Zep EEG Testing

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Intro

We currently use Presentation (from Neurobs) for stimuli presentation in in EEG experiments. Presentation is proprietary software that overall works very well but requires additional development skills from the technical staff. Zep would allow the EEG lab to switch to Linux. Zep is something we all know. With the acquisition of a BeexyBox X we can now feasibly send EEG markers from Zep. Simply connect the digital out port to the BioSemi 'trigger' box.

The BioSemi EEg equipment has a large parallel connector. Currently the Presentation software uses a PCI-card based parallel port to send markers. Sending markers happens on onsets of stimuli events or are script triggered. Within the EEG recordings the timing of markers are crucial. EEG-data analysis generally consists of averaging many trials. Any variation in the marker timing will very likely result in a net loss of signal and loss of statistical power; bad data.

On the hardware level the markers are an X number of lines that are active in a Y configuration to transfer a single integer across the parallel port. The single integer is then recorded within the EEG recording with the time-stamp of when it is received. Possible timing jitter can be caused by any of the many interaction layers between the hardware and the software.

Test

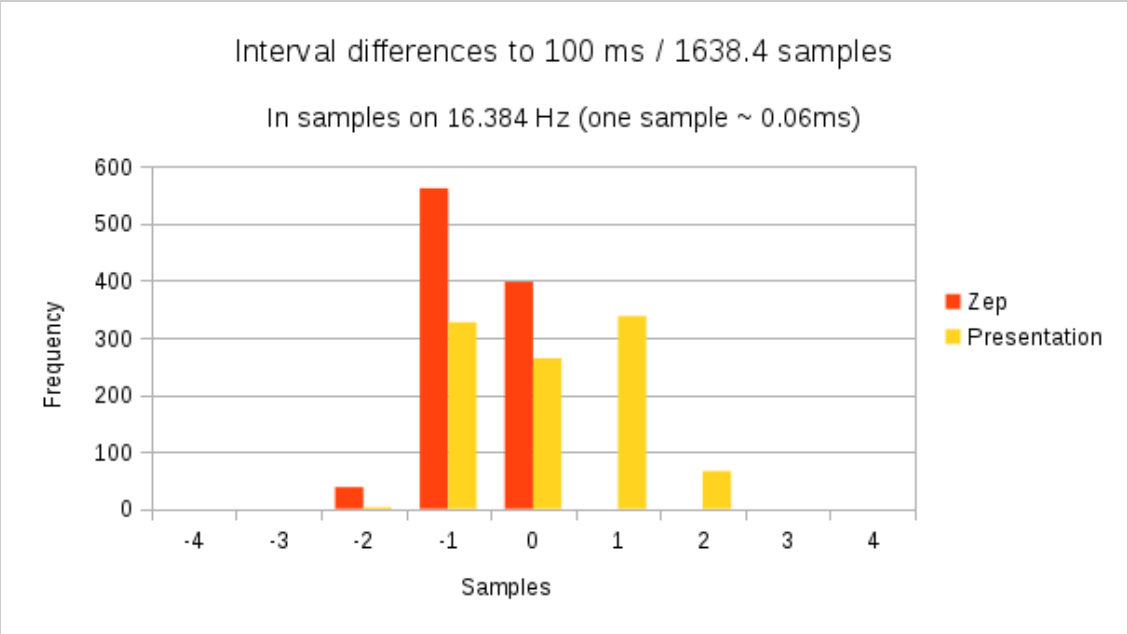
We cannot suddenly drop Presentation and start using Zep without testing the properties of the latency. The variance in latency needs to be equal or better than that of Presentation. I devised a simplest test. The test consists of sending markers at fixed intervals and compare the requested intervals with the actual intervals found in the recording. The differences between the intervals show the variation of the latency. The results are below.

Results

We send a marker pulses of 20 ms every 100 ms. We did this for both Zep and Presentation. The signal (including markers) was recorded by the BioSemi equipment at 16kHz (i.e. one sample ~0.06 ms). The recording stopped after having sent a 1000 markers. BrainVision Analyzer was then used to extract the marker timings from the .bdf files.

The repository holding the scripts used for testing can be found here (https://gitlab.lab.hum.uu.nl/uilots-labs/beexybox-eeg-integration).

	Mean (ms)	SD (ms)	MIN (ms)	MAX (ms)	MEDIAN (ms)	MIN (samples)	MAX (samples)	MEDIAN (samples)
Zep	-0.039	0.034	-0.122	0.000	-1	-2	0	-1
Presentation	0.008	0.059	-0.122	0.122	0	-2	2	0



Histogram of a latency test at 100 ms interval using 20 ms pulses and repeated a 1000 times.

Conclusion

The results would suggest that Zep markers perform equally or even better than Presentation. The maximum offset of the perfect interval was two samples for Zep. Most of the times it was only off by one sample. This is to be expected since 100 milliseconds is not a round number of samples; 100 Ms is 1638.4 samples. Somewhere within the 1639st sample after the first marker onset the next marker starts. Another subtly is that the used testing methodology can be argued to **double** the jitter. This doubling is due to

each recorded interval being marked by two markers. Each of the markers adds jitter to the interval.

Sampling on 16kHz shows that Zep is nearly perfect in timing. Since most recordings are at 2kHz we can conclude that Zep markers can safely be used for experiments.

Module

In the (near) future a Zep module for sending markers can be found here: https://github.com/UiL-OTS-labs/ZEP-EEG-Markers-Module