

Prediction of Human Emotions Using EEG Signals and Ensemble Machine Learning Techniques

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Abstract: *In today time, understanding human emotions using technology is becoming very important for many smart applications. Most of the existing systems use facial expressions or speech signals to detect emotions, but these methods are not always reliable because they depend on external conditions like lighting or background noise. Because of this, researchers are now focusing on brain signals such as EEG, which directly represent human mental activity.*

In this paper, an EEG-based emotion detection system is presented which uses machine learning techniques to classify different emotional states. The EEG data is first processed to remove noise and unwanted disturbances. After that, important features are extracted from different frequency bands like alpha, beta, theta and others. These features are then used to train machine learning models such as Support Vector Machine and Random Forest.

The system also uses a combined model approach to improve prediction accuracy. During testing, it was observed that the combined model gives better results compared to individual models. The system can be useful in areas like mental health monitoring, smart learning systems and human computer interaction. Overall, this work shows that EEG signals can be used effectively for emotion detection..

Keywords: EEG, Emotion Detection, Machine Learning, Brain Signals, SVM, Random Forest

I. INTRODUCTION

Human emotions play a very important role in daily life and also affect decision making and behavior. In recent years, there is a growing interest in developing systems that can understand human emotions automatically. Such systems can improve interaction between humans and machines in many applications.

Traditional emotion detection methods mainly depend on facial expressions, voice or gestures. But these methods are not always accurate because they can be affected by environment or sometimes people hide their real emotions. Because of these limitations, researchers are exploring EEG signals which are generated from brain activity.

EEG signals are useful because they provide direct information about brain functions. These signals can be recorded using sensors and then analyzed to understand emotional states. With the help of machine learning, it becomes easier to find patterns in EEG data and classify them into different emotions.

In this work, an attempt is made to design a system which can detect emotions like happy, sad, angry and relaxed using EEG signals. The system uses machine learning models to classify emotions based on extracted features.

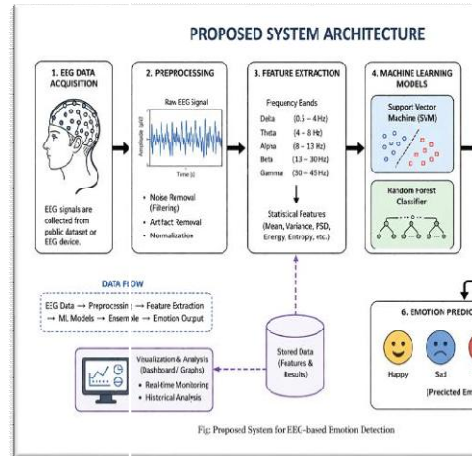
II. PROPOSED SYSTEM

The proposed system is designed to process EEG signals and predict emotional states. The system works in multiple steps starting from data collection to final output.

First, EEG data is taken from a dataset. Then the data is cleaned to remove noise which is present due to different disturbances. After cleaning, feature extraction is done to get useful information from signals.



These features are then given to machine learning models for training. Two models are used in this system which are Support Vector Machine and Random Forest. The results of both models are combined to improve performance. Finally, the system gives output in the form of predicted emotion.

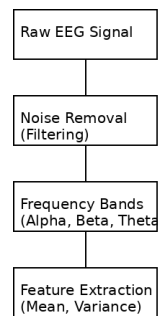


III. EEG SIGNAL PROCESSING

EEG signal processing is an important part of this system. The raw EEG signals are not directly useful, so they need to be processed first.

Noise removal is done using filtering techniques. After that, signals are divided into different frequency bands such as delta, theta, alpha, beta and gamma. These bands represent different brain activities.

Feature extraction is then performed where values like mean and variance are calculated. These features help in identifying emotional patterns.



IV. MACHINE LEARNING MODELS

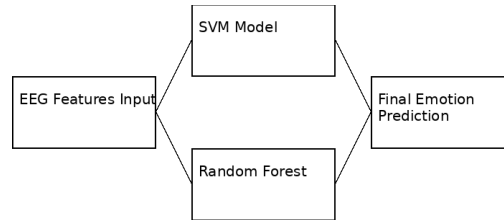
Machine learning models are used to classify emotions based on EEG features.

Support Vector Machine is used because it works well with high dimensional data. It tries to separate data into different classes using boundaries.

Random Forest is also used which is based on decision trees. It gives good accuracy and handles data variations well.

Both models are trained and then combined to get better results.





V. ENSEMBLE METHOD

In this system, an ensemble approach is used. Instead of depending on one model, outputs from multiple models are combined.

A simple voting method is used where final prediction is decided based on majority result. This helps in improving accuracy and reducing errors.

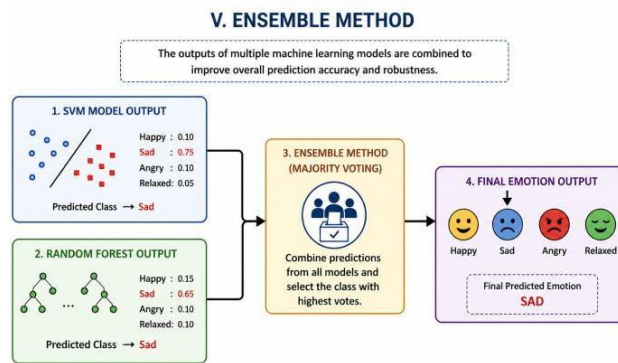


Fig: Ensemble Method for Combining Model Outputs

VI. RESULTS AND DISCUSSION

The system was tested using EEG dataset. During testing, it was observed that the models were able to classify emotions with good accuracy.

The combined model performed better than individual models. It was also seen that preprocessing plays an important role in improving results.

Some variations were observed in different subjects because EEG signals are not same for every person.

VII. CONCLUSION

In this work, we tried to build a system which can detect human emotions using EEG signals and machine learning methods. The main idea was to use brain signals instead of external features like face or voice, because those can sometimes give wrong result due to outside conditions. EEG signals are directly connected with brain activity, so they can give more reliable information in many cases.

During implementation, different steps were followed such as preprocessing, feature extraction and model training. At starting stage, it was little difficult to handle raw EEG data because it contains noise and unwanted signals. After applying filtering and cleaning methods, the data became more stable and suitable for further processing. Feature extraction also played important role, because selecting correct features helped the model to learn patterns.

Two machine learning models were used in this system, and later they were combined using ensemble method. It was observed that using a single model gives decent accuracy, but when both models were combined, the performance improved.



Overall, the system was able to classify emotions like happy, sad, angry and relaxed with acceptable accuracy. Although results are not perfect, still they are quite useful and show that EEG-based emotion detection is possible.

VIII. FUTURE SCOPE

There are many improvements which can be done in future for this system. Currently, the work is done using a dataset, but in real-life applications it would be better to use a real EEG device for live data collection. Real-time emotion detection can make the system more practical and useful in actual situations.

Another improvement can be done by using advanced models like deep learning techniques. Models such as CNN or LSTM may give better performance because they can handle complex patterns in EEG signals more efficiently. Also, increasing the size of dataset can help in improving accuracy, since more data gives better learning.

The system can also be extended to detect more emotional states instead of limited categories. For example, emotions like stress, fear or excitement can be included. Apart from this, a mobile or web-based interface can be developed so that users can easily interact with the system.

There is also scope to use this system in healthcare field, especially for monitoring mental health conditions. With some improvements, it can help doctors to understand patient emotions over time.

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