Emotion detection

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Computer vision CCAI-433

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Abstract

Facial emotional expression perception is a crucial component of human communication, enabling social interactions through its informational, evocative, and motivating effects. Thus, computational efforts to automatically classify facial emotional expressions, among other uses, may help to improve human-machine interactions. Moreover, in this paper we experiment two models: convolutional neural networks (CNN) and support vector machine (SVM) and applying it on the JAFFE dataset that is the short of the Japanese Female Facial Expression dataset.

Introduction

The technique of detecting human emotions is known as emotion recognition. People's ability to recognize the emotions of others varies tremendously. The use of technology to assist people with emotion identification is a relatively new field of study. In general, the technology works best when various modalities are used in context, for example, the most use computer vision and artificial intelligence.

Problem statement

The issue of human emotion detection and recognition is a difficult problem in computer vision and artificial intelligence which also play a significant role in human communication. The challenges of emotion detection are properly detecting the face, classifying the emotions, the neutral emotion which is also called the blank expression.

Objective

Recognize emotions based on face characteristics and activities. Consequently, we aim to detect emotion in several methodologies and determine which methodology produces the best results.

Movitiation

While emotion is such a vital part of human existence, the need for a relevance of automatic emotion detection has increased in tandem with the growing importance of human-computer interface applications. Automated emotion classification might also help people who have trouble recognizing emotion, such as youngsters with developmental-behavioral disorders like autism. Emotions are a mental state that may be perceived and identified in a variety of ways, including visual aspects in photos, videos, and speech. As an outcome, psychological studies and a variety of real-world challenges would benefit.

Literature Review

Many studies have been conducted to detect face emotion recognition. provided a framework for recognizing expressions based on the appearance of chosen face patches. This approach identifies emotions by examining a few face patches, and it employs a variety of databases, including the Japanese Female Facial Expressions(JAFFE) and The Extended Cohn-Kanade (CK+) databases, on which we will focus.

1. **Virtual facial expression recognition using deep CNN with ensemble learning[1]**

   In this paper, the authors used 5 datasets which are UIBVFED, FERG, CK+, JAFFE, and TFEID. Also, the feature extraction method that uses Viola-Jones algorithm and Haar feature selection and classification technique of the images is DCNN which uses SVM, Random Forest, and logistic Regression. This paper has a good accuracy for the performance but there is some limitation of the proposed models is the low performance in case of face occlusion.

2. **Deep-Emotion: Facial Expression Recognition Using Attentional Convolutional Network[2]**

   The authors of this paper use FER-2013, CK+, FERG, and JAFFE datasets. The feature extraction is CNN and attentional convolutional networks to classify the emotion in facial images. This paper highlights that attention to special regions is important for detecting facial expressions.

3. **Facial Emotion Detection Using Neural Network[3]**

   In this paper, they used the dataset for emotions coming from different online and offline media. Such as Google, Kaggle, Friends, and family. The feature extraction uses are the Viola-Jones algorithm and DCNN.use are Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) algorithm. The results of the paper were good, an image was successfully classified, and classify the sentiment of the image and choose the match emotion for the image but it needs more data to perform better and to enhance the accuracy.

4. **Facial emotion recognition using deep learning[4]**

   In this paper, they used the CK+ database and Convolutional Neural Networks (CNN) for feature extraction. Then classification by support vector machine (SVM).In this paper, the algorithm has been achieved using a data-driven deep learning model along with the right choice of DNN architecture and training procedure, and the results are good.

5. **Facial Expression Classification Based on SVM, KNN and MLP Classifiers[5]**

This paper uses CK+ dataset with HOG algorithm to extract the features from the images. Also, it uses the SVM ,MLP, and K-nearest neighbor (KNN) as classification techniques. Moreover, after experimenting with the models, the performance of each model is different from the other. So, SVM accuracy = 93.89%. for a seven-class emotional expression set, K-NN accuracy = 79.97%, and NN accuracy = 82.97%.

6. **Facial emotion detection using modified eyemap–mouthmap algorithm on an enhanced image and classification with TensorFlow[6]**

The experiment of this paper is evaluated on the KDEF database, Oulu-CASIA dataset, and CK+ dataset. Using Viola Jones algorithm for detecting faces and eyes. Also, used a modified mouthmap algorithm to map the mouth and detect it by applying a neural network based on tensorFlow that used to classify the extracted features by softmax approach. So, performance of this experiment shows on the validation accuracy that is 31 % and training accuracy with 98.1 %

Dataset

Initially, this project uses the Japanese Female Facial Expression dataset (JAFFE) which is labeled and classified into seven classes: angry, sad, happy, neutral, surprise, disgust, and fear. Also, performing a one-hot encoding is a binary vector representation of category data. This necessitates mapping the category data to integer values. Then, each integer value will be represented as a binary vector with all zero values except the integer's index, which is denoted by a one. Moreover, we split the dataset into training sets and testing sets. The training set will be 70% and the testing set will be 30%[9].

Implementation

This section will provide the details of the implementation of the project that uses two models CNN model and the SVM model and will compare the accuracy of each model.

Models

- ***Convolutional neural networks (CNN)***

Convolutional neural networks transformed this field by learning fundamental forms in the initial layers and growing to learn picture attributes in the deeper layers, resulting in more accurate image categorization.

We use the sequential command to create the CNN model after reshaping the photos; the number of filters is sixty-four, the size is 3x3, and the input shape is (128,128,3) After that, apply activation relu, then maxpool to select the maximum value in the pixel's neighborhood, and finally utilize function dropout to avoid overfitting.

After creating the first convolution layer, we generate four more, then use flatten to transform the 2D array to a 1D array for usage in dense layers, such that a fully connected layer is added between the convolution and softmax layers to classify the picture test into the appropriate class. Finally, we utilize compile to train a model with the gradient base optimizer 'Adm' and categorical_crossentropy to manage multi-classification, and the accuracy report is accurate[8].

- ***Support vector machine (SVM)***

  The SVM method is an excellent classification algorithm. It is a supervised learning method that is used the most to divide data into categories. A collection of label data is used to train SVM. SVM has the benefit of being able to solve both classification and regression issues. To divide or classify two classes, SVM constructs a decision boundary, which is a hyperplane between them. SVM is also utilized in picture classification and object detection.

Preprocessing

Preprocessing images for model SVM, we first identify eyes by landmark, rotate the face by the angle between the eyes y-axis and x-axis, and then crop the original 256x256 picture into 96x128 by reducing background impacts. Because the lighting conditions in the JAFFE database change, we employ histogram equalization to eliminate lighting impacts.

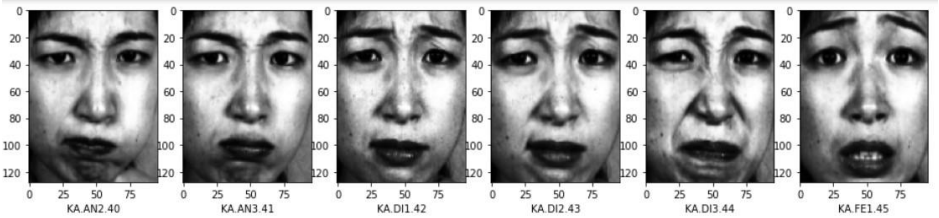

Figure 1: Histogram JAFFE after preprocess

The CNN preprocessing is different from SVM model, after the images of the dataset are loaded, we will resize its size to (128,128) each image will be appended to array list and convert its type to float and divide it by 255. Then define the number of classes and convert the classes to one-hot encoding that creates a new binary feature for each category and assigns a value of 1 to the feature of each sample that corresponds to

its original category. Also, after converting classes to one-hot encoding we shuffle the dataset to ensure that each data point creates an independent change on the model[8].

Extract features

- ***Convolutional neural networks (CNN)***

  CNNs are capable of generating features from time series data and frequency representation pictures automatically. These characteristics are then forwarded to a classifier network to be classified. The given input data is first sent to a feature extraction network, and the retrieved features are then sent to a classifier network. There are a lot of convolutional and pooling layer pairings in the feature extraction network[8].

- ***Support vector machine (SVM)***

  We employ the Discrete Wavelet Transform (DWT), a valuable method for extracting picture attributes since it allows you to examine photographs at various resolutions. To extract the LL, we utilize it twice on the cropped pictures, meaning the image is created by two continuous low-pass filters. Subsequently, from each image, we utilize PCA to extract essential features, which are then used to extract critical attributes. To make comparisons between the accuracies of the two models.[7]

Classification

- ***Convolutional neural networks (CNN)***

  The softmax function is most commonly used as an activation function in a neural network model. The outputs are normalized using the softmax function, which converts them from weighted sum values to probabilities that total to one. Each number in the softmax function's output is interpreted as the likelihood of belonging to each class. As a result, we use softmax for defined test images, with each value in the softmax function's output determining the probability of membership for each class[8].

- ***Support vector machine (SVM)***

  We apply tree-based one-against-one SVMs to accomplish multiclass classification since we want to distinguish seven different face emotions. The linear SVM is used to recognize seven facial expressions in the JAFFE database.

Results

After experiment, each model we found out that the SVM model performs better, and its accuracy is 0.93. Otherwise, CNN models that perform a little bit good with accuracy 0.70 that lead to determine the SVM as a good model to use for emotion detection. But I believe that CNN model will perform better than SVM.

Figure 2: SVM confusion matrix

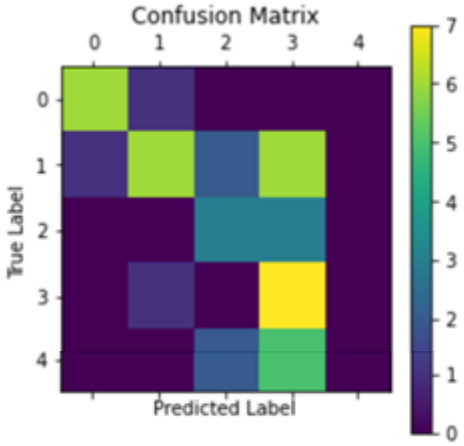

Figure 3: CNN confusion matrix

Figure 4: Result of the prediction of CNN

If you see the result of CNN prediction you will say it has a good accuracy, but it's the opposite that you can notice its confusion matrix that classify some of the inputs in the wrong class which effect the accuracy of the model.

	CNN	SVM
Accuracy	0.7	0.93

Table 1: Comparison between the accuracy of the two model

Future works

After comparing the accuracy of CNN and SVM that show in Table(1), we feel that if we employ the same prepocossing as SVM, CNN will offer us better results. Additionally, can we apply the KNN model on JAFFE to compare it to CNN and SVM to see which one gives us the best results.

We'd would also like to demonstrate how we can identify emotion in live video using webCam and emotion recognition.

Conclusion

We use the JAFFE database to examine several feature representation and expression classification algorithms in order to distinguish seven different face expressions. The suggested system employs DWT, PCA, and linear one-again-one SVMs, as evidenced by experimental results. Also, we implemented two types of Convolutional Neural Networks (CNN) algorithms on the JAFFE dataset, and while the results are promising, the Support Vector Machine (SVM) technique obtains a greater accuracy of 0.23 .

References

[1] Chirra, V.R.R., Uyyala, S.R. and Kolli, V.K.K., 2021. Virtual facial expression recognition using deep CNN with ensemble learning. *Journal of Ambient Intelligence and Humanized Computing*, *12*(12), pp.10581-10599.

[2] Minaee, S., Minaei, M. and Abdolrashidi, A., 2021. Deep-emotion: Facial expression recognition using attentional convolutional network. *Sensors*, *21*(9), p.3046. Lastname, W. (2009).

[3]]Ali, M.F., Khatun, M. and Turzo, N.A., 2020. Facial Emotion Detection Using Neural Network. *the international journal of scientific and engineering research*.

[4] Wu, C.D. and Chen, L.H., 2019. Facial emotion recognition using deep learning. *arXiv preprint arXiv:1910.11113*.

[5] Dino, H.I. and Abdulrazzaq, M.B., 2019, April. Facial expression classification based on SVM, KNN and MLP classifiers. In *2019 International Conference on Advanced Science and Engineering (ICOASE)* (pp. 70-75). IEEE.

[6] Joseph, A. and Geetha, P., 2020. Facial emotion detection using modified eyemap–mouthmap algorithm on an enhanced image and classification with tensorflow. *The Visual Computer*, *36*(3), pp.529-539.

[7]Shih, F. Y., Chuang, C. F., & Wang, P. S. (2008). Performance comparisons of facial expression recognition in JAFFE database. *International Journal of Pattern Recognition and Artificial Intelligence*, *22*(03), 445-459.

[8] katoch99 (2022). Emotion-Recognition/Emotion Recognition.ipynb at master · katoch99/Emotion-Recognition. [online] GitHub. Available at: https://github.com/katoch99/Emotion-Recognition/blob/master/Emotion%20Recognition.ipynb.

[9]paperswithcode.com. (n.d.). Papers with Code - JAFFE Dataset. [online] Available at: https://paperswithcode.com/dataset/jaffe.

[10]Khayata, A. (2022). *Facial Expression Recognition In Jaffe Database*. [online] GitHub. Available at: https://github.com/anas-899/facial-expression-recognition-Jaffe.