A NEW VIDEO ACTIGRAPHY METHOD FOR NON-CONTACT ANALYSIS OF BODY MOVEMENT DURING SLEEP

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Objectives

To assess sleep in the home situation, wrist actigraphy is often used. However, it is an on-body sensor which may influence sleep and it only collects data on the movement of one wrist. Video actigraphy methods overcome these issues.

We developed a near infrared (NIR) sleep monitoring system (see Figure 1). It can handle many viewing angles and NIR lighting settings, which makes installation in the bedroom easy.

The NIR sleep monitoring system performs the analysis in real-time and with volatile memory, so that privacy issues are limited.

The aim of this study was to compare the activity levels from wrist and video actigraphy.

Figure 1. The sleep monitoring system, using NIR LEDs and a NIR sensitive camera

Figure 2. Resulting color-coded motion vectors from the processed video images. Blue area: hand moves to the right. Green area: head moves to the left.

Figure 3. Resulting motion vectors from the processed video images. The different colors indicate different motion of the corresponding body parts.

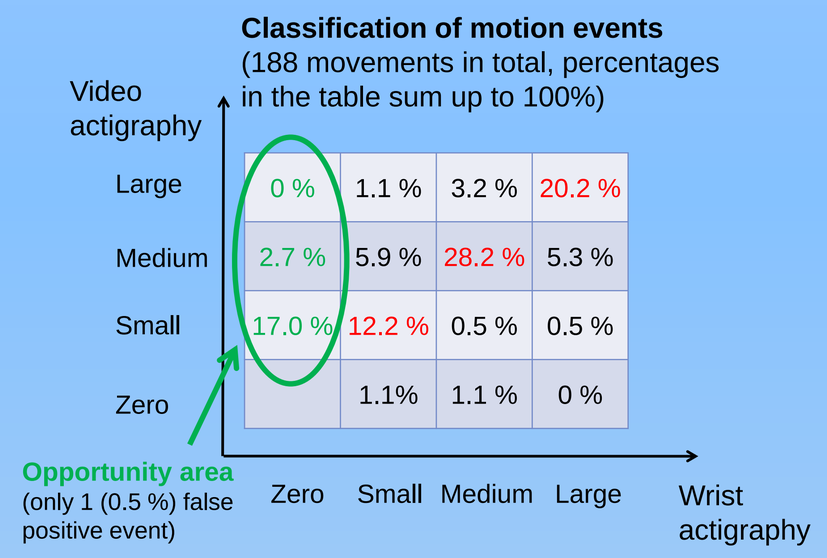

Figure 4. System validation with an overview of the classified motion events. The good correspondences and the opportunity area for video are highlighted.

Methods

Experimental setup
Five participants were monitored using both wrist actigraphy and the video actigraphy system in their own bedroom (see Figure 2).

The participants installed the system such that the bed was in line-of-sight and the non-visible NIR light was strong enough.

The angle between image sensor and bed, type of beds and blankets varied among the participants. This allowed us to test the system under different conditions.

Video-based activity estimation method
Recursive search motion estimation is performed on two consecutive video images. The video-based actigraphy measure is derived from the computed motion vectors (see Figure 2 and Figure 3).

Results

The motion data obtained by the video actigraphy system corresponded well to the wrist actigraphy signals for small, medium, and large motions (see Figure 4).

Opportunity areas for video arise when dealing with body part movements, e.g. of legs, that are not detected by wrist actigraphy.

Further, arm, leg, head and torso movements, and tossing and turning, were detected even though the person was sleeping under a blanket and in various positions.

The system could handle the different angles, beds, and blankets well.

Conclusion

Our off-body video actigraphy system can successfully replace on-body actigraphs to monitor a sleeping person's movements. The system is convenient and easy to use in real home situations.

Future work will explore the system's opportunities beyond the possibilities of wrist actigraphy, such as motion analysis of specific body parts over time, which is relevant for e.g. PLM detection.

When developed further, the system may be a cheap and easy to use solution for personalized sleep awareness and for an early and convenient diagnosis of sleep disorders.