Fuzzy systems and dynamical recurrent networks for ECoG-based BCI

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What is a BCI?

A BCI can formally be defined as a communication and control channel that does not depend on the brain’s normal output channels of peripheral nerves and muscles [1].

![Figure 1: General scheme of a BCI](image)

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**Figure 1:** General scheme of a BCI
Measuring brain activity

Figure 2: Recording sites for electrophysiological signals used by BCI systems (Modified from Wolpaw and Birbaumer [2]).
Why to use ECoG?

Advantages:
- ECoG signals have higher amplitude than EEG
- ECoG signals are less vulnerable to some electrical noise sources
- ECoG has higher spatial resolution than EEG
- ECoG has a broader bandwidth than EEG

Disadvantages:
- It is necessary a craniotomy
- ECoG is only available through clinical programs
General method of analysis: Power changes

Describe these changes using linguistic variables through fuzzy inference systems.

*if-then* rules

*if* power in mu is low *and* power in beta is medium low *and* power in Gamma is high *then* a motor imagery task has begun [3]
A particular example using ECoG signals

Figure 3: Experiment setup for this study.
The study was set out to determine whether it was possible to faithfully decode the time course of flexion of each finger in humans using ECoG [4].
The use of power in gamma band

Figure 4: Example of power in gamma band of some trials and their corresponding digitized finger flexion. Correlation value between these two signals $r = 0.51$
Proposed Algorithm

Figure 5: Proposed methodology for decoding finger movement from ECoG signals
Results of decode finger movement

Figure 6: Example of decoded finger movement. Correlation value between these two signals $r = 0.72$
Conclusions

- ECoG signals can be used to accurately decode the time course of the flexion of individual fingers.
- An architecture based on neurofuzzy systems and recurrent neural networks for decode time course of finger flexion was presented.
- The proposed methodology yielded a maximum correlation value of 0.7 when correlation was computed between decoded movement and finger movement recorded.
- The results provide evidence that ECoG may support BCI systems with finely constructed movements.
References


References II