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Detection and Recognition of Human Emotion using Neural Network

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Abstract: Detecting and recognizing human emotion is a big challenge in computer vision and artificial intelligence. Emotions are a big part of human communication. Most of the communication takes place through emotion. The main aim of our project is to develop a robust system which can detect as well as recognize human emotion from live feed. There are some emotions which are universal to all human beings like angry, sad, happy, surprise, fear, disgust and neutral. The methodology of this system is based on two stages- facial detection is done by extraction of Haar Cascade features of a face using Viola Jones algorithm and then the emotion is verified and recognized using Deep Neural network. This has appliactions in fields of security, surveillance, robotics etc.

Keywords: facial detection, Haar Cascade features, Viola Jones, Neural Network.

INTRODUCTION

Human emotion and face expression is one of the most powerful tool of communication. Facial expression are very expressive. It is found that the linguistic component of a message contributes to only a meagre 7% of the total significance of the effect of the message, whereas the tone indicates about 38% of the total signal and the remaining in turn signified or portrayed 55%. of the total message. Feature Extraction of the facial features is a very widely sought after implementation in the fields of surveillance(video or images), biometrics as well as HCI(human computer interface. Here facial image is used as a medium to read human emotion. The research on human's emotion can be traced back to the Darwin's pioneer working and since then has attracted a lot of researchers to this area. There are seven basic emotions that are universal to human beings. Namely, neutral, angry, disgust, fear, happy, sad, and surprise and these basic emotions can be recognized from human's facial expression. Solving the problem of revognising facial features is not a very simple job since each individuals face varies from person to person. There are a lot of factors influencing the features like physical characteristics as well and sex, genes and age. Therefore because of intense variability the challenge is not easy. There are many factors that have to be taken while developing a emotion recognition system. The main stage in any face processing system is to detect the face accurately and classify them. The facial expression recognition system should work in all diverse environment like change in surrounding light and different illumination problems, use of spectacles, presence of facial hair etc. These are some problems that the system should be able to overcome to create an ideal system.

A generala biometric process has four stages of process flows: face detection, preprocessing, Feature Extraction, and Face Recognition.

Face Detection

This is the first step in face processing. The main purpose of this step is to detect face from the images from dataset. In this step individual images are taken from the dataset, scanned and then verified wether the image contains a face or just background image. The face determination system determins if the input data(image) is a face. After this step the result is sent for pre-processing so that facial features can be extracted from the face image.

Pre-Processing

Since any unprocessed or raw image data is easily corrupted by noise and hardware issues. This step is done to find smooth face images by removing unwanted noise, blur images and shadowing effects. There are many techniques available for image pre processing. Many of them are based on pixel transformation like pixel brightness transformation, geometric transformation, image restoration etc. Without pre-processing good quality images cannot be obtained to achieve a high accuracy detection system. The resultant images are used to extract facial expressions.

Feature Extraction and Face Recognition

This step is critical step as it extracts the features using the applied feature extraction algorithm. The steps performs compression of information, reduction irrelevant features as well as removing the noise of the data. After this the facial region is converted into a vector with a given dimension in which the facial features correspond to their locations. After the prior step is done, analysis of the features is done and then the recognition part is used to learn each person's face and then store it in the database. After the model is trained, then the model is tested against a given input image. All the previous steps like preprocessing and others are performed again. If it works perfectly the model is able to correctly able to determine the person's identity without the consent of the individual himself. While the evaluation of the model is must be able to determine if the assumption is correct or not.

Classification

This is the last step in any image processing system. There are numerous methods and techniques to classify images. Neural network is a very powerful technique for classification. It works for both linear and non linear dataset. It works even for images not in the dataset as it is a self learning model which consists of many hidden layers. In the recent years, many models of artificial neural networks has been used. There are many approaches within ANN like deep convolutional neural network, radial basis function neural network, back propagation feed forward neural network, bilinear neural network etc. There are many other classification techniques like clustering, decision tree, support vector machines etc.

RELATED WORK

Emotion detection and recognition has shown a notable advancement in the field of computer vision and artificial intelligence. The paper proposes Viola Jones algorithm to extract Haar like features for detecting a face and to verify and categorize human emotion using neural network. The paper proposes a system that detects human emotion by extracting facial features. A wide variety of methodologies have been used in this field to detect human emotions.

One of the breakthrough publication on Face detection was given by Ihor Paily. This work shows detection of face by extracting Haar like features and then categorizing them using neural network [2].

In another work the scholars have taken an interesting approach to the problem of mapping facial expressions because of the challenges posed by the 2-dimensionlaity of an image and therefore trying to do a digital image analysis using the region of interest. Here the scholars have used the features of the lips and analyze them according to the expression that they make [4].

Another work done on facial expression recognition explores statistical unsupervised technique called ICA (independent component analysis) along with the feature optimizing techniques called genetic algorithm uses a concept of evolutionary systems in biology to implement a system to recognize and predict facial emotions [3].

It is also proved by Kharat and Dudul that about 55% effect of overall emotion expression is facial expression which is contributed during social interactions [5].

PROPOSED SYSTEM

The problem statements we have are having robust and automated face detection, analysis of the captured image and its meaningful analysis by facial expressions, creating data sets for test and training and then the designing and the implementation of perfectly fitted classifiers to learn underlying classifiers to learn the vectors of the facial descriptors. We propose a model desing which is capable of recognising upto six models which are considered universal among all walks of cultures. Mainly being fear, happiness, sadness, surprise,disgust and lastly surprise. Our system would be to understand a face and its charactieristics and then make a weighted assumption of the identity of the person.

This algorithm is mainly helped from the most widely used algorithms at this task, known as the Viola-Jones algorithm.

METHODOLOGY

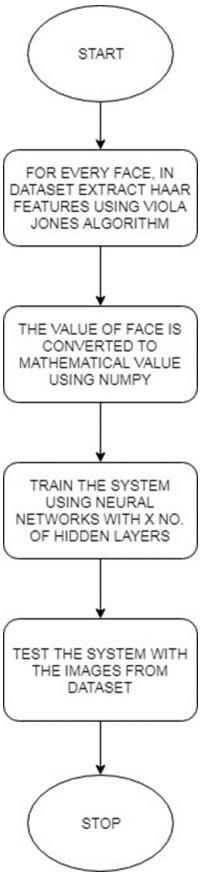

FIGURE 1. Initial Workflow of Training the Model

Viola Jones Algorithm to implement Recognition of Individual identity

The first phase of this system is to detect the face and to extract the Haar cascade features of the face using Viola Jones algorithm. This is one of the first step in every face processing system. This is more robust, as compared to simple colour thresholds and template matching. There are 3 haar like features that a computer is instructed to look for. Basically the computers are instructed to look for dark feature regions. For example in any face the eyebrows are above the eyes. The computers are instructed to look for two rectangle dark feature regions using fast pixel area calculation. A basic rectangular Haar-like feature can be explained in terms of the absolute asymmetry of the aggreagate of locactions at points in the interior of the window, that are assumed to be area and ratio inside the given image.

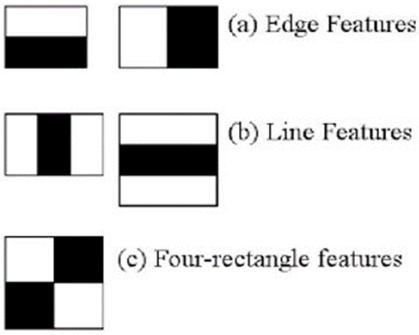

FIGURE 2. Different classes of Haar classifiers

These features were used by Viola and Jones in their framework. The insight behind the algorithm is to combine classifiers into cascades thus reducing the need for exteran support from background images. The feature extraction is based on haar features. Viola Jones algorithm uses a feature which is a two- quadrilateral (mostly it assumes the shape of the rectangle) and the difference in the aggregate of the points in the interior of the two rectangular shapes; a triplet of rectangles for locating descriptors and the sum within two exterior shapes deducted from the aggregate in the pivotal four sided shape. Also, lastly the quad of rectangles' difference at the diagonal couple of rectangualar shape of object descriptors. Every face has basic congruent properties. These congruencies may be checked or verified against Haar Features.

A few descriptors colloquial to a human face are:

- The eyes vicinity is differently illuminated more often darker than the upper-cheeks.
- The nose bridge section is more beaming than the eyes.

Group of features creating an collective match of face descriptors:

- Region and scale: eyes, mouth, section of nasal region
- Inensities: gradient descent of corresponding location values

Neural Network to classify emotion

The concept of neural networks is biologically inspired paradigm which allows a computer to learn from the given data. It is an adaptive learning method. An Artifical Neural

network model is built on a group of symbiotic units or nodes called artificial neurons. Each connection between the neurons have the capability to transmit a signal to each other. The node that receives the signal processes it and then signals its own signal to interconnnected nodes and the cycle continues.The units which are also known as single perceptrons are joined to the other units of the layer and the strength of the network is valuated or signified by the values ranging from -1 to 1 from each joined or connected unit to another. The negative links are called as inhibitionary excitations and the positive links are called as activity excitations. More the value to the extreme ranges stronger the network between each unit to its connections. A transher function is also an inherent part of the neural unit. In terms of neural units there are several types of units that can classified and they are input units, hidden units and the output units. The first of the three is responsible for taking in the given data for further processing. The intermediate layers between the input and the output that is the hidden layer/unit is resposible for the complex processing and the last output unit is responsible for the outputs targets. While the information is passed in the neural model the weights of the units are changed and modified in accordance to the input and the the activation value generated from the activation function is then passed onto the next layer or units. The desired outcome of this approach was to solve complex problems similar to a human brain. With some experiments over time, scholars shifted towards matching explicit mental abilities, paving the way for deviations from the biological networks. Neural Networks are starting to be used on a group of learning based tasks and types of tasks which require inference to be made.

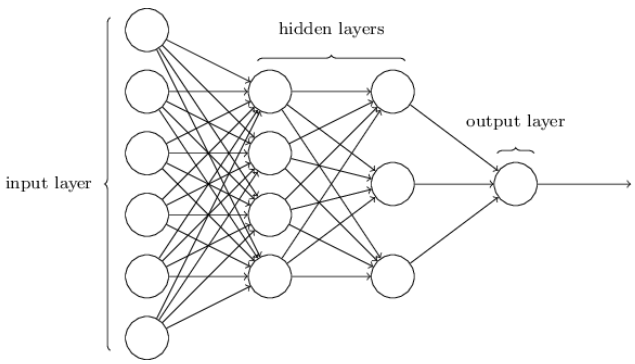

FIGURE 3. Convolutional Neural Structure

Deep learning is a type of modern machine learning that is generally used and more suitable to solve higher level predictions which are more complex to solve and predict. It differs in the number of hidden layers that is able to process and understand more and more as the number of hidden layers increase. But in simple terms it is defined by a neural network that has more than one hidden layer.

DATASET

Neural networks and deep networks in particular, are known for their need for large amounts of training data. Moreover, the choice of images used for training are responsible for a big part of the performance of the eventual model. This enables or requires a highly qualitative and a bigger volume of dataset. Emotion recognition has several standardised and well reputed datasets available online which range from a few hundred photos to tens of thousands of images whille also ranging immensely in resolution. The datasets differ mainly on quantity, quality, and 'cleanliness' of the images. For this system we use the FER 2013 dataset which has more than thousands of faces with all types of emotions. For this system training will be done using 9000 samples from the FER-2013 data with another 1000 new samples for validation.

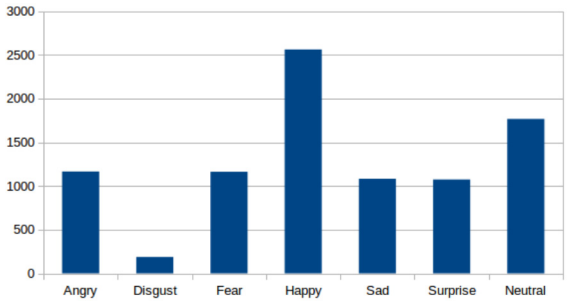

FIGURE 4. No. of images per emotion in training set

IMPLEMENTATION

Using tflearn as the frontend and the tensorflow as the backend, we creating a neural network model that is used to train the facial emotion which are in the FER-2013 dataset and then validate, evaluate and then test the model. The model which is being used is a Convolutional Neural Network which sufficient dropout layers as well as pooling to prevent overfitting of the model as well as increase efficiency.

FIGURE 5. Implementation Test(Neutral)

FIGURE 6. Implementation Test(Happy)

Accuracy of Detection Model	
Emotion	Accuracy(Percent)
Happy	67
Neutral	72
Sad	71

Table 1. Table of Emotions versus Observed Accuracy

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