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Use Cases Enabled by a Wireless Monitoring System for Physiological Signals

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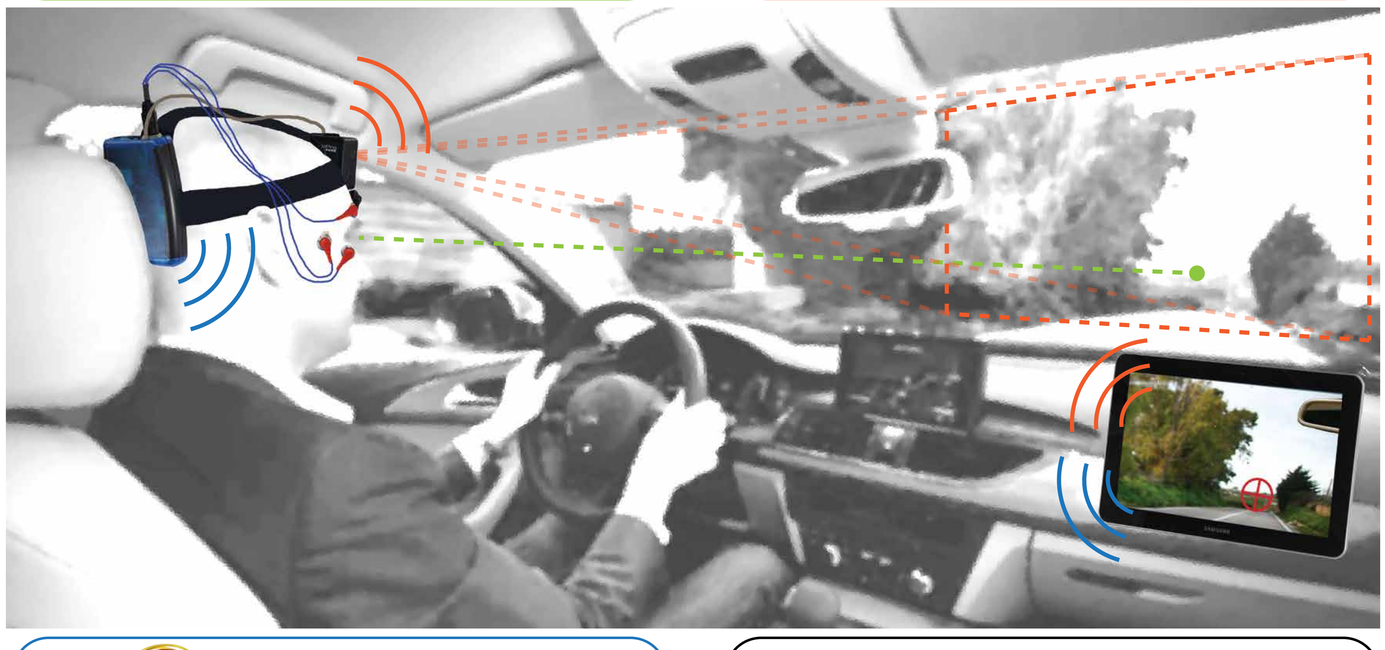
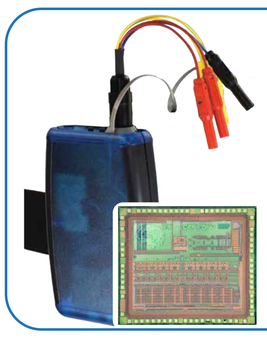
Electro-Oculography (EOG) Based Fitness to Drive Test

There is a requirement for regular testing of the fitness to drive for license holders - in particular for elderly drivers. Today's tests (Mini-Mental- State Examination, Clock Drawing test, ...) are purely medical. They do not reflect the exact demand of driving and are thus often questioned by both, experts and the persons concerned. In contrast, the proposed test can be done on-road in the examinee's own car.
It is based on EOG for recording the eye movement and a camera recording a head-centered video. Combining the data allows to determine the point of gaze and thus to analyze the patient's eye movements and focus. Saccadic eye movements have been identified by recent research as a physiological marker of overall cognitive status [1, 2].

EOG
- Corneo-retinal potential measurement
- DC potentials can be mapped to H&V deflection of the eye
- Maximum deflection ca. 30°

- Camera records a head-centered video of the drive
- Flashing LEDs add information for syncronization with the EOG
- Camera:
  - WLAN live preview (480p)
  - 1080p / 50fps video saved for offline analysis
  - FOV >60° H&V





EOG Device
- 2 ch. (H&V) EOG based on ETH's *Cerebro* 8-ch. data acquisition ASIC for electrodes based measurements
- Bluetooth data streaming
- Generation of synchronization signals (flashing LEDs on cam.)

- Miniaturization is planed

Computer Aided Analysis
- Low resolution live preview of the point of gaze allows to abort the test in grave cases

- Offline analysis on a HD video results in an objective fitness-to-drive test

References

[1] T. J. Anderson and M. R. MacAskill, "Eye movements in patients with neu rodegenerative disorders," Nature Reviews Neurology, vol. 9, pp. 74–85, Feb. 2013.
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[3] Nussbaumer-Ochsner Y. et al., "Air travel and altitude", 2010.
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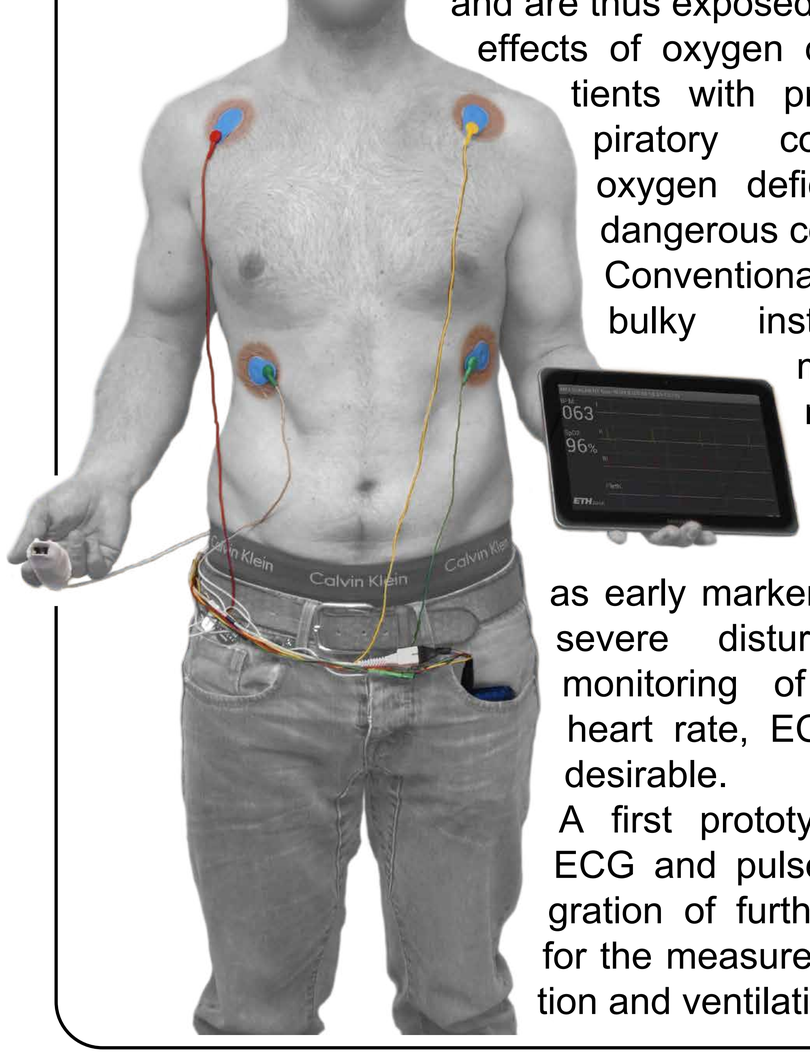
Early Detection of Alterations in Cardio-Respiratory Function

Millions of persons are exposed to reduced barometric pressure, e.g. during air journeys or when travelling to the mountains, and are thus exposed to potentially harmful effects of oxygen deficiency [3]. In patients with preexisting cardio-respiratory conditions hypobaric oxygen deficiency may lead to dangerous complications [4].
Conventional testing requires bulky instrumentation which makes it impossible to measure during ordinary activities. To detect subtle alterations in lung function as early markers of impending more severe disturbances, continuous monitoring of oxygen saturation, heart rate, ECG and ventilation is desirable.
A first prototype system provides ECG and pulse oximetry. The integration of further sensing hardware for the measurement of motion, position and ventilation is planned.



Continuous Recording of EEG Signals in the Sleep Laboratory

The electroencephalogram (EEG) provides an non-invasive opportunity to record the activity of neuronal populations. The EEG is highly correlated with a variety of cognitive functions, behavior, and cortical states - these features have made it a standard research tools for understanding brain behavior and disorders.
Today's understandings of brain function are limited to lab or hospital environments since the used heavy and wired instrumentation prevents measurements in everyday situations. Even in stationary situations, e.g., sleep monitoring in a lab, the long wires connecting the electrodes on the proband to the amplifier can disturb the proband, leading to a bad sleep and thus affecting the 'experiment'.
A portable wireless device will enable countless new applications for EEG from tracking the sleepiness of truck drivers to monitoring brain activity as a function of time of day and to tracking of minor epileptic episodes.