Journal of Information & Optimization Sciences
ISSN 0252-2667 (Print), ISSN 2169-0103 (Online)
Vol. 44 (2023), No. 6, pp. 1115–1126
DOI : 10.47974/JIOS-1446

Facial emotion recognition using neural networks

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Abstract

Data mining, conjointly known as information acquisition or information acquisition, is usually as the method of analyzing information from completely different views and summarizing it into helpful information. Image processing is said to read a high-quality image where a machine aims to determine the physical content of a picture or image sequence. Emotional recognition has become an efficient analysis approach in image processing and applications supporting human interaction with computers. This study conducts experimental analysis on the detection of facial emotions. The flow of our emotional awareness system includes the essential method within the FER system. This includes image capture, pre-image process, face detection, feature removal, etc. Our methodology focuses on

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live pictures in love with a digital camera. The aim of this study is to develop an automatic system for recognizing facial expressions in depressed individuals and therefore providing them with music medical care to alleviate stress. Thoughtful feelings of testing embrace joy, sadness, surprise, fear, disgust, and anger that is universally accepted is also explored.

Subject Classification: *62M45, 76E17.*

Keywords: *Facial detection, Haar Cascade features, Viola Jones, Neural network.*

Introduction

Everywhere non-verbal communication is a vital aspect of human communication (Vamshi et. al., 2016; Ihor, 2008; Anchal et. al., 2015). Our body language can depict our emotions and intentions without the need of us having to say a word. Our facial expressions are an important part of non-verbal communication. So, it is fair that we make good use of these expressions and process any data that we can get from them and make good use of it.

Facial emotion recognition has been a topic under research for a long time (Namrata et. al., 2014; Govind et. al., 2008; Debishree et. al., 2016). Ever since the research began on having machines recognize faces and facial expression, developers and researchers have developed various ways of achieving emotion recognition. Having machines recognize faces will have quite a number of functionalities that would help in improving the quality of life for the general population. Some of them are: a) Helping read the emotions of perpetrators in criminal investigations. b) Helping reduce crime by installing software in bank and airport security systems, where we predict that our project will help in reducing the number of bank robberies, airplane hijacks by tracking the emotions of criminals. c) Helping in improving the overall quality of education in educational institutes by analyzing the interest of students in the classroom. d) Helping in improving the overall quality of education in educational institutes by analyzing the interest of students in the classroom. e) Helping prevent accidents by processing the alertness of pilots & drivers.

Now that we have established the uses of this project, let's take a look at how many emotions are we working with. We have 7 different emotions in this project, which are as follows: Happy, Sad, Fear, Anger, Surprise, Disgust and Neutral. These are differentiated on the basis of the specific movement of the respective facial muscles when we feel the said emotion, For example, relaxed eyebrows, open and upturned mouth indicate that a person is happy (Nitzan et. al., 2013; Amit et. al., 2018). Similarly, there are

movements for other emotions as well that will be discussed later on. However, one thing is pretty clear here, that we need an input device, such as a camera to take the input and then process that input so that we can look at the real time changes and facial muscle movements in the test subject's face. A number of challenges are faced when it comes to recognize the face like changes in lighting, pose of the subject, background etc. Moreover, after detecting the face the challenge of processing the data to detect the emotions of the face still remains. This processing of the input to get the output is done using neural networks in our proposed research.

Neural Networks

Neural Network is a paradigm used to simulate the functions of neurons. It is made up of artificially created neurons which are called nodes. A network (Khan et. al., 2022; Kumar et. al., 2021) of these nodes comprises of multiple nodes which copy the behavior of biological neurons and then pass the output to the other nodes. The motive of ANN is to train data so that the accuracy of the predictions can be improved over time. Neural networks are the core of Deep leaning and AI and they are used in a variety of other AI applications like deciphering scenes in a video, speech recognition, face identification, finger print recognition, iris recognition, etc (Andreea et. al.2015; Ethem et. al., 2010).

A general biometric process consist of following stages of process flows: identifying faces, preprocessing, extraction of features, and detection of face (Thyagarajan et. al., 2022) (Virmani et. al., 2020) (Dubey et. al., 2020).

Detection of Face

This is the primary step within the processing faces. The primary objective of this stage is to identify faces in photographs from the dataset. A selection of photos is made from the dataset, scanned, then shown to point out if the image features a face or is simply a background image. If the input file (picture) may be a face, the face dedication device determines it. Following this stage, the result is transmitted for pre-processing so as to extract facial functions from the face image (Jain et. al., 2019) (Gaeta et. al., 2006).

Pre-Processing

Any unprocessed photo is prone to corruption from hardware and background noise problems. In this phase, task is to seek out slender face photos along with undesirable blur and noise pix and shadowing results. For image pre-processing, a variety of methods are available. Tons among them supported pixel transformation like transformation of the geometric shape and pixel brightness, photograph regeneration and so on. Lacking preprocessing precise pleasant pictures can't get in order to realize a detection with great accuracy gadget. The outcome from these photographs won't be able to capture face expressions**.**

Face Recognition and Feature Extraction

This phase is crucial since it uses the applicable feature extraction method to extract the features. The procedures involved are record compression, discount inappropriate features additionally doing away with the noise of the knowledge. The facial position is then turned into a vector with a specific dimension, with the countenance corresponding to those spots. A step after the first is administered, it is possible to analyse the features after which the recognition component is used to look up at each person's face and store it in the database. The model is tested against a specific input photo once it has been trained. All previous procedures, including pre-processing and other stages, are repeated. If everything goes according to methodology, the version will be prepared to decide a character's identity without the character's input. While evaluating, the model is required to ascertain whether the idea is true or false.

Category

Any machine that processes photos comes to a stop here. There are numerous methods and methods for categorizing pictures. The neural community technique to classification may be quite effective. Every linear and non-linear dataset can be used with it. It is a self-learning model with many hidden layers, so it works even for images outside the dataset. Many different types of synthetic neural networks have been used in recent years. There are several techniques used in ANN, including deep convolutional neural networks, radial foundation neural networks, feed forward neural networks that propagate again, bilinear neural networks, and so on. There are numerous different categorization methods, including clustering, decision trees, support vector machines, and more.

Related Work

Emotion detection and reputation has shown a extremely good development within the domain of imaginative and prescient artificial intelligence. The paper proposes Viola Jones set of rules (Ethem et. al., 2010) to extract Haar like functions for detecting a face and to verify and categorize human emotions. The paper proposes a system that detects human emotion by extracting facial capabilities, enormous sort of methodologies were utilized in this field to find human emotions. This work highlights the extraction of Haar-like features and neural network-based classification of those features (Ahmad et. al., 2020) to detect faces. Due to the difficulties presented by an image's 2- dimensionality, the researchers have employed an exciting technique in their prior work to attempt to map face expressions. They have attempted a virtual photograph analysis employing the situation of interest. Here, the researchers have made use of the lips' natural functions and analysed how they interact with the expressions they produce (Ahmad et. al., 2019). Other research on countenance popularity investigates the statistical unsupervised method known as ICA (independent thing analysis) alongside feature-optimizing techniques known as genetic algorithms, which employs the idea of biological evolutionary systems to put into practice a tool to recognize and anticipate facial emotions (Ahmad et. al., 2022). It is also demonstrated with the aid of Kharat and Dudul that the countenance contributes to the duration of social contacts to the tune of roughly 55 percent of the effect of normal emotion expression (Ethem et. al., 2010).

Proposed Methodology

Our challenges include having a reliable and programmed face location, evaluating the captured image and its important investigation by looks, creating records units for research and instruction, and then planning and executing fully prepared classifiers to investigate underlying classifiers to focus on the vectors of the facial descriptors. We propose a model design that can identify up to six models that could be considered common across all social strata. Stress, contentment, misery, wonder, disgust, and finally wonder, in that order. Our framework aims to first notice a face and its features before forming a weighted suspicion about the person's personality. Initial Training Process for the Model is given in Figure 1.

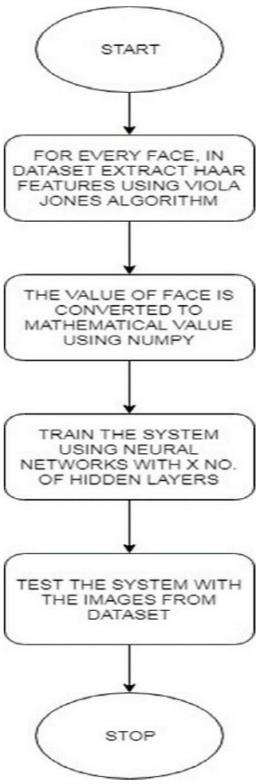

Figure 1

Initial Training Process for the Model

Viola Jones Algorithm to Implement Individual Identity Recognition

Using the Viola-Jones calculation, the first step in this framework is to identify faces and focus on flowing parts of Haar faces. This is quite possibly the advancement in any facial treatment framework. This is more dependable than straightforward variety thresholding and design coordinating. There are three capacities a PC should search for. Essentially, the PC is asked to search for the dull areas of usefulness. For instance, on all faces, the eyebrows are over the eyes. The PC is asked to utilize quick pixel region computations to track down the two region of the rectangular dull component. Haar's essential rectangular component can be portrayed to flat out unevenness of a bunch of positions in a window that is taken as a region and an extent inside a given picture.

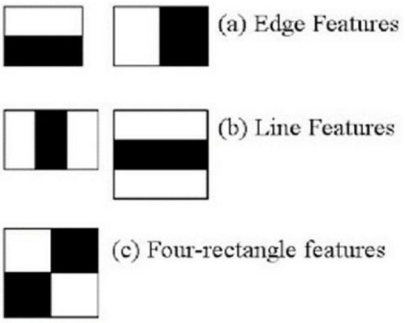

Figure 2

Different classes of Haar classifiers

Different classes of Haar classifiers is given in Figure 2. This capacity was utilized by Viola and Jones in their system. The possibility of the calculation is to diminish the requirement for outside help for foundation pictures by flowing classifiers. Include extraction depends on Haar highlights. The Viola-Jones calculation utilizes a capacity that addresses the distinction between two quadrilaterals (for the most part rectangular) and the arrangement of focus inside the two square shapes. Take away the internal amount of the two external shapes from the amount of the three rectangular and essential four-sided shapes to oblige the descriptor. Lastly, four contrasts among rectangular and corner to corner sets of rectangular article descriptors. Every feature has default compatible properties. These matches can be tried or confirmed against Haar's properties.

A few informal portrayals of the human face are:

1. The border of the eye is enlightened distinctively and is frequently more obscure than the upper piece of the cheek.
2. The scaffold of the nose sparkles more than the eyes.
3. Utilitarian gatherings that produce aggregate facial descriptor matches:
4. Region and scale: eye, mouth, and nose locales Force: slant plunge of relating position values.

Neural Network to classify emotion

A PC can benefit from the provided information thanks to the idea of neural networks, which is an organically invigorated viewpoint. It is a flexible learning method. A collection of cooperative nodes or hubs known

as "fake neurons" serves as the foundation for an artificial brain network model. Each connection between neurons has the ability to send and receive signals. The cycle continues as the hub that receives the sign cycles it and then flags its own sign to other hubs that are connected. The units, which are also known as single perceptron's, are connected to other units of the layer, and the strength of the organization is assessed or denoted by the characteristics that flow from one connected or related unit to another. Concealment excitation refers to negative associations, whilst positive associations are referred to as action excitation. The bigger the worth of the outrageous reach, the more grounded the organization between each square and its associations. Move capacities are additionally a necessary piece of the brain unit. There are a few kinds of units that can be characterized with regards to brain units: input units, dormant units, and result units. The responsibility for gathering the provided information for further management falls on the first of the three. The end result unit is accountable for the result targets, but the secret layer/unit in between the information and the result is in charge of the complicated treatment. The loads of the units are adjusted and altered when the input is transmitted through the neural network, and the enactment esteem produced by the initiation work is then sent to the layer or units below. The ideal outcome of this methodology is to approach complicated problems like a human thinking. For certain investigations over the long haul, researchers moved towards matching unequivocal mental capacities, making ready for deviations from the natural organizations. Brain organizations are beginning to be utilized on a gathering of learning based errands and sorts of undertakings which expect deduction to be made.

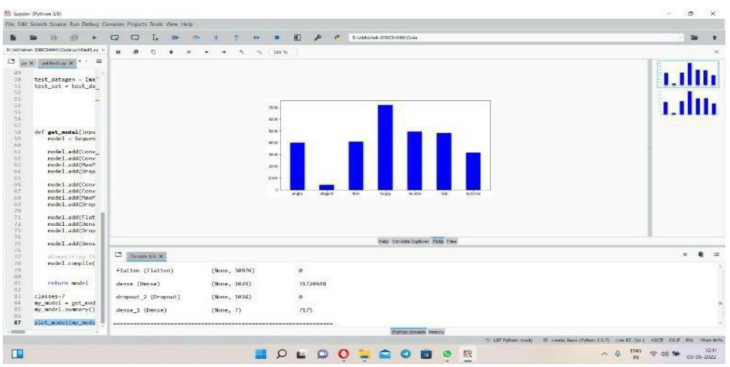

Figure 3

Neural Structure with Convolutions

Neural Structure with Convolutions is given in Figure 3. Deep learning advanced AI is frequently used and is better suited to deal with projections at a more substantial level that are more difficult to handle and anticipate. Deep Learning is more qualified to addressing more significant level forecasts that are harder to tackle and foresee. As the quantity of secret layers expands, increasingly more are recognized by the quantity of secret layers that can be handled and perceived. In any case, basically, this is a brain network with at least one secret layers.

Dataset

Neural networks, particularly profound organizations, are known to require a lot of preparing information. Additionally, the selection of pictures utilized for preparing significantly accurate pixels decides the exhibition of the last model. This permit requires better caliber, bigger informational collections. Feeling acknowledged has a few normalized and deep rooted datasets accessible from web, going in goal from many photographs to a huge number of pictures. Informational collections vary mostly in the count, the images' "virtue" and quality. We use the FER 2013 dataset, which has more than 1,000 appearances with a variety of emotions, for this framework. The framework is prepared utilizing 28,709 examples of FER2013 information and 3,589 new examples for approval. Images per emotion in the training set is given in Figure 4.

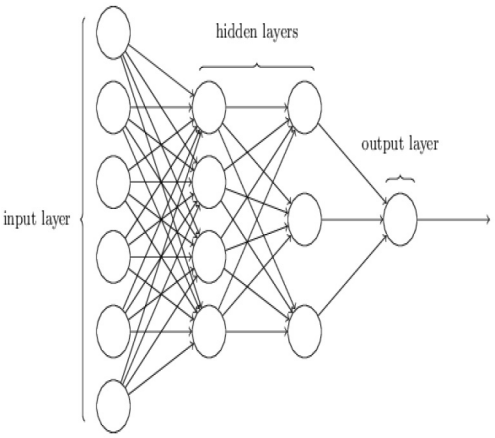

Figure 4

Images per emotion in the training set

Experimental Analysis

A neural network model is used to prepare facial feelings on the FER2013 dataset utilizing tf as the front end and tensor flow as the backend, then, at the final point, approve, assess, and examine the model. The adopted model is a Convolutional brain network with sufficient dropout layers and pooling to prevent model overfitting and advance competence. Emotions vs Observed accuracy is given in Table 1.

Table 1

Emotions vs Observed accuracy

Emotions	Accuracy
Sad	75
Neutral	69
Happy	80

Conclusion

To recognize facial expressions, we put forth a Convolutional Neural Network design. we attempted to identify 7 categories of face expression. The mean square error decreases as the quantity of training data grows while utilizing the FER(2013) database to train using different training data sizes. We may infer from the experiment that as the training data increases, the mean square error decreases. Additionally, the system's performance reaches a rate of accuracy of 66%. We will focus on CNN architect's design for the next effort in order to achieve a better outcome.

Conflicts of Interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors..

Funding

This research did not receive any specific grant from agencies in the public, commercial or not for profit sectors.

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