REAL-TIME EEG EVENT DETECTION FOR AUGMENTED HUMAN MACHINE INTERACTION

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Recent research in neuroimaging has identified electroencephalography (EEG) signals that are correlated with cognitive processing states such as attention, memory encoding and recall, perceived reaction errors, and motor intent. We envision that real-time monitoring of EEG brain activity has the potential to revolutionize human-machine interaction by making interfaces adaptive to such mental states.

We are developing, in this context, a robust non-invasive brain-computer interface (BCI) that measures individual cognitive events in real-time and maps brain activity to generate a feedback signal used for monitoring and interface control.

We aim to demonstrate, using three different candidate EEG signals, the utility of the BCI for improving subject performance in the following scenarios:

(1) Perceived error and conflict. Error related negativity (ERN) in EEG has been linked to perceived response errors and conflicts in decision making. We are developing a BCI system to measure the ERN and predict task-related errors. The system is being evaluated as an automated real-time decision checker for time-sensitive control tasks. Detected reaction errors will be corrected or "flagged," requiring additional confirmation before execution of critical commands.

(2) Working memory encoding. Transient modulation of oscillations in the theta (4-8 Hz) and gamma (20-30 Hz) bands, recorded using EEG and magnetoencephalography (MEG), have been implicated in the encoding and retrieval of semantic information in working memory. We are developing a system which exploits these neural correlates of semantic processing to construct an automated "tutor" that will re-enforce semantics in memory intensive tasks. When the tutor detects problems with semantic information processing it can alert the subject of anticipated memory recall deficits, repeat portions of the training sequence, etc.

(3) Motor imagery. A number of neural signals have been shown to correlate with motor intent, including lateralized alpha (10-12 Hz) band activity in EEG and short transient pulses in MEG over the motor cortex. We are developing a system to predict, on a single trial basis, motor intent through robust and differential classification of motor imagery generated by a subject. This will enable an intuitive, hands-free, communication channel that bypasses the motor system.

We will report initial results for ERN detection/error correction and prediction of motor intent via motor imagery.