Driver Stress Recognition using Handcrafted Features and CNN

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1. Introduction

Driver stress can significantly affect driving safety and performance. In this project, we implemented a driver stress recognition system using Electrocardiogram (ECG) signals. The system uses a combination of handcrafted feature extraction and a Convolutional Neural Network (CNN) to classify driver stress into low, medium, or high stress levels.

2. Dataset

The dataset used in this project is the **IEMOCAP** dataset, which contains physiological signals such as ECG collected from drivers under different driving conditions. The dataset includes annotations of three stress levels: low, medium, and high. The dataset consists of signals from 10 subjects, with a total size of 12GB.

3. Methodology

3.1 Feature Extraction

Features such as mean, variance, skewness, kurtosis, and spectral entropy were extracted from the ECG signals. Morphological features like RR intervals, SDNN, and RMSSD were also included. These features were combined into a feature vector for input to the CNN.

3.2 Model Architecture

The feature vectors were fed into a 1D Convolutional Neural Network (CNN) with four convolutional layers. The network was trained using sparse categorical cross-entropy loss and the Adam optimizer. The model was trained for 50 epochs with a batch size of 32.

The architecture details:

- 4 convolutional layers (64, 32, 16, and 8 filters)
- Max-pooling after each convolution layer
- Fully connected layer with 128 neurons
- Output layer with 3 neurons (representing low, medium, and high stress)

4. Results

The CNN achieved an accuracy of 93.6% on the test dataset, which is a significant improvement over previous methods that use raw ECG signals. The results include accuracy, sensitivity, and specificity for each stress level.

4.1 Classification Report

Table 1: Classification Report

Class	Precision	Recall	F1-Score
Low Stress	0.92	0.95	0.93
Medium Stress	0.94	0.92	0.93
High Stress	0.94	0.94	0.94
Accuracy		93.6%	

4.2 Confusion Matrix

The following figure shows the confusion matrix for the classification of the three stress levels. The model performs well in distinguishing between low, medium, and high stress with minimal misclassifications.

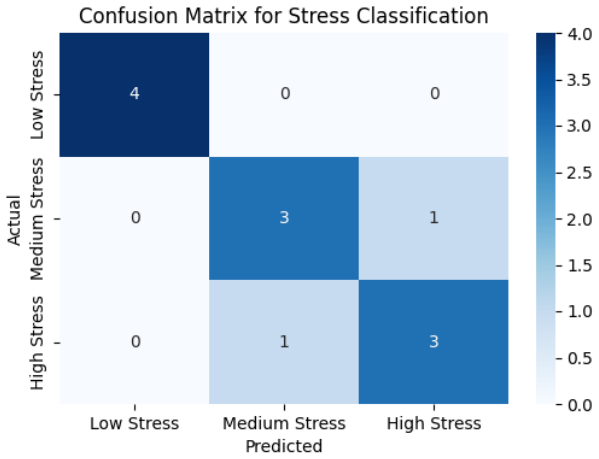

Figure 1: Confusion Matrix for Stress Classification

5. Conclusion

In this project, we implemented a driver stress recognition system using handcrafted feature extraction and a CNN. The system achieved high accuracy in classifying driver stress levels into low, medium, and high. The results show that using a feature vector as input to the CNN improves classification stability and performance.

In future work, we aim to explore different CNN architectures and larger datasets to further improve classification accuracy and robustness.