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Emotion Recognition Using Face Detection

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***Abstract*- Human-machine interaction is one of the most important aspects of computing. Automatic emotion recognition has been an active topic for research since the last decade. Analyzing unique patterns of human emotions will help machines to understand humans better. Face detection and emotion recognition can be used in several application areas. It can be used in real-time monitoring, security and in gaming applications. In recent years, deep learning has provided a whole fresh approach to understanding and process real-time data. It provides effective methods and algorithms to process images, audio, video, and metadata. In this paper, we propose a system that aims to classify human emotions in different categories such as happy, sad, neutral, disgust, ange and fear. It bases our paper upon the idea of using different techniques of machine learning such as neural networks, haar cascade, principal component analysis (PCA), and facial features extraction to classify human emotions.**

***Keywords*- Machine Learning, Neural Networks, Haar Cascade, Open-CV, Deep Learning, SVM**

I.INTRODUCTION

We can classify facial expressions of humans into seven basic emotions–happy, sad, fear, surprise, anger, disgust, and neutral. The key question is whether modern computers can do a better job than humans in analyzing human emotional states? The answer to this question is - Deep Learning. This paper proposes a system design using a neural network to give the machine an interface and the ability to process, extract and analyze human emotions.

The operational flow of the system will be:
- Identify faces.
- Extracting facial features.
- Analyzing the gesture of facial features and changes in the appearance of facial expressions.
- Classifying emotion categories.
- Provide emotion analysis.

The main aim is to increase the accuracy of the system so that it can be integrated with any other systems and simplify human-machine interaction. Modern technology is evolving at such a fast pace so we can use it in a better way to create an application such as emotion recognition. The primary motivation behind this system is to simplify and improve human-machine interaction.

II. LITERATURE REVIEW

[1] Human face detection has been playing an important part in human-machine interaction and computer vision-based applications. This paper has proposed a human face detection algorithm by using the haar cascade algorithm along with a combination of three weak classifiers which are skin hue histogram matching, mouth detection and eyes detection.

The key idea behind this paper is to follow the given steps:
- First, analyze the images of people by using a primitive haar cascade algorithm.
- Then, get rid of the negative results by using a weak classifier such as skin hue matching.
- Next, another weak classifier such as eyes detection is applied and some non-human faces are removed from the dataset.
- Finally, a mouth detection classifier is appended to decrease the ratio of false-positive results.

The final dataset comprises only the positive image set in which the human face has been detected. It helps in training the model more efficiently to generate results with higher accuracy. With the help of OpenCV, different images of people are tested under various occlusions and illuminations. These images are also tested on different degrees of rotations. In both training and testing sets, it has been seen that the algorithm is more effective and capable of achieving higher accuracy and state of performance.

The algorithm proposed in this paper is easy to implement. The algorithm was tested using OpenCV 3.3.0 and Intel i7 processor with 8 GB RAM. It took several minutes to detect 344 faces from 30 images under different light conditions and angles.In a training dataset, the faces detected by primitive haar cascade algorithm were 440 with 78.18% PPV (Positive Prediction Value). The algorithm proposed in this paper successfully detected 351 faces with 98.01% PPV (Positive Prediction Value). Nearly 20% increment in accuracy was observed using this algorithm.

In conclusion, the devised algorithm is more promising and as per research, it could be improved to increase the success rate while keeping nearly zero wrong rejection.

[2]In this paper, the authors have described how the recognition of human faces plays a vital role in many applications, e.g. in video surveillance and the management of facial image databases. They have tried to design and implement a security system based on various machine learning techniques and algorithms.

Principal Component Analysis (PCA) is the algorithm that represents the faces in vectorized form. It outputs the most dominant feature vectors from the present set of the faces, which can be used in the comparison of video frames.

Faces can be recognized in frames using the haar cascade to extract the characteristics of a human face. The Support Vector Machine (SVM) algorithm is used to classify between data sets using the kernel, i.e. for classification.

The performance of the system depends on the extraction of the attributes using PCA and Haar-cascade and their classification using SVM to get accurate results. These algorithms give different accuracy rates under different conditions. The model accuracy achieved is based on a different number of faces and Eigenfaces. For less number of Eigenfaces higher accuracy is achieved, while for more number of Eigenfaces lesser accuracy is achieved.

Number of Eigenfaces	Accuracy
75	99
200	67

[3]Emotion aware mobile applications have been increasing a lot lately. Because of the smart features and accessibility of mobile devices, emotion recognition has been in demand. An emotion recognition system needs to be real-time and accurate. A mobile device has a limited processing power hence to optimize emotion recognition the algorithm should have less computation time.

In this paper, the authorshave proposed high- performance solution for emotion recognition in mobile devices. The solution is to capture faces using embedded cameras in mobile devices. Apply a face detection module to theseimages to extract faces from them. Bandlet transforms are then realized on the detected faces and for each block, local binary pattern histograms are calculated. These blocks are later concatenated.

The Kruskal-Wallis feature selection is applied to select the most dominant blocks. These dominant blocks are then fed to a Gaussian mixture model-based classifier to classify the emotions. The experimental result achieved with this solution provides higher accuracy in a reasonable time.

The dataset on which the model is trained is JAFFE that contains 213 images of faces of 10 Japanese actresses. All these images are gray and of resolution 256 x 256. With this approach, the final accuracy achieved using this solution is approximately 99.8%. The high performance of this algorithm makes it efficient to implement emotion recognition in less powered mobile devices.

[4] Emotion recognition has an important role in computing. Analysis of compound facial expressions of humans has attracted the high interest of researchers working in human-machine interaction. Compound facial emotion is a combination of dominant and complementary emotions. Dominant emotions are happy-disgust and complementary emotions are sad-fear.

Analysis of compound emotions is limited to unbalanced data distributions and few categories. This results in inaccuracies. The problem of unbalanced and limited data is solved by using the iCV-MEFED dataset that contains over 50 classes of compound emotions that are assessed by psychologists.

Normally human emotions are classified into seven basic categories such as,

- Happy
- Sad
- Anger
- Disgust
- Fear
- Neutral
- Contempt

Training the machine model to classify these basic emotions sometimes lead to inaccuracy of the result. Hence, in this paper, the authors have defined a new dataset containing compound emotions such as happily surprised, angrily surprised, surprisingly fearful, and many more. Training the neural network over 50 categories heavily increased the accuracy of emotion detection.

[5]In this paper, the authors have proposed a solution to detect ID cards using face detection with the help of Tensorflow. Computer vision's primary goal is to identify various objects of different sizes and patterns. The major limitation of computer vision is the viewpoint and illumination of the object. The authors have proposed a working solution to detect ID cards using Tensorflow's object detection API. For detecting faces, haar cascade method is used.

The method defined by the authors is as follows,

- Data collection
- Image labeling
- Training data generation
- Label mapping

- Training configuration
- Inference graph
- ID card detection

The process of face detection is defined as follows,

- Data collection
- Collecting positive images
- Collecting negative images
- Training the system with both positive and negative images
- Generating an XML file
- Face detection

In conclusion, the proposed model was tested for ID card detection. Tensorflow object detection API was used for model testing and training. The proposed system could detect ID cards in the given image. It could also detect faces and output the coordinates of detected faces.

III. CONCLUSION

Emotion recognition is one of the most popular topics of computer vision. Different applications have been developed in this domain in the last decade. Emotion recognition is being widely used in video games and to build IoT based application that involves face detection.

Few applications of emotion recognition are emotion-based media player, brain-computer interfaces, speech voice intonation, distance learning, and rehabilitation monitoring, etc. Face detection is an efficient technique that is used for emotion recognition. Natural language processing is another method that can be used to recognize emotions based on audio data.

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