



Adaptive estimation of single response evoked potentials

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Abstract

A new adaptive filtering algorithm and structure is developed to estimate response-to-response variations in evoked responses. The evoked responses are modeled as the sum of three uncorrelated signal components: ensemble average, noise, and stochastic signal variation. A two stage time sequenced filter structure exhibiting improved convergence characteristics is developed along with a modified P-vector algorithm (mPa) which eliminates the need for a separate desired signal electrode. The mPa adaptive filter is tested with simulated and human EP data. The mPa filter is able to estimate signal variations from one response to the next.

Keywords: Evoked potential; LMS; Adaptive; Estimation

I. Introduction

Evoked potentials (EPs) are transient non-stationary signals often buried in the ongoing electroencephalogram (EEG). Traditional optimum filtering techniques have proven inadequate for estimating the underlying EPs (Carlton & Datz, 1980; Gevins, 1984). In particular, little has been done to estimate the response-to-response variation in the EPs. Adaptive filters usually require a separate electrode or sensor to provide a desired response which must contain correlated signal information. Ideally, noise components in the desired response electrode are uncorrelated

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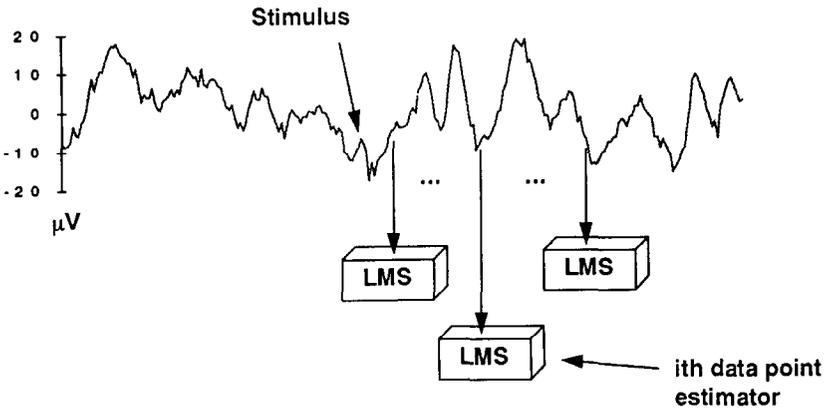


Fig. 1. Time-sequenced adaptive filter.

with noise in the filter input. The EEG, unfortunately, is highly correlated among the scalp electrodes.

Several researchers have attempted to use adaptive filters for EP processing. Widrow and Ferrara (1981) derived the multi-channel adaptive signal enhancer which Thakor (1987) and Slifka (1988) later applied to EPs with mixed results. In both cases the EP estimates were highly biased with component amplitudes attenuated by the filter. Madhavan (1988) observed that much of the EEG reduction was due to ensemble averaging rather than adaptive filtering. Slifka (1988) observed

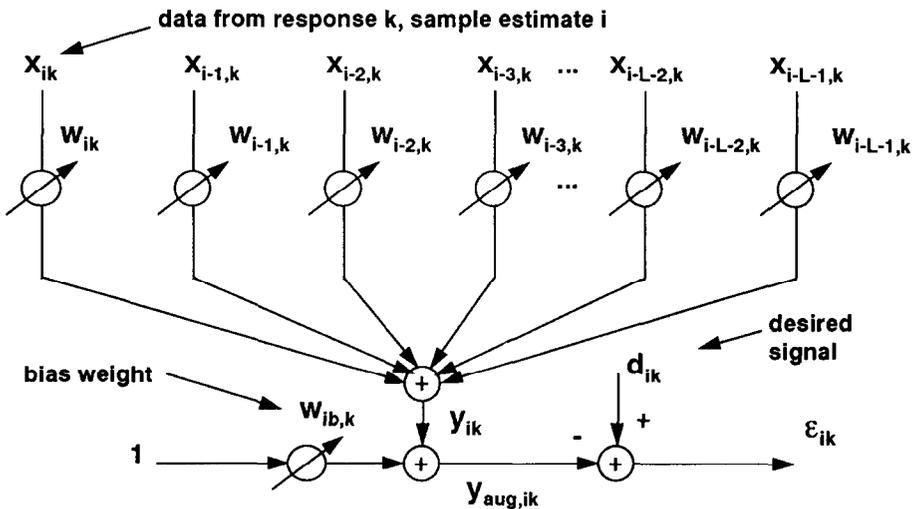


Fig. 2. The adaptive linear combiner.

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