An Evaluation of Timing and Synchronization among Tobii, Affectiva, and Emotiv Physiological Devices

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Timing and synchronization are crucial elements in psychophysiological research, where consecutive data samples may be separated by no more than a millisecond or two. Psychologists and neuroscientists typically combine specialized hardware and software that provide the level of precise integration needed to address their research questions. However, this hardware and software is often expensive and complex to use.

In recent years, physiological recording devices designed for clinical or consumer applications have become more widely available. These devices aim to be inexpensive, easy to use, and/or less intrusive than traditional research equipment. For example, Affectiva's Q Sensor is a wireless device used to record skin conductance, temperature, and motion. A wrist strap and dry electrodes enable the Q Sensor to be worn during normal daily activities, and the battery allows for up to 24 hours of data recording. Another example is Emotiv's EPOC headset, which is an inexpensive wireless electroencephalography (EEG) device. Both of these devices were designed for consumer and assistive applications as well as research.

Such devices may be particularly useful for business and information systems (IS) researchers. Their relative inconspicuousness allows for data collection in settings that more accurately reflect real-world situations. Devices which are less expensive and/or easier to use also increase accessibility to this area of research. For instance, smaller schools and individual researchers may be able to acquire these devices more easily.

For researchers looking to integrate data from multiple physiological recording devices, a key question is how well data from such devices can be synchronized. The purpose of this study is to answer that question with regard to three specific devices: Tobii T60 eye tracker, Affectiva Q Sensor, and Emotiv EPOC headset.

A technical report by Hairston (2012) provided an analysis of timing drift and variability (also known as jitter) among four common EEG systems (one of which was the Emotiv system). In his study, Hairston examined timing differences between a stimulus presentation computer running E-Prime and the data acquisition computer running each EEG system's native software.

The current study extends Hairston's work in three ways: 1) timing drift and jitter are evaluated simultaneously for the three physiological devices previously listed, 2) data are collected over longer periods of time to determine the impact of drift during experiments involving complex tasks or a greater number of trials, and 3) performance of the Emotiv system is compared with Hairston's results to determine whether a newer firmware version improves timing accuracy.

One challenge with testing these devices relates to event recording. While the Tobii and Emotiv systems can read event markers from external devices (e.g., through TTL signals), Q Sensor version 1.0 does not. This version of Q Sensor is self-contained and only records data locally on the device itself. It is necessary to instead simulate event markers in the data through a transistor switch connected to the stimulus computer's parallel port. Figure 1 shows how the systems are connected.

Timestamps from each device are regressed on timestamps from the stimulus computer to determine drift. Means and standard deviations of timestamp differences reflect jitter. Results of the analysis will be presented at the retreat.

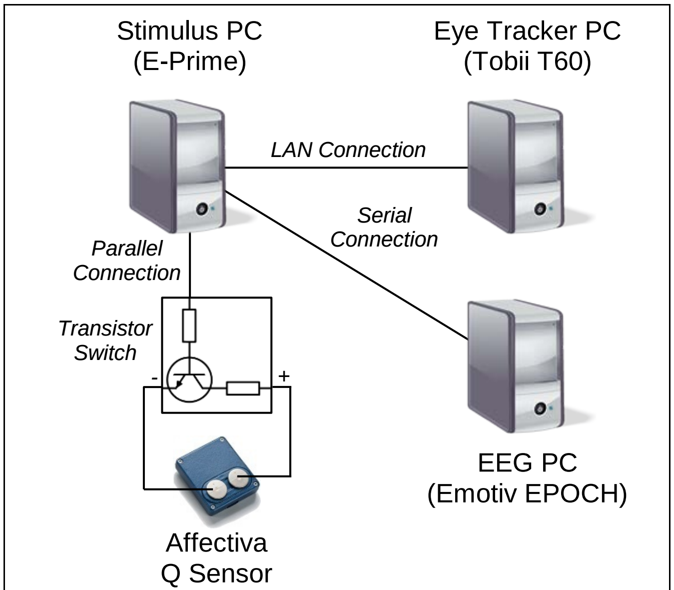

Figure 1. System Connections used for Testing

References

❖ Hairston, W. D. 2012. "Accounting for Timing Drift and Variability in Contemporary Electroencephalography (EEG) Systems," U.S. Army Research Laboratory Technical Report ARL-TR-5945, Aberdeen Proving Ground, MD.