Automatic Artefact Compensation in EOG Signals

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Abstract. We present a general framework for automatic detection and compensation of artefacts in Electrooculography signals. Based on experiments and subsequent evaluations we propose a selection of compensation algorithms covering the major sources of EOG artefacts. We also propose an optimised procedure for applying these algorithms to EOG signals as a pre-stage to further signal processing.

1 Introduction

Electrooculography (EOG) allows to measure changes in the resting potential between the cornea and retina. These changes are mainly caused by eye movements which inversely allows to track eye movements and reconstruct gaze direction by analysing EOG signals.
While signal artefacts are also an issue in static setups, they become even more critical in wearable settings as changing environments and different kinds of body movements hamper correct signal analysis. Adapted strategies and algorithms for signal processing need to be developed which are able to cope with these special conditions.

2 Related Work

EOG signals are usually degraded by diverse forms of noise such as mains hum interference, EMG from facial muscle activity, blink artefacts, baseline drift or crosstalk between electrode pairs. Mains hum and EMG artefacts can usually be removed with simple noise filters, whereas crosstalk and baseline drift correction require more complex algorithms.
Existing approaches for blink detection include template matching [1], velocity thresholding or detection based on wavelets [2]. For solving the baseline drift problem, various methods have been published like using wavelet packets [3], polynomial fitting or digital/FIR filtering.
However, all these algorithms have only been evaluated separately. An optimised solution covering all aspects of EOG signal processing and taking into account interdependencies between the different components hasn't been developed so far.

3 Artefact Compensation Framework (ACF)

We propose such a framework which integrates components for blink removal, segmentation, drift reduction and calibration. The central idea is to segment EOG signals based on their characteristics and remove artefacts individually for each segment. The flowchart of this framework is given in figure 1.

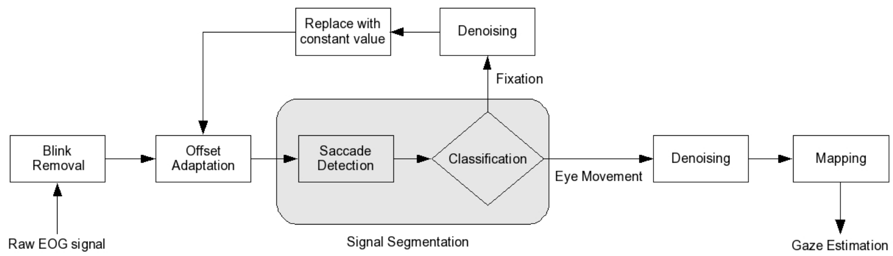

Fig. 1. Artefact Compensation Framework Flowchart

First, blinks are removed from the raw EOG signal. In a second step, the signal is segmented based on special signal characteristics. Afterwards, for each of the segments, a classification is performed which decides whether the segment describes an eye movement or a fixation with superimposed baseline drift. Segments classified as eye movements only get denoised. In case of a fixation period, after denoising, the whole segment is replaced by the first value of the filtered signal. The offset between the segments' first and last value is assumed to be caused by baseline drift and used to adapt the signal. A final transformation maps signal levels to gaze angles. A possible result is shown in figure 2.

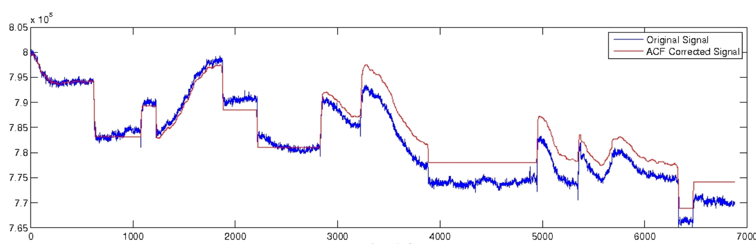

Fig. 2. ACF corrected EOG signal

References

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