Literature Review

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Paper title:
An Efficient Approach to EEG-Based Emotion Recognition using LSTM Network.

Paper link:
https://ieeexplore.ieee.org/document/8248513

1 Summary:

1.1 Motivation:
Emotion awareness is extremely important for improving psychological well-being and enriching daily life experiences, as well as providing significant insights into how to address mental health issues. Valence and Arousal, Approach and Withdrawal, and Positive and Negative Models all contribute to a better understanding of emotions, paving the way for the development of emotion identification systems that use physiological signals such as EEG. Accurate categorization of emotions including calm, tension, happiness, and sorrow is critical for improving human-computer interaction and adapting computer behavior to match user emotions, resulting in more intuitive and responsive interfaces.

1.2 Contribution:
The study investigated the efficiency of the LSTM model for EEG-based emotion recognition, and found significant classification accuracies for both the Valence and Arousal scales. By investigating the use of frequency domain information such as band power, the study improved the accuracy of emotion identification algorithms. Using the DEAP dataset, a comparative investigation of several classification algorithms revealed that the LSTM model regularly outperformed other classifiers in terms of accuracy. Furthermore, the study demonstrated the potential of EEG data for real-time emotion monitoring, providing the framework for the creation of efficient headgear models specifically designed for emotion identification purposes.

1.3 Methodology:
To test emotion detection, the study used the DEAP dataset, which consisted of preprocessed EEG signals from 32 channels. Band power, a frequency-domain characteristic, was derived from these signals to aid categorization. The study used the ` model to attain significant accuracies in determining valence and arousal. Previous research has shown that LSTM networks are effective at processing sequential data such as EEG signals, highlighting their

applicability for this purpose. Through thorough research, the LSTM model outperformed other classifiers, demonstrating its efficacy in emotion identification tasks.

1.4 Conclusion:

The proposed LSTM model achieved outstanding classification accuracies of 94.69% for Valence and 93.13% for Arousal scales, significantly outperforming other classifiers. With an average improvement of 16 in testing accuracies, the LSTM classifier regularly beat its competitors, demonstrating its competence in emotion identification. These findings highlight the ability of LSTM models to provide exact assessments of emotional states, paving the door for applications in a variety of fields, including healthcare, human-computer interaction, and mental wellbeing.

Furthermore, the work emphasizes the need of obtaining band power parameters from EEG data for precise emotion detection tasks. Using these qualities, researchers can get a better understanding of the complex dynamics of emotional reactions, contributing to advances in psychological health and well-being. Furthermore, the study's practical applications include the creation of effective headgear models for real-time emotion monitoring, which will provide crucial insights into individuals' emotional states and allow for individualized solutions when needed.

2 Limitations:

2.1 First limitation:

The study relies primarily on EEG data for emotion detection and it may limit the kinds of variables analyzed for categorization.

2.2 Second limitation:

Future work proposals include examining subject-independent models and constructing 3-D emotion models, highlighting areas where the current study may have shortcomings.

2.3 Third limitation:

While reaching excellent accuracy, the research might benefit from examining other frequency domain variables beyond band power for greater performance.

3 Synthesis:

The work investigates the effectiveness of the LSTM model for EEG-based Emotion Recognition, revealing outstanding classification accuracies for both the Valence and Arousal scales. It underlines the importance of feature extraction from the dataset and classifier selection in determining emotion classification accuracy. Using the DEAP dataset, which includes EEG signals and physiological data obtained as people rated videos based on emotional states, the study sets a strong standard for classification tasks. Given the necessity of correctly distinguishing emotions such as calm, tension, pleasure, and sorrow, features derived from datasets play an important role in assuring exact categorization.The LSTM model emerges as a favored alternative for emotion prediction due to its capacity to handle sequential data and preserve prior occurrences, which improves the accuracy of emotion identification procedures.

Paper title:
PNN for EEG-based Emotion Recognition

Paper link:
https://ieeexplore.ieee.org/document/7844584

1 Summary:

1.1 Motivation:

Emotion recognition is critical in human-computer interaction systems because it directly influences user experience and system intelligence. With a rising emphasis on real-time emotion recognition, machine learning techniques have become critical in this field. As a result, academics have been investigating several approaches for effectively detecting human emotions, with the goal of enriching interactive experiences and improving computer systems' flexibility and reactivity to user emotional states.

1.2 Contribution:

The work presents a ReliefF-based channel selection method aiming at simplifying emotion identification by lowering the number of channels needed, hence improving practical usability. The integration of this approach with the PNN classifier greatly reduces computational complexity, making the system more suitable for real-world applications. The findings show that with only 9 channels for valence and 8 channels for arousal, the system can reach up to 98% of maximum classification accuracy, highlighting its increased efficiency and efficacy. This simplified technique not only increases the feasibility of implementing emotion detection systems, but also demonstrates the potential for wider use in a variety of fields where real-time emotion monitoring is required.

1.3 Methodology:

The study used a probabilistic neural network (PNN) to detect emotions from EEG signals, with validation and feature extraction performed using the DEAP emotion database. To improve practical emotion identification, a ReliefF-based channel selection method was created, which successfully reduced the number of channels used. The study systematically evaluated the performance of the PNN model to the Support Vector Machine (SVM) for emotion categorization, giving insight on the usefulness of various techniques. Through methodical experimentation across several frequency bands, the study delves into the specific contributions of each band to the overarching objective of emotion identification, giving vital insights for future research and application development in this field.

1.4 Conclusion:

The study tried to investigate the efficacy of emotion detection using Probabilistic Neural Networks (PNN), which yielded similar accuracy to Support Vector Machines (SVM) across 32 participants for valence and arousal. However, combining a ReliefF-based channel selection algorithm with PNN improved practical usability by achieving 98% of the maximum classification accuracy with significantly fewer channels—only 9 for valence and 8 for arousal, compared to 19 and 14 for SVM. While SVM had slightly higher maximum classification accuracy, PNN had the advantage of using much fewer channels to get equivalent results. These findings highlight the promise of PNN in real-time emotion identification applications, which is enhanced by the suggested channel selection approach's efficiency while maintaining accuracy.

2 Limitations:

2.1 First limitation:

The suggested channel selection method might have difficulties in obtaining all important information for emotion identification, perhaps resulting in information loss.

2.2 Second limitation:

The study focused on EEG-based emotion recognition, which may restrict the generalizability to other modalities.

3 Synthesis:

The study focused on EEG-based emotion recognition with the PNN classifier, which produced higher accuracy levels for both valence and arousal. To improve practical applicability, a ReliefF-based channel selection method was developed, which optimizes the number of channels required. The study used the DEAP database, which included EEG signals and peripheral physiological data from 32 people collected while watching music videos, to identify emotional states. Preprocessing methods, such as downsampling, artifact removal, and band-pass filtering, were used to improve EEG data for future classification tasks.

Paper title:
EEG-based emotion recognition using empirical wavelet transform

Paper link:
https://ieeexplore.ieee.org/document/8248513

1 Summary:

1.1 Motivation:

The purpose of the study was to discuss the significance of emotion recognition in brain-machine interface applications.

1.2 Contribution:

The work presents a unique EEG-based emotion identification method that uses empirical wavelet transform (EWT) in combination with an autoregressive (AR) model. Using this technique, the study achieves significant identification rates of 67.3% for the arousal dimension and 64.3% for the valence dimension, outperforming other previous methods. Particularly interesting is the demonstration of the parameter "p"'s influence on recognition accuracy within EEG-based emotion recognition frameworks, which sheds light on its critical role in improving the efficacy of emotion recognition systems. Through thorough testing and analysis, the work not only increases our understanding of EEG-based emotion detection approaches, but also gives vital insights for improving parameter selection to improve recognition accuracy in the future.

1.3 Methodology:

The Empirical Wavelet Transform (EWT) approach was used in the article to decompose EEG signals, which involved partitioning the original signal's Fourier spectrum into contiguous segments and creating empirical wavelets as bandpass filters. In addition, an Autoregressive (AR) model was used to aid feature extraction, with AR coefficients computed using the Burg algorithm. The suggested system included an organized process for data gathering, feature extraction using EWT and the AR model, and emotion categorization using a Support Vector Machine (SVM) classifier. This methodological framework provides a systematic and complete approach to EEG-based emotion identification by combining modern signal processing techniques with machine learning approaches.

1.4 Conclusion:

The suggested technique in the research produced impressive recognition rates of 67.3% for the arousal component and 64.3% for the valence dimension, demonstrating its effectiveness in EEG-based emotion recognition. Notably, there was a noticeable pattern in the growth of classification accuracy, with s3 consistently beating s9 on both valence- and arousal-based emotion detection tests. This improved result when compared to certain current approaches demonstrates the usefulness of the suggested methodology. Furthermore, the study revealed the critical function of parameter selection, revealing that the choice of "p" has a considerable impact on identification accuracy, with bigger "p" values not always correlated with better performance. These findings have important implications for future research on improving parameter selection and enhancing EEG-based emotion identification systems.

2 Limitations:

2.1 First limitation:

The suggested technique achieved a recognition rate of 67.3% for the arousal dimension and 64.3% for the valence dimension, indicating space for improvement.

2.2 Second limitation:

The EWT approach utilized for EEG signal decomposition lacks the basis of mathematical theory, which may impose constraints into the analysis process.

3 Synthesis:

The research described a new EEG-based emotion identification approach that combined empirical wavelet transform (EWT) with an autoregressive (AR) model, yielding recognition rates of 67.3% for the arousal dimension and 64.3% for the valence dimension. EWT was used to decompose the original EEG signal, including techniques such as splitting the Fourier spectrum and constructing empirical wavelets as bandpass filters. Furthermore, the classification problem was presented as an optimization task inside the empirical mode, offering a new viewpoint on EEG-based emotion identification. Furthermore, the study clarified the role of the parameter "p" in impacting identification accuracy within this framework, providing important insights for future research in this area.

Reference :

- *PNN for EEG-based Emotion Recognition*. (2016, October 1). IEEE Conference Publication | IEEE Xplore. https://ieeexplore.ieee.org/document/7844584
- *An Efficient Approach to EEG-Based Emotion Recognition using LSTM Network*. (2020, February 1). IEEE Conference Publication | IEEE Xplore. https://ieeexplore.ieee.org/document/9068691
- *EEG-based emotion recognition using empirical wavelet transform*. (2017, November 1). IEEE Conference Publication | IEEE Xplore. https://ieeexplore.ieee.org/document/8248513: