Poster No. 10

Title: Mental Workload Classification with Functional Near-Infrared Spectroscopy: Model-Based and Data-Driven Approaches

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Abstract:

We assessed the potential of functional near-infrared spectroscopy (fNIRS) to discriminate between different levels of mental workloads. Model-based approaches have shown that changes in oxy- and deoxyhemoglobin concentrations, as measured with fNIRS, are related to changes in brain activation in the human prefrontal cortex. The magnitudes and phase delays of hemoglobin signals provide insight into the underlying physiological processes related to brain activity. In this work, we implemented a data-driven approach, a k-nearest neighbors algorithm, as a technique for mental workload classification.

To create different mental workload levels, subjects memorized the number of colored squares on a cube. The working memory required for a trial increased with an increased number of colored squares. The features used for classification were the maximum amplitudes of oxy- and deoxyhemoglobin concentration changes. We implemented a 3-nearest neighbor algorithm to classify trials of varying difficulty into mental workload groups. A trial was considered successfully classified if two of its three nearest neighbors were in the same group. Results for three subjects showed that a 3-nearest neighbor algorithm was able to discriminate between three mental workloads: a resting state and states with a two or four colored cube. Classification accuracy ranged from 44.4% to72.2%. The results supported the potential of machine learning algorithms to transform fNIRS measurements into classifications of mental states.

Future work includes the selection of additional features and assessing alternative discriminative models in order to enhance classification abilities. For example, algorithms such as support vector machines (SVMs) have also been used to classify mental workloads. An application of this technology is in the field of human-computer interfaces where a computer dynamically adjusts its interface based on the user's mental workload.