

Wearable Eye Tracker

Detecting Eye Movements During Physical Activities

Keywords

Electrooculography (EOG), eye movements, wearable, long-term recordings, adaptive real-time signal processing, artefact compensation, interactive gaming, input device, human-computer interaction (HCI)

Background

For medical examinations such as the diagnosis of disorders in the oculomotor system or for the detection of REM phases in sleep polygraphy, so far, patients have to visit a specialized hospital or doctor. During such a consultation, eye movements are usually recorded using electrooculography (EOG) and analysed by hand in a postprocessing step. It would be desirable to be able to perform an automatic recording and analysis of eye movements of a person over a longer period of time in daily life.

With interactive games having become very popular, the interest in novel input devices (such as the Wii from Nintendo) increases. Eye movements could be implemented as a new gesture-based input channel for these games. For this, they have to be recorded robustly and unobtrusively during physical activity.

To achieve this, EOG electrodes can be attached to a glasses frame worn by the user which minimizes disturbances during physical activities. However, eye movement recordings have to be made robust to the following external influences:

- Changes in ambient light
- Optokinetic effects of head-eye interaction and physical activity
- Changes in skin humidity caused by sweating
- Other similar signal artefacts

System

- A wearable eye tracker (see Fig. 1) which consists of goggles with dry electrodes integrated into the frame for EOG recording and an analysis component which processes the signals in real-time. Another unit worn on the body allows for data storage and wireless transmission over several hours.
- A corresponding procedure for signal processing and eye movement analysis which performs automatic compensation and adaptive processing of EOG signals in real-time by taking into account data from one or more additional sensors (e.g. light sensor, accelerometer, humidity sensor).

Fields of Application

- Medical: e.g. long-term examinations of eye movements and their characteristics
- Research: e.g. psychological diagnosis or the analysis of human social interactions
- Home care: e.g. monitoring of disabled or elderly people and automatic notification of medical emergency
- Game industry: e.g. as a new input device for traditional and novel interactive games
- Novel interfaces for consumer electronics

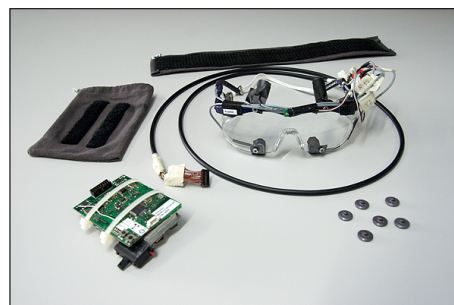


Fig. 1: Prototype of the wearable eye tracker: goggles, pocket device, dry electrodes and armlet with cloth bag.

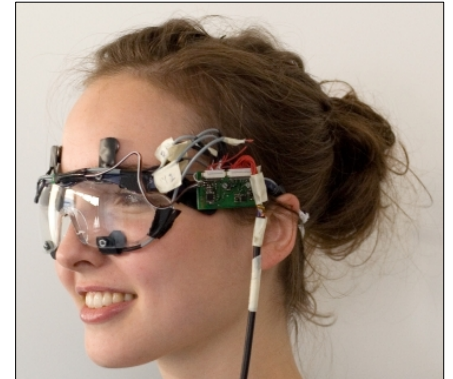


Fig. 2: Goggles with integrated EOG electrodes and signal processing unit worn on the head.

Main Advantages

- Wearable and unobtrusive device with complete integration into goggles possible (see Fig. 2)
- Use of dry electrodes
- Automatic analysis, data storage and wireless transmission
- Long-term, daily-life recordings
- Adaptive real-time signal processing and artefact compensation

References

- Bulling et al., *It's in Your Eyes - Towards Context-Awareness and Mobile HCI Using Wearable EOG Goggles* UbiComp 2008
- Bulling et al., *Robust Recognition of Reading Activity in Transit Using Wearable Electrooculography* Pervasive 2008

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