The MIRAGE91 Brain–Computer Interface

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Abstract

MIRAGE91 (Motor Imagery Racing Graz established 1991) is the name of the official Brain-Computer Interface (BCI) Racing Team at the Graz University of Technology. Our BCI captures brain activity by electroencephalography (EEG) and utilizes changes in oscillatory components caused by four different mental tasks to generate control signals. We measure EEG with 32 active Ag/AgCl electrodes and two 16-channel biosignal amplifiers. A standard laptop hosts all necessary software and also sends the control commands via network to the Cybathlon Brain Runners game. Our custom made TOBI SignalServer handles data acquisition from the amplifiers and provides an interface to Matlab/Simulink, where signal processing is performed [1]. First we filter EEG in alpha and beta bands separately. Then, we normalize channels to their resting variance to reduce the influence of high variance channels. Resting variance is estimated from a prior resting measurement. After that, we perform spatial filtering with common spatial patterns (CSP) in a one class vs. one class manner and use four filters per CSP model. Then we calculate logarithmic band power over one-second sliding windows and use an analytical shrinkage regularized linear discriminant analysis (sLDA) to calculate class probabilities. If the class probability of one of the four classes exceeds a threshold for a certain time, we send a command to the game. With this BCI, the best run time of our motor impaired pilot was 117 seconds and the best run time over all was 107 seconds (10 fields per class, runtime without input is 165 seconds). Lessons learned from designing our system will influence future BCI system design in terms of robust signal processing at low trials-to-features ratios and BCI personalization.

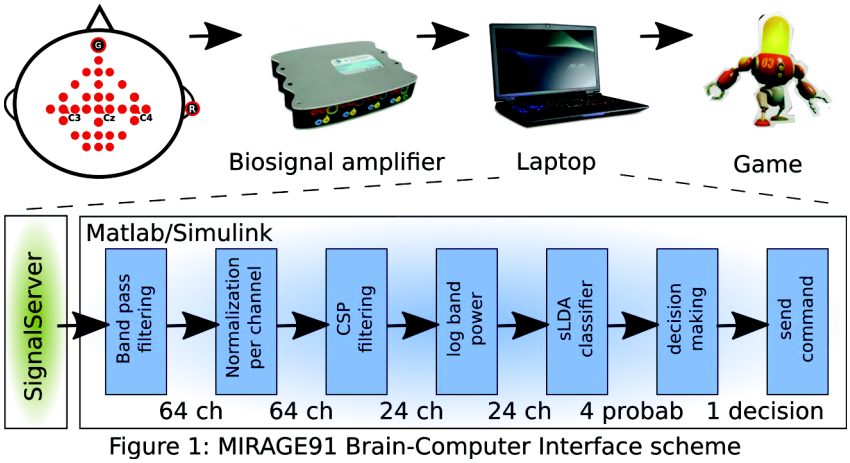

Figure 1: MIRAGE91 Brain-Computer Interface scheme

References

[1] G. Müller-Putz et al., ‘‘Towards non-invasive hybrid brain-computer interfaces: Framework, practice, clinical application and beyond,’’ Proc. IEEE, vol. 103, no. 6, pp. 926–943, Jun. 2015.

Short Biography

David Steyrl is teaching and research assistant at the Institute of Neural Engineering (BCI-Lab), Graz University of Technology, Austria. He received his M.Sc. in electrical and biomedical engineering from Graz University of Technology in 2012. His research interests include biosignal processing and machine learning for simultaneous EEG-fMRI and brain-computer interfaces. Currently he is working towards his PhD degree in computer science.