Data Synchronization for Cognitive Load Estimation in Driving Simulator-based Experiments

Zeljko Medenica, Andrew L. Kun
zeljko.medenica@unh.edu, andrew.kun@unh.edu
www.project54.unh.edu
www.unh.edu

1. Background:

There exist many measures which can be sensitive to cognitive load changes, such as driving performance, physiological and subjective. Studies have shown that none of these measures is a panacea, thus requiring researchers to often collect more than one measure using different equipment.

2. Problem:

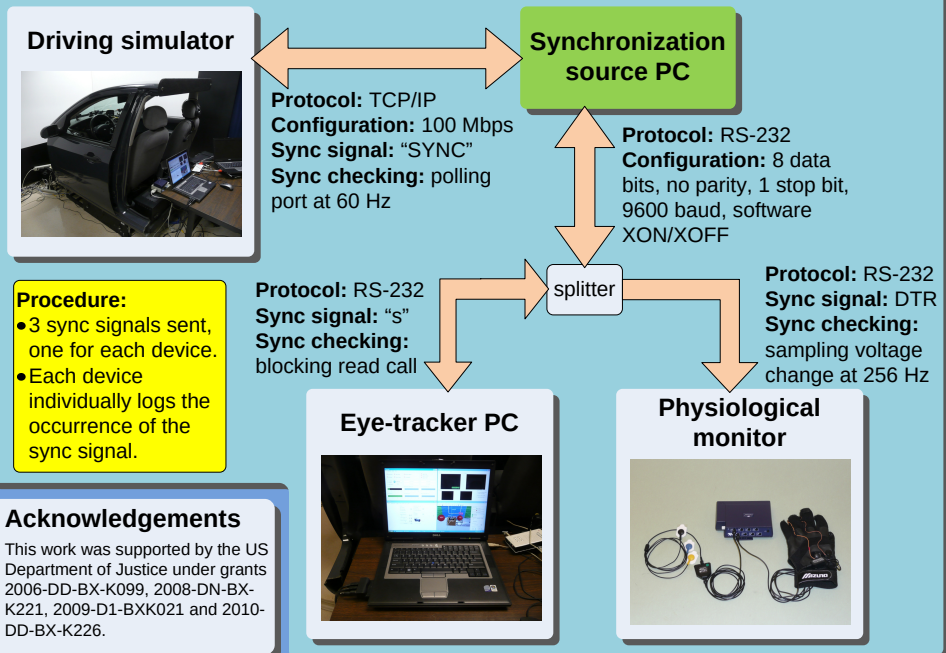
The fact that different equipment has to be used in collecting data means that a reliable solution for data synchronization is necessary.

3. Approach:

We propose synchronizing data collections using TCP/IP and serial (RS-232) communication. We demonstrate these concepts on the following equipment commonly used in our studies:

- Driving simulator,
- Eye-tracker,
- Physiological monitor.

4. Hardware and software configuration:



Procedure:

- 3 sync signals sent, one for each device.
- Each device individually logs the occurrence of the sync signal.

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5. Testing proposed solution:

The proposed solution was tested by measuring the round-trip delay: time for the sync signal to travel from the source PC to the desired destination and back.

2000 sync signals sent every 2 seconds. The following one-way delays obtained:

- **Towards driving simulator:** max delay 7.5 msec, min delay 0 msec, average delay 6.33 msec, standard deviation 2.73 msec.
- **Towards eye-tracker's PC:** max delay 8 msec, min delay 0 msec, average delay 7.98 msec, standard deviation 0.198 msec.
- **Towards physiological monitor:** estimated maximum delay of 3.9 msec imposed by the monitor (1/256 Hz). Maximum signal change delay 1/9600 = 0.104 msec.

7. Conclusions

- The proposed solution demonstrated low and reliable delays.
- 8 msec delay over RS-232 allows sampling rates up to 125 Hz.
- 7.5 msec delay over TCP/IP allows sampling rates up to 133 Hz.
- 0.104 msec delay in DTR voltage change would allow sampling rates up to 9.6 kHz.
- The longest observed delay supports data sampling rates which are faster than the ones typically observed in literature.