



EEG Signal Processing for Driver Sleepiness Detection

The Swedish National Road and Transport Research Institute (VTI) has an opening for two master thesis projects at the Human, vehicle, Transport system interaction unit (MFT). The objectives of the MSc theses are to develop signal processing algorithms able to extract the sleepiness level of a car driver based on multi-channel EEG data.

VTI and MFT

VTI is an independent and internationally prominent research institute in the transport sector. Its principal task is to conduct research relating to infrastructure, traffic and transport and its operations include all modes of transport. VTI has about 200 employees and is located in Linköping (head office), Gothenburg, Stockholm, Borlänge and Lund.

MFT conducts research on individual's possibilities and limitations in their interaction with traffic and other road users. In particular, this includes road user states such as sleepiness and inattention. With knowledge of how different states affect the goal of safe, sustainable travel, we can optimize the transport environment on the basis of the individual's possibilities and limitations.

Background

Finding a valid, robust and objective measure of driver sleepiness is difficult. The classic approach is to measure brain activity via an electroencephalogram (EEG), do a joint time-frequency analysis, and extract certain frequency components that have been found to relate to sleepiness. Unfortunately, this method doesn't work very well. Two recent findings in sleep research may aid in the development of new improved measures of driver sleepiness, *local sleep* and the *default mode network*.

Project topics

Over the past year we have acquired physiological data from 30 drivers at several occasions while driving an advanced driving simulator. Recorded data include a 31-channel EEG, EMG, EOG, ECG and data from the vehicle. The enormous task of analysing the data is just to begin, and we want your help in the analysis process.

Topic 1. Basically, task focused networks in the brain are activated when you are performing a task whereas the default mode network is activated in between tasks, e.g. when your mind wanders. Insufficient sleep affects how the default mode network is deactivated, resulting in default mode intrusions on task performance. The

topic of the first thesis project is to detect default mode activity while driving and investigate how it relates to driver sleepiness. Brain connectivity estimators, such as the directed transfer function, may be used to detect default mode activity.

Topic 2. Sleep has been thought of as a global phenomenon, but today it appears as if regions of the brain typically fall asleep at different times. During periods of local sleep, the eyes are open, the person is responsive to stimuli and the global EEG indicates an awake state. If a local brain region that is required for a particular task goes offline (falls asleep), performance errors are expected. The topic of the second thesis is to detect signs of local sleepiness and investigate how it relates to driver sleepiness. Low resolution electromagnetic tomography (an algorithm for solving the inverse problem, i.e. estimating which brain structure a certain scalp signal originate from), may be one way of solving this task.

The two MSc thesis works will be carried out individually and two separate reports will be written. However, much of the work is overlapping and team work will be highly beneficial for both projects. The thesis work is planned to start in January 2016 and is located to Linköping.

Qualification

- A genuine interest in mathematics and signal analysis.
- Engineering background within the areas of control, signal processing, biomedical engineering or similar area.
- Personal key qualities should include ambitious, diligent and open minded.
- Ability to work independently and to take initiatives.
- Language proficiency: English and preferably Swedish (the report will be written in English).

Application instruction

Deadline: Dec 31, 2015

Send your application with CV to: christer.ahlstrom@vti.se