

# Using accelerometers as actigraphs

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## Objectives

Actigraphy is an accepted measure of sleep wake cycles. Typically actigraphs quantify uniaxial movement into proprietary epoch based activity counts which are then used for sleep wake classification. With recent technical advances new accelerometers can record raw three dimensional acceleration values for 3-4 weeks. This is comparable to traditional actigraphs. Currently it is unknown how raw accelerometer values correspond to standard actigraph activity counts. Analysis has been done for Actigraph GT1M during wakefulness [1].



Figure 1. Used devices GENEActiv (Activinsights Ltd) and AW7 (CamNtech Ltd).

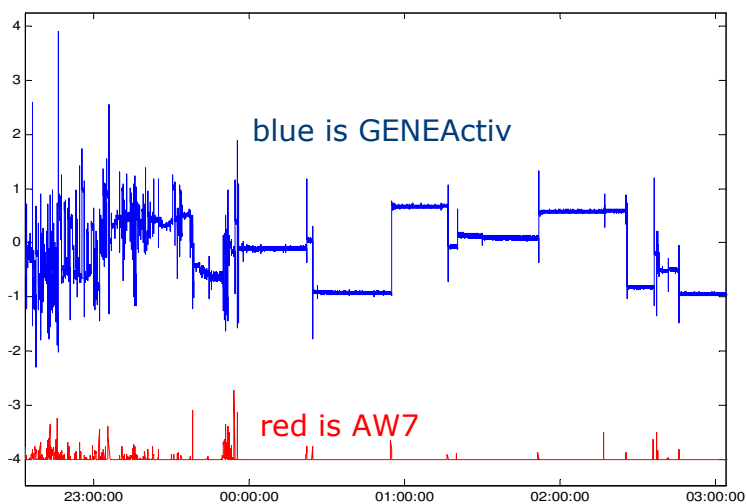


Figure 2. Raw data examples. Red AW7 2 s epoch data is scaled to 1/100 with -4 g offset.

## Methods

In this study we studied how the new GENEActiv (Activinsights Ltd) raw 100 Hz accelerometer values could be transformed into values comparable to a common actigraph (Actiwatch 7, CamNtech Ltd). A total of 372 hours of 24h activity data was collected from four participants with two devices fixed together. After temporal alignment of data the three dimensional raw GENEActiv accelerometer values were converted into epoch values (G) by filtering

one axes values and calculating maximum absolute values inside 1 second epochs. These maximum values were then summed over 30 s epochs (G). With AW7 actiwatch 15 of 2 s epoch values were summed. Epoch values were tested also for sleep classification using the Actiwatch algorithm.

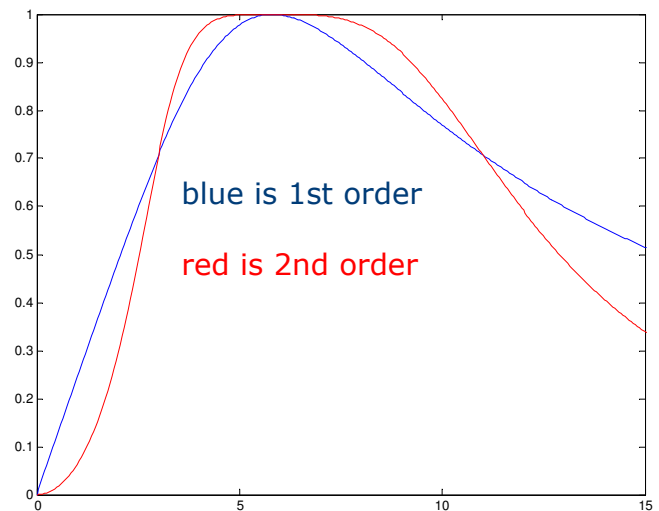


Figure 3. Amplitude responses of the used 1st (blue) and 2nd (red) order filters 3-11 Hz.

## Results

With a 1st order butterworth IIR filter with bandwidth 3-11 Hz, correlation coefficient between calculated epoch values between two devices was 0.96. The equation to obtain Actiwatch 30 s epoch data (A) was  $A=49G-23$ , where G was calculated as described earlier. Agreement of wake/sleep classification between devices of 24h data between devices was 94%. With a 2nd order filter the results were 0.95,  $A=53G-20$ , and 93%.

When using transverse plane axes of the accelerometer results were worse 0.89 (61%) and 0.87 (59%). With 10 hz downsampled data and 3 Hz 1st order high pass filtering results were 0.93 (94%). It is not clear if there is a benefit in using multiple axes and high sampling rates [2].

## Conclusion

New three dimensional accelerometers can be used to obtain activity counts comparable to traditional actigraph. However new algorithms should be developed and validated against polysomnography to take advantage of additional recorded data. New algorithms could lead to better agreement with polysomnography. While this development is undertaken, results comparable to standard actigraphs can be obtained by simple filtering.

## References

- [1] van Hees VT, Pias M, Taherian S, Ekelund U, Brage S. A method to compare new and traditional accelerometry data in physical activity monitoring. World of Wireless Mobile and Multimedia Networks (WoWMoM). 2010
- [2] Zhang S, Murray P, Zillmer R, Eston RG, Catt M, Rowlands AV. Activity Classification using the GENE: Optimum Sampling Frequency and Number of Axes. Med Sci Sports Exerc. In press.