Electrically evoked auditory steady-state response and stimulation artifact estimation using Kalman Filtering

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Cochlear Implants (CIs) can be used to restore hearing of people with severe to profound hearing loss. Part of the hearing restoration process is the regular CI fitting, which is time consuming and with a large variability across clinicians and CI recipients. Furthermore, it requires interaction with the subject and is therefore difficult to assess in populations that cannot give reliable subjective feedback, such as infants. Electrically evoked auditory steady-state responses (EASSRs) can serve as an objective measure to determine stimulation levels, and are therefore a promising step towards fully automated, objective fitting of CIs. A major challenge when recording EASSRs are the stimulation artifacts of the implant, which make the neural response detection in EEG cumbersome. Methods such as Linear Interpolation (LI), Template Subtraction (TS) and Independent Component Analysis (ICA) have been used to remove the artifact from the measured signal. However, they either fail to clearly separate artifact and response (ICA), require extra measurements (TS) or are unable to remove the artifact when it exceeds the inter-pulse interval (LI), e.g. for clinical stimulation settings of the CI.

Here, Kalman Filtering (KF) is used to estimate EASSRs on a dataset of 10 adult CI users as acquired in [Gransier et al (2020) Sci. Rep. 10:15406]. EASSRs were elicited with commonly used CI settings (900pps, monopolar mode), over a range of modulation frequencies from 34Hz to 43Hz. Instead of requiring a-priori knowledge of the expected artifact shape to estimate the neural response, the KF approach estimates both, the neural response and the required artifact model.
Preliminary results show that KF is able to differentiate neural response and stimulation artifact, even without removal of signal components as for instance required in LI. The latencies of the responses are similar to those reported in the literature, indicating a good separation between artifact and neural response. Furthermore, KF is in some cases able to remove the artifact when LI fails to do so.

In conclusion, our KF approach is able to estimate a linear model of neural response and stimulation artifact when using clinical stimulation parameters. The advantages of KF over other artifact removal techniques will be discussed at the

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