# Feature Fusion for the Detection of Microsleep Events

Martin Golz[1], David Sommer[1], Mo Chen[2], Udo Trutschel[3], and Danilo Mandic[2]

[1] Dptm. of Computer Science, University of Applied Sciences, 98574 Schmalkalden, Germany
[2] Dptm. of Electrical & Electronic Engineering, Imperial College, London, SW7 2BT, UK
[3] Circadian Technologies, Inc., 2 Main Street, Stoneham, MA 02480, USA

## Abstract

A combination of linear and nonlinear methods for feature fusion is introduced and the performance of this methodology is illustrated on a real-world problem: the detection of sudden and non-anticipated lapses of attention in car drivers due to drowsiness. To achieve this, signals coming from heterogeneous sources are processed, namely the brain electric activity, variation in the pupil size, and eye and eyelid movements. For all the signals considered, the features are extracted both in the spectral domain and in state space. Linear features are obtained by the modified periodogram, whereas the nonlinear features are based on the recently introduced method of Delay Vector Variance (DVV). The decision process based on such fused features is achieved by Support Vector Machines (SVM) and Learning Vector Quantization (LVQ) neural networks. For the latter also methods of metrics adaptation in the input space are applied. The parameters of all utilized algorithms are optimized empirically in order to gain maximal classification accuracy. It is also shown that metrics adaptation by weighting the input features can improve the classification accuracy, but only to a limited extent. Limited improvements are also obtained when fusing features of selected signals, but highest improvements are gained by fusion of features of all available signals. In this case test errors are reduced down to 9 % in the mean, which clearly illustrates the potential of our methodology to establish a reference standard of drowsiness and microsleep detection devices for future online driver monitoring.