ADAPTIVE INTERFERENCE REDUCTION (AIR) IN CUFF ELECTRODE RECORDINGS

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ABSTRACT

A method is presented that significantly reduces residual EMG artefacts in ENG recording systems. The closed-loop system is based on the true-tripole method however here the gains are adjusted automatically to reduce the EMG contamination.

INTRODUCTION

Neural signals (ENG) recorded from insulating cuffs fitted with electrodes and placed around nerve bundles can replace artificial sensors in providing feedback signals in *functional electrical stimulation* (FES) applications. Typical applications include correction of foot-drop and hand grasp in tetraplegic patients [1]. Unfortunately, the ENG signal recorded using this method is on the order of a few μV whereas interfering potentials can have amplitudes of many mV. The main source of interference is the electromyographic (EMG) potential generated by excited muscles near the cuff. Various methods have been suggested to overcome this difficulty, mostly based on the use of multiple electrode structures within the cuff [2]. However residual EMG artefacts are still present in the recorded signal. In order to reduce residual EMG, high-order filtering (HOF) has been proposed, however this is not optimal in situation where the spectra of the ENG and the EMG overlap [3]. In this paper we present a method called *adaptive interference reduction* (AIR) that significantly reduces EMG contamination without the need for high-order filtering.

METHOD

The operation of the AIR system can be described as follows. The outputs from the three electrodes in a true-tripole arrangement [4] are fed in pairs into two adaptive gain blocks G_1 and G_2. Then the absolute values of the outputs y_1 and y_2, which are biased in favour of the EMG activity, because of the relative magnitude of EMG and ENG, are compared and a command signal (+1/-1) is produced depending on which is larger. This command signal is then integrated and fed back to control the gains. Finally, the outputs y_1 and y_2 are added and the residual interference is therefore largely removed.

RESULTS

Fig. 1 shows recording of ENG activity (amplified by 1000) when the experimenter stroked the index finger of a tetraplegic patient during EMG activated reflexes. The upper trace shows the output from the open-loop true triple.

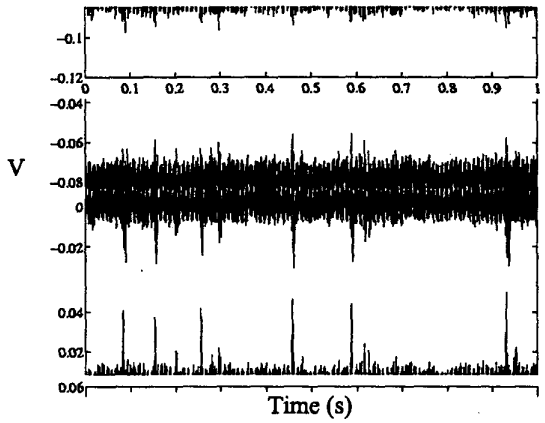

Fig. 1. ENG recordings during EMG reflexes. Open-loop true-tripole (upper trace). Output from the AIR method (lower trace).

Residual EMG is still present every time an EMG reflex is initiated. The lower trace shows the output from the AIR method. The AIR method reduced the artefacts by more than 50% compared to the open-loop true-tripole with no feedback. In addition, simulation results show that the AIR method can separate signals very closely spaced in the frequency spectrum where the filtering method would fail.

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