N. Mora, V. Bianchi, I. De Munari, P. Ciampolini. ***Design for a low cost brain-computer interface for environmental and home control.*** *Gerontechnology 2012;11(2):300;* doi:10.4017/gt.2012.11.02.604.00 **Purpose** Modern ICT-technologies can positively impact the current aging-population scenario: ambient assisted living (AAL) techniques aim to make the home environment more intelligent and cooperative and help to accomplish daily living tasks, whereas ICT-based assistive technologies (AT) deal with specific needs of people with disabilities. In this abstract, we discuss an integrated approach, which exploits AT-techniques, namely brain-computer interfaces (BCI)[1], to make AAL-benefits available to people with severe motor impairments. BCI, however, commonly involves expensive and somewhat bulky gear, and are therefore scarcely suitable for such a purpose. We aim to improve usability of BCI-based home control by devising a light device with a low electrode count. Manufacturing costs, as well as power consumption, are kept low by exploiting standard, low-power electronic circuitry. **Method** CARDEA[2] is an AAL-system which exploits LAN-technologies to implement safety, home and environmental control, and monitoring applications (such as localization, fall detection, heartbeat, and breathing rates) in a unique, convergent vision. The BCI-module was integrated into the CARDEA-system, to allow end users – such as impaired subjects or people in constant need of care – to take full advantage from such features. The BCI-module acquires EEG-signals and exploits the steady state visually evoked potentials (SSVEP) paradigm; a small number of dry-contact electrodes (up to 5, held in place by a headband) is used for user's comfort. An analog front-end (AFE) for continuous EEG-monitoring was designed. For best noise performance (signal amplitudes are as low as a few μV, affected by motion artifacts and other interference sources), a low-noise, high-gain instrumentation amplifier was adopted. To cope with large DC-offsets at the electrodes, AC-coupling techniques were implemented. An analog, second-order low-pass filter with a 159 Hz cut-off frequency (compatible also with ECG-acquisition) limits the signal bandwidth prior to digitization by a 24-bit analog to digital converter. Digital filtering is performed subsequently to deal with narrower bandwidth shaping. In order to promptly connect the module to CARDEA (and looking for device interoperability) the BCI-module also features autonomous data processing capability. This reduces the need for complex, high-performance communication protocols, allowing the adoption of low-power wireless standards, such as ZigBee. **Results & Discussion** First, the CARDEA-interaction scheme was validated: a single-channel, commercial device (NeuroSky MindSet) was used to control ambient lighting, exploiting the SSVEP-paradigm. Testing was carried out with a set of ten untrained, healthy volunteers (in the 21-to-45 age range), and an average of 60% selection accuracy was attained. The design of a dedicated hardware platform was then carried out in an effort to improve and extend the capability of the EEG-signal monitoring, exploiting multi-channel acquisition techniques. Referring to the AFE described above, an integrated noise of 0.2 μVrms was estimated over the signal bandwidth, which should be more than sufficient to clearly distinguish relevant features of the brain waves. The board currently being developed will allow a more comprehensive set of tests, aimed at characterizing performance with respect to the actual number and position of exploited electrodes, with the goal of setting optimal specifications for a low-cost, embedded BCI-module suitable for AAL-applications.

References

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