EEG - BASED SPEECH RECOGNITION

By:

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INTRODUCTION

Imagined speech recognition using non-invasive BCIs enables communication for individuals with paralysis by decoding brain signals. Preprocessing methods like filtering and ICA enhance signal quality, while machine learning algorithms classify and decode neural activity, advancing accessible communication technologies.

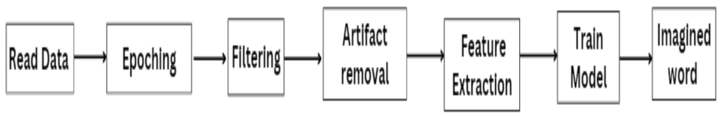
OBJECTIVES

- To design a filter for pre-processing raw EEG data.
- To implement effective artifact removal techniques.
- To extract features from processed EEG data and predict the imagined word.

SYSTEM OVERVIEW

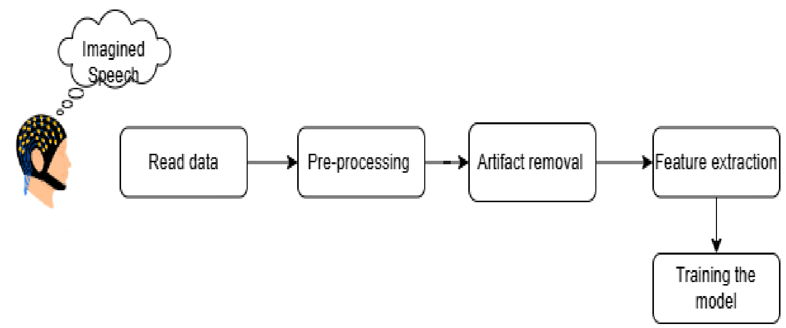
EEG Bases speech recognition typically follows a structured process consisting of six main steps:

1. Read Data: EEG signals are acquired from the KARA ONE database using a 64-channel Neuroscan Quick-cap.
2. Epoching: EEG data is segmented into epochs focusing on the imagined speech state, excluding other cognitive phases.
3. Filter : Bandpass filtering (2–45 Hz) removes noise and isolates relevant brain activity.
4. Artifact Removal: Independent Component Analysis (ICA) removes noise such as eye blinks and muscle movements.
5. Feature Extraction: Features like mean, energy, curve length, and high-frequency energy are extracted from pre-processed EEG data
6. Classification: SVM classifies features from pre-processed EEG, while LSTM uses raw EEG to capture temporal dependencies.



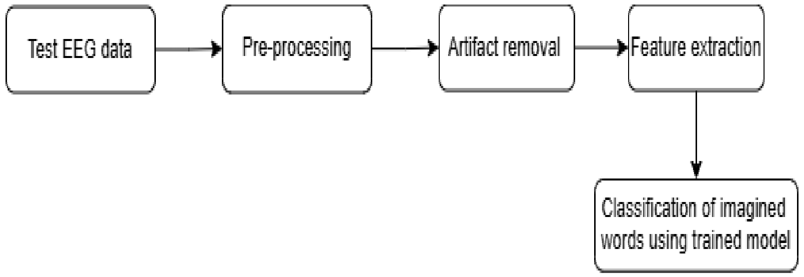
Block Diagram of system overview

BLOCK DIAGRAM OF MODEL TRAINING



Steps involved in training the model

BLOCK DIAGRAM OF MODEL TESTING



Steps involved in testing the model

SYSTEM SOFTWARE

•Python is used for filtering, Epoching, training, testing, classification, and plotting of EEG signals.

•MATLAB and EEGLAB are used for loading the raw EEG data and performing ICA to remove artifacts.

RESULTS AND DISCUSSION

The SVM model's accuracy improved from 51% to 69% with ICA preprocessing. ICA effectively removed artifacts and noise from the raw EEG data, enhancing signal quality and boosting the model's performance.

The LSTM model, trained and tested individually on each participant, showed widely varying accuracy. It achieved 62.50% with participant MM15 and only 8.33% with participant P02, highlighting challenges related to individual differences and data quality in real-time EEG classification.

ID	MM 05	MM 08	MM 09	MM 10	MM 11	MM 12	MM 14
Accuracy(%)	16.67	25.00	54.17	54.17	41.67	33.33	29.17
ID	MM 15	MM 16	MM 18	MM 19	MM 20	MM 21	P02
Accuracy(%)	62.50	20.83	41.67	33.33	25.00	20.83	8.33

Model	Accuracy
SVM without ICA	51%
SVM with ICA	69%

CONCLUSION

▪An EEG-based imagined speech recognition system was developed to decode neural signals for assistive communication technologies.
▪FIR filters were designed for noise removal, and ICA was applied to eliminate artifacts like eye blinks and muscle movements, improving signal quality.
▪Features were extracted from the processed EEG signals and classified using SVM and participant-specific LSTM networks, showcasing their potential for robust real-time applications.

REFERENCES

1] University of Toronto, Department of Computer Science, The KARA ONE Database: Phonological Categories in imagined and articulated speech, accessed on 08 November 2023, https://www.cs.toronto.edu/~complingweb/data/karaOne/karaOne.html

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