ and own.

Comparison of different models of CNN's with a different number of layers number of hidden layers and filters is performed [5]. Shallow CNN,6-layer CNN and deeper CNN are compared. On comparison of 6-layer and Shallow network, we can find that adding one more convolutional and max-pooling layer increase the performance. Testing accuracy of deeper CNN is greater and has higher accuracy as it contains dropout layer which prevents overfitting. This model can be modified by adding weights to important parts of the face which can help to recognize facial emotion.

Some researchers has analyzed different methods of learning rate set and different optimization algorithm of solving optimal parameters of influence on image classification. [6] With an increasing number of iterations, the recognition rate of each algorithm has improved and multistep is best in those algorithms. It can be seen that SGD can reduce error with an increase in a number of iterations and SGD with momentum is better than NAG from the results obtained from different solving strategies in testing data. The shallow network seems to have a good recognition effect.

III. PROPOSED SYSTEM

There are many approaches on facial emotion recognition based on some features such as Histograms of Oriented Gradients (HOG) features, Scale Invariant Feature Transform (SIFT) descriptors, Gabor filter or Local Binary Patterns (LBP) which gives a high degree of accuracy. The proposed system uses deep CNN for recognizing the seven states of facial emotions. A convolutional neural network is used as it is more precise and accurate. In this approach, emotion expression recognition has been presented which include following steps: Pre-processing, Human detection, Face detection, Face extraction and Facial expression detection using CNN classifier.

Home-Brewed (own) dataset is used which comprise of a number of video frames containing numerous facial expressions out of which frames are extracted is given as input to the system.

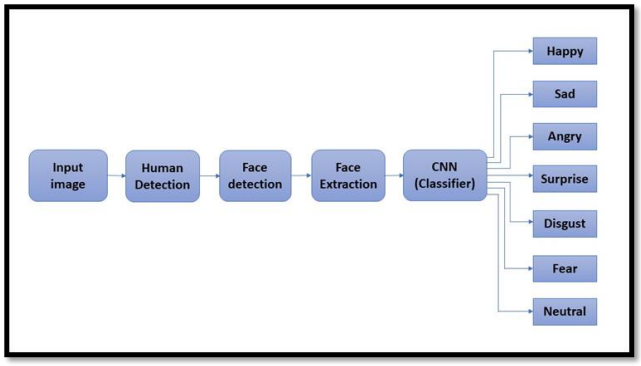

Fig.1 Block diagram

1. Human Detection- There is some representative sample of techniques for finding people using visual input. These are classified with respect to need for pre-processing (background subtraction or direct detection) features used to describe human appearance (shape, color, motion) use of explicit body models and learning technique. YOLO is a new approach to object detection. This algorithm processes images in real time in 45 frames per seconds. YOLO makes more localization errors but is less likely to predict false-positives on background compared with the state-of-art detection system. A single convolutional network predicts multiple bounding boxes and classes probabilities for those boxes. YOLO trains on full images and optimizes detection performance.

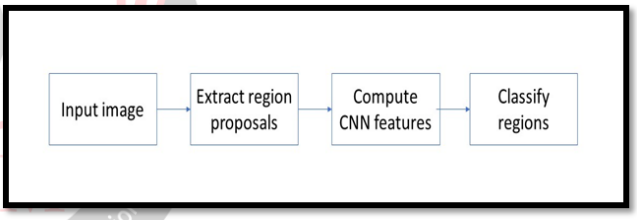

Fig.2 YOLO Detection system

Processing of images using YOLO is simple and straightforward. This step involves

(a) Resizes the input image to 448 x 448.

(b) Single convolutional network on the image.

(c) Thresholds the resulting detections by the model's confidence.

(d) Classify the image into particular objects.

2. Face Detection- Face detection is a technology that is used in a variety of applications which identifies human faces in digital images. It is regarded as a specific class of object detection. Algorithm of face detection depends on the detection of the frontal faces. The image of a person is matched bit by bit which is very similar to image detection. The images which are stored in the database are matched.

Following are the face detection algorithms:

• Model-based face tracking-There seems to be a revival of edge-based methods using geometric models in this

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algorithm.

• Weak classifier cascades-This is the most commonly used algorithm for face detection. Haar features are used in this cascade which yields impressive results after excessive training.

• HOGs and Deep Learning (multi-layered neural network) are used for face recognition than for face detecting while HOGs are complete state of art for the face recognition process.

Fig.3 Faces detected by Anchor boxes

3. Face extraction- For face extraction coffee model is loaded from the disk. Video is imported and the frame is extracted (along with its features h &w) out of it. Particular parameters are set for an input frame such that the size of the image is resized to 300 x 300, its scale factor is set to 0.1, and also its mean is calculated. After computing inputs to the network, we compute forward pass. we store the results as detections. treshold value is set to 0.7 and if the confidence matrix value meets the threshold then that particular frame which meets all the features set are extracted and stored at the particular locations. The faces are detected using the bounding boxes. The frames extracted contains mixed emotional images. we need to sort those images according to every emotion.

4. CNN- Seven states of facial expressions are recognized by the deep convolutional network which includes three steps of feature learning, selection, classification. Model having more than two layers were difficult to train, as this model contains many layers it is trained using GPU.

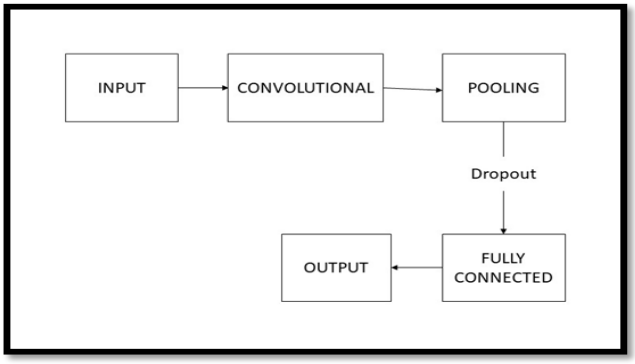

Fig 4. CNN Model

CNN includes six components: an Input layer, Convolutional layer Pooling layer, Dropout layer, Fully connected layer. The convolutional layer is the core function of CNN. This layer is used for feature extraction and it uses one or more than twodimensional vector and linear filters are used to extract the features. After convolutional layer, the pooling function is used to extract the features and the commonly used pooling functions are the max pooling and the average pooling function.

Ak = max(hk) -(1)

Ak = mean(hk) -(2)

Dropout layer is introduced to prevent overfitting. The output obtained by the pooling layer is the input feature to the fully connected layer. This layer uses high-level features extracted during the convolutional and pooling layers and classifies the input image. The output layer represents the class of the input image which its size equal to a number of classes.[2]

IV. IMPLEMENTATION

Database preparation-

Images are extracted and cropped into a particular size and are stored into a particular location. This image contains images of all emotion categories these are sorted into those particular emotional state and out of which 80% of data is used for training those images and 20% of data is used for testing.

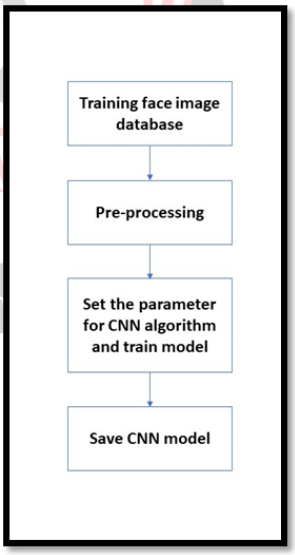

Fig.5 Training data

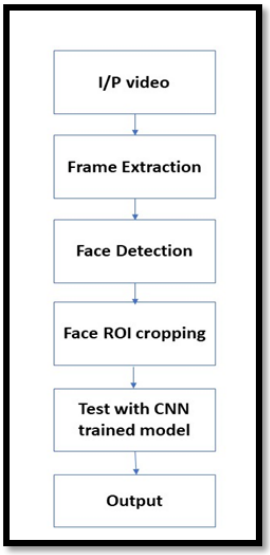

Fig.6 Testing data

The proposed system is implemented using the open-source computer vision (OpenCV) library on the Raspberry Pi platform. OpenCV library has an open source BSD license. Originally, OpenCV is written in C language but now available in C++ interface and python. OpenCV runs on most of the Operating system including Linux, Raspbian, Windows, etc.

Python is the high-level programming language which is the most demanding language in the industry for the year

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2019. It is an interpreted language. It supports various programming scripts and syntax which allow programming in most of the language like C++ or Java.

Raspberry Pi is a credit card size, Debian based operating system. Raspbian is the low-performance ARM, CPU of the raspberry pi.

V. RESULTS

The proposed system was trained on own dataset for facial expression studies. The dataset contains 50 video frames having varied emotional content among which 30K frames were extracted and trained. The dataset contains images for the expressions: Happy, Angry, Sad, Surprised, Neutral, Disgust, Fear. In this work, some preprocessing techniques were applied to the images for extracting exact expressed emotions on the face for increased accuracy.

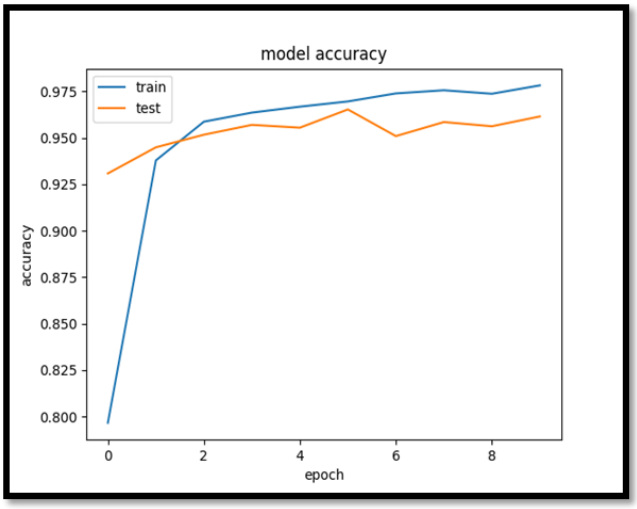

Fig.7 Model Accuracy

In order to train the CNN model, VGG net is used. The accuracy obtained from the model is 97 % for training and 96 % for testing and the loss observed is less than 0.1% for training and less than0.2 % for testing which is very less. It is observed that there is a correlation between the disgust and angry label and the network performs very well in estimating happy sad and angry labels.

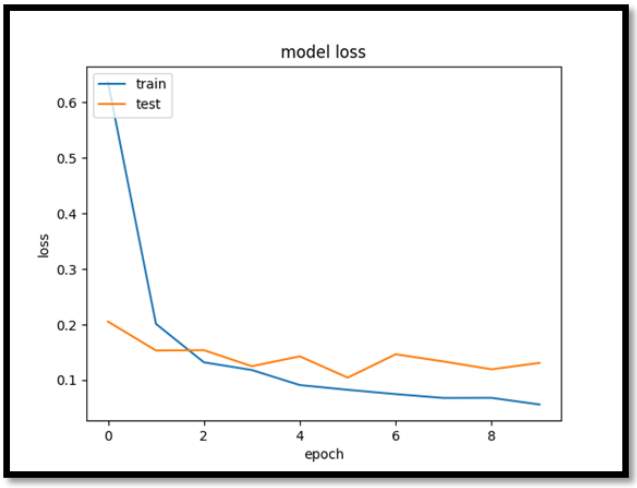

Fig 8. Model Loss

VI. CONCLUSION

This paper presents an emotion recognition system with an approach of detecting the feature points of the face and classifying into seven basic emotional categories. Convolutional Neural Network trains the data and is able to detect facial emotions and classify them into emotional states. CNN is developed for optimal feature extraction and classification and it is used as this model is more precise and gives the highest accuracy. The experimental results prove that CNN is able to learn automatically the characteristics of facial expression and increase facial emotion accuracy.

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