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T02: EMG signal processing

SEPARATION OF PROPAGATING AND NON-PROPAGATING COMPONENTS IN SURFACE EMG

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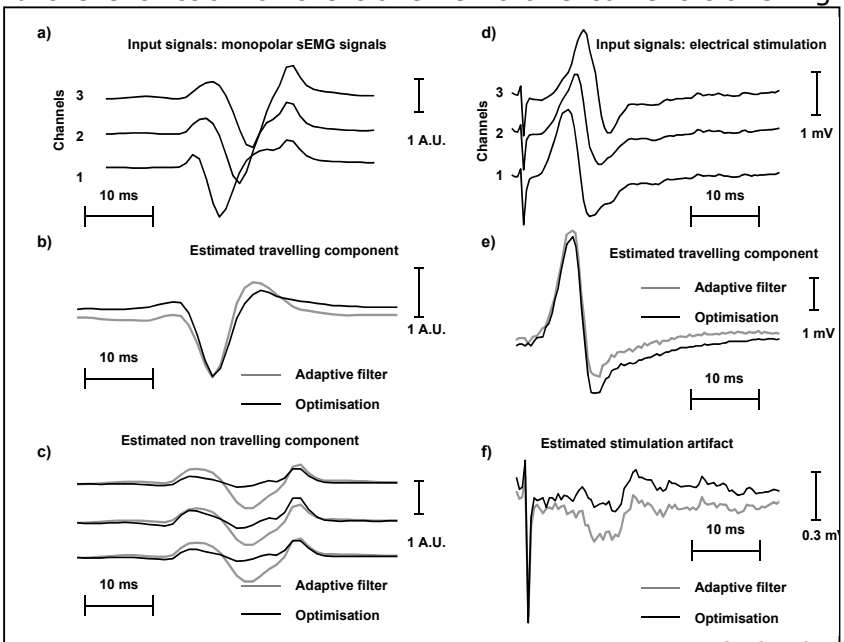
AIMS: Surface electromyogram (EMG) detected by electrode arrays along muscle fibre direction can be approximated by the sum of propagating (across channels) and non-propagating components. A technique to separate propagating and non-propagating components in surface EMG signals is developed. The method is applicable to signals with one propagating and one non-propagating component.
Methods: The method is based on two steps: the first is an adaptive filter, which allows to obtain an estimation of the delay between signals detected at different channels and a first estimate of the travelling and non-travelling components; the second step is based on a regularisation method and is used to optimise the estimation of the two components. The method was optimised on simulated signals, and then applied to single motor unit action potentials (MUAP) and to M-waves.
Results: The new method was first tested on synthetic signals constituted by the sum of a propagating and a non-propagating signals and then applied to simulated and experimental EMG signals. Simulated signals were generated by a cylindrical, layered volume conductor model. Experimental signals were monopolar surface EMG signals collected from the abductor pollicis brevis muscle and M-waves recorded during transcutaneous electrical stimulation of the biceps muscle.
Conclusions: The main contribution to non-propagating components in a MUAP is given by the generation and the extinction of the transmembrane current travelling along the fibres. The automatic identification of such non-propagating components is useful for both estimating anatomical features (position of the innervation zone and tendons) and to decrease bias in conduction velocity (CV) estimation. In the case of M-waves, the main non-propagating component is the stimulation artifact, in addition to those mentioned above. The technique may find different applications: in single motor unit (MU) studies, for decreasing the variability and bias of CV estimates due to the presence of the non-propagating components or for detecting automatically the position of the innervation zone and of a tendon; in processing M-waves, it could be useful to remove the stimulation artifact.



APPLICATION TO THREE MONOPOLAR SURFACE EMG SIGNALS, A),B), C), COLLECTED FROM THE ABDUCTOR POLLICIS BREVIS MUSCLE. APPLICATION TO A SURFACE EMG SIGNAL RECORDED DURING TRANSCUTANEOUS ELECTRICAL STIMULATION OF THE BICEPS BRACHII MUSCLE, D), E), F).