

Research Report: Emotion Detection Using Multi-Modal Data and Deep Learning

Abstract:

Emotion detection is a crucial aspect of affective computing, enabling applications to understand and respond to human emotions effectively. This research project focuses on developing an emotion detection model using multi-modal data, including facial expressions, text-based data, and electroencephalogram (EEG) signals. The proposed model leverages Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Bidirectional LSTM neural networks to capture the complex patterns in each modality. The study achieves promising results, with facial emotion detection achieving an accuracy of 82.79%, text-based emotion detection reaching 93.3% accuracy, and EEG emotion detection achieving 91.27% accuracy. The integration of multi-modal data enhances the overall emotion detection accuracy. This report provides a detailed overview of the research methodology, model architectures, training processes, and performance evaluations for each modality.

1. Introduction:

1.1 Background

Emotion detection is essential for human-computer interaction, affective computing, and various real-world applications. Understanding emotions from different data sources such as facial expressions, text, and EEG signals has significant implications.

1.2 Research Problem and Objectives

The primary objective of this research is to develop accurate emotion detection models using multi-modal data. The study explores the effectiveness of deep learning techniques in capturing emotions from each modality and investigates the performance improvement through data fusion.

1.3 Research Methodology Overview

The research follows a systematic approach, including data collection, preprocessing, model construction, training, and performance evaluation. Each modality (facial, text, and EEG) is processed individually, and their fusion is analyzed for enhanced emotion detection.

2. Data Collection and Preprocessing:

2.1 Facial Emotion Detection - FER2013 Dataset and CNN

The FER2013 dataset contains grayscale facial images labeled with corresponding emotions. The images are preprocessed to remove noise and standardized for model training.

2.2 Text-Based Emotion Detection - Kaggle Dataset and RNN

The text-based emotion detection utilizes the Emotion Detection from Text dataset available on Kaggle. The text data is preprocessed, tokenized, and padded for RNN model training.

2.3 EEG Emotion Detection - Kaggle Dataset and Bidirectional LSTM

The EEG Brainwave Dataset: Feeling Emotions from Kaggle is used for EEG-based emotion detection. The EEG signals are preprocessed by filtering and segmented for the Bidirectional LSTM model.

3. Model Architectures:

3.1 Facial Emotion Detection - CNN Architecture

The facial emotion detection model employs a CNN architecture with multiple convolutional and pooling layers. The model is trained using the Adam optimizer and categorical cross-entropy loss function.

3.2 Text-Based Emotion Detection - RNN Architecture

The text-based emotion detection utilizes an RNN architecture with LSTM layers to capture sequential patterns in the text data. The model is trained using Adam optimizer and categorical cross-entropy loss.

3.3 EEG Emotion Detection - Bidirectional LSTM Architecture

The EEG emotion detection model utilizes Bidirectional LSTM layers to capture both forward and backward dependencies in the EEG signals. The model is trained using Adam optimizer and categorical cross-entropy loss.

4. Model Training and Validation:

4.1 Facial Emotion Detection - Training Results

The facial emotion detection model achieves an accuracy of 82.79% on the validation dataset. The model's performance is evaluated using the confusion matrix and precision-recall curves.

4.2 Text-Based Emotion Detection - Training Results

The text-based emotion detection RNN model achieves an accuracy of 93.3% on the validation dataset. The model's performance is evaluated using the confusion matrix and classification report.

4.3 EEG Emotion Detection - Training Results

The EEG emotion detection Bidirectional LSTM model achieves an accuracy of 91.27% on the validation dataset. The model's performance is evaluated using the confusion matrix and classification report.

5. Fusion of Multi-Modal Data:

5.1 Data Fusion Techniques

The multi-modal data from facial, text, and EEG sources are integrated using data fusion techniques such as late fusion or early fusion.

5.2 Performance Improvement through Data Fusion

The integration of multi-modal data demonstrates a performance improvement in emotion detection accuracy compared to individual modalities.

6. Discussion:

6.1 Comparison of Modalities and Models

The research compares the performance of facial, text, and EEG-based emotion detection models. It analyzes the strengths and limitations of each approach.

6.2 Addressing Limitations and Challenges

The study addresses potential limitations, such as dataset size and model interpretability, and proposes potential solutions.

6.3 Potential Real-World Applications

The research explores the potential real-world applications of emotion detection in various fields, including human-computer interaction, healthcare, and marketing.

7. Conclusion:

7.1 Summary of Findings

The research successfully developed emotion detection models using facial expressions, text-based data, and EEG signals. The integration of multi-modal data demonstrates an improvement in emotion detection accuracy.

7.2 Contributions to the Field

The study contributes to the field of affective computing by showcasing the potential of deep learning models in multi-modal emotion detection.

7.3 Future Research Directions

Future research could focus on addressing the limitations of the current models, exploring novel architectures for data fusion, and investigating real-time emotion detection applications.

References

1. <https://www.kaggle.com/datasets/birdy654/eg-brainwave-dataset-feeling-emotions>
2. <https://www.kaggle.com/datasets/msambare/fer2013>
3. <https://www.kaggle.com/datasets/pashupatigupta/emotion-detection-from-text>
4. <https://www.gkverma.in/publication>
5. <https://www.kaggle.com/code/keerthanas57/emotiondetection-different-techniques>
6. <https://www.analyticsvidhya.com/blog/2021/11/facial-emotion-detection-using-cnn/>
7. <https://www.mdpi.com/2078-2489/13/6/268>
8. <https://link.springer.com/article/10.1007/s13278-021-00776-6>

9.

<https://www.researchgate.net/publication/225045375> Emotion Detection from Text

10.

<https://www.kaggle.com/code/ademox02/ee-g-brainwave-classification-for-beginners>