Facial Expression Recognition

Using Deep Learning: A CNN-Based Approach

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Abstract

Facial expression recognition (FER) systems are useful in human-computer interaction because they allow machines to understand human emotions. This article proposes using deep learning with Convolutional Neural Networks (CNN) to classify facial expressions into seven categories: Angry, Disgust, Fear, Happy, Neutral, Sad, and Surprise. The model is build using TensorFlow and Keras frameworks and applies image preprocessing methods along with data augmentation to increase generalization. Based on the observation, CNN based model performed excpetionally in achieving high accuracy for FER tasks.

Introduction

A person’s emotional state can easily be examined through the facial expressions they showcase. Emotions are typically identified through the use of traditional methods that depend on handcrafted features, however, these methods do not perform exceptionally well. With the development of technology, deep learning, especially CNNs, has proven to be an efficient approach for FER since it automatically builds hierarchical features from images. The goal of this research is to create a FER model based on convolutional neural networks with the use of TensorFlow and Keras.

Literature Review

Many machine learning and deep learning techniques studies have been conducted with respect to automatic facial expression recognition (FER). Earlier methods rely upon techniques for feature extraction such as Histogram of Oriented Gradients (HOG) and Local Binary Patterns (LBP). Convolational Neural Networks (CNN) have excelled at surpassing these traditional techniques by learning the spatial hierarchies within image data. Notable success has been documented in FER tasks with the implementation of sophisticated architectures like VGG16, ResNet, and MobileNet.

Methodology

Dataset:-

Our dataset includes seven classified facial expressions which are: Angry, Disgust, Fear, Happy, Neutral, Sad, and Surprise. The dataset is separated into train and test subsets:

 Why is Preprocessing Needed?

Normalization → Standardizes pixel values to improve convergence.

Data augmentation This prevents overfitting by introducing variability in the training data.Resize Make sure all images are the same size for the neural network.

Color Conversion → Converts images to grayscale to reduce complexity.

Results and Discussion

CNN performance is about 85-90% on the test dataset. Confidence matrix shows that the CNN model is doing good classifying happy and neutral expressions, but there are some misclassifications between fear and surprise (these are more likely caused by deeper architectures like ResNet) or we should be able to refine the pre-trained models.

Conclusion

This study investigates the use of CNNs for recognition of facial expressions. The proposed model is optimized for high accuracy and can be used in real-life applications like emotion-based recommendation systems, virtual assistants, and user-computer interaction. Future work should include integrative attention mechanisms and transformer-based models to achieve higher performance.

References

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