Report. g.Nautilus latencies.

1. Methodology

Several experiments were conducted to determine latencies occuring when using the g.Nautilus device. All experiments utilized a photoresistor to detect the true onset time of appearance of images. The signal from the photoresistor was digitized in arduino and sent in two ways: directly to PC via USB and to Digital Input of the g.Nautilus. Here is the description of the trigger channels recorded during the experiments and depicted in the Fig.1:

- “arduino”: signal from the Arduino connected directly to PC via USB (this signal always appears first, because it has almost no latency);
- “DI”: signal from the Arduino connected via Digital Input of the g.Nautilus (this signal appears later than “arduino” and most likely shows the default latency of the g.Nautilus device);
- “tap-ch”: one of the EEG channels that was tapped on. That tapping moment could be detected both from EEG data and from the video recorded during the experiments;
- “GroupID”: image appearance moments as recorded by the ParadigmPresenter - a Simulink block from g.tec that displays the images on the screen;

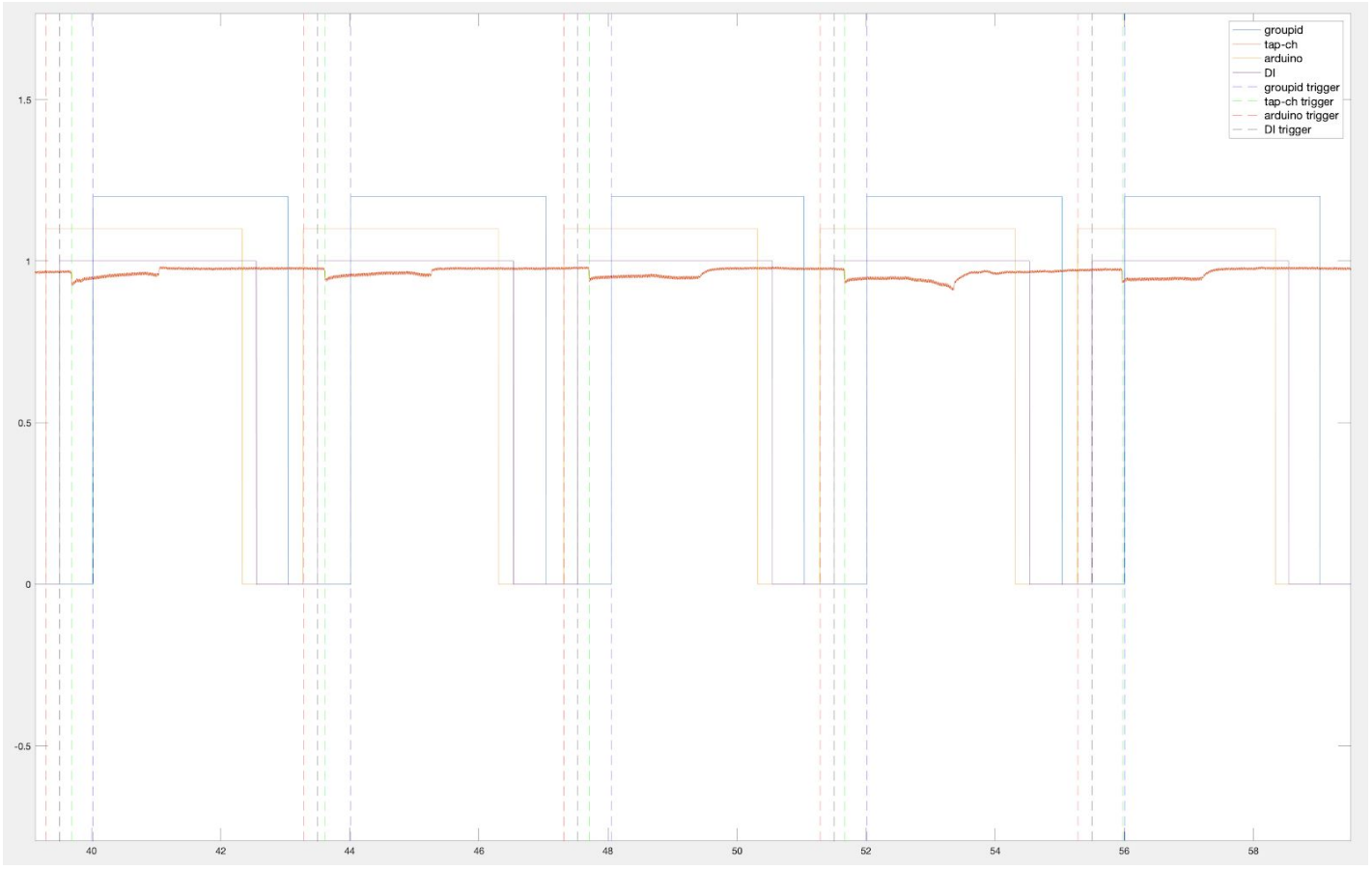

Fig.1. GroupID, tapping, arduino and Digital Input channels.

2. Conclusion

Two types of latencies occurred during the experiments:
1. g.Nautilus data (EEG and DI) are recorded with the delay (~250ms). This delay is confirmed by the g.tec company.
2. GroupID is recorded with ~800ms delay relative to the true onset time.
Question: Are these latencies stable over various experiments and different laptops?

3. Stability of the latencies

To address this question, additional experiments were conducted with Lenovo440 (old Lenovo that was available and used during all the eSports experiments) and Lenovo480 (newer Lenovo with better characteristics).

Figures 2 and 3 suggest that both types of delays are quite stable over various runs and setups (on/off simulink lamp block, small/fullscreen) for the newer Lenovo laptop, except for the case of the busy laptop. It is clear that if the laptop was busy with other tasks, then the delay was significantly incresed.

In contrast, figures 4 and 5 show that the Lenovo-440 have greater latencies, which are not stable over different runs. Apparently, the experiment itself is too heavy task for this laptop, that is why it is constantly being used in the “busy” mode. It is worth mentioning that the delay of DI and GroupID is correlated, which suggests that the cause of both delays is the high load of the CPU.

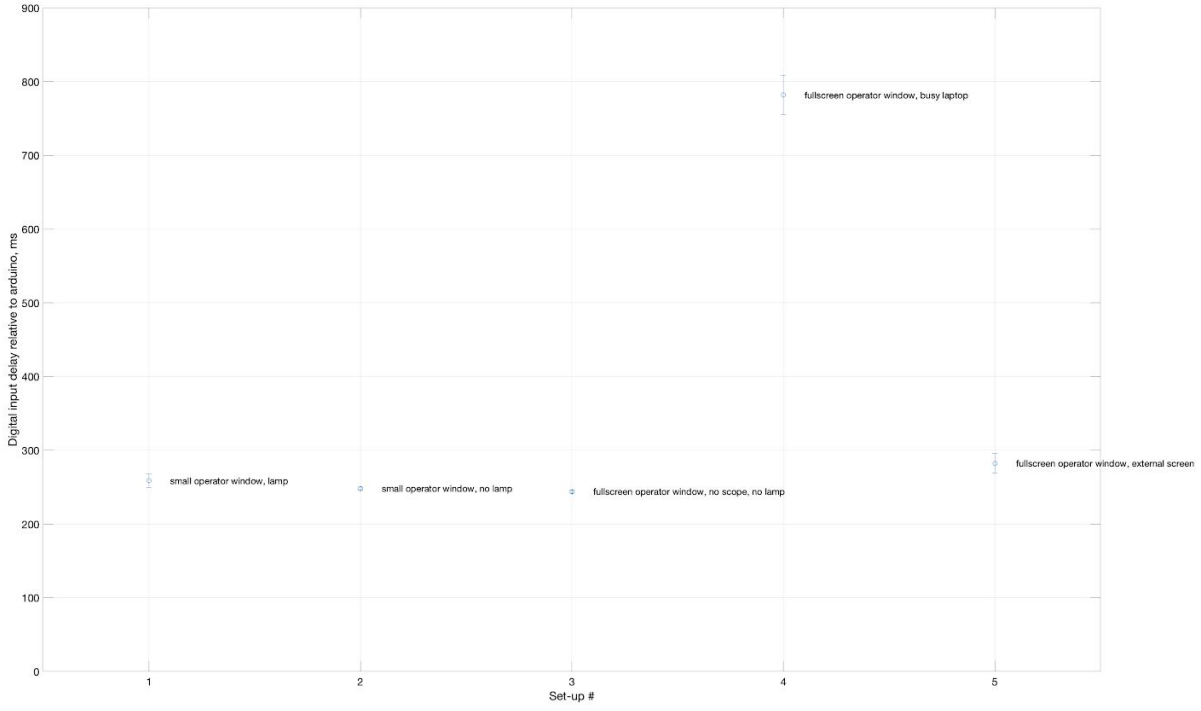

Fig.2. Digital Input delay when recorded on the Lenovo-480 (the newer laptop). The delay is stable except for the busy laptop set-up.

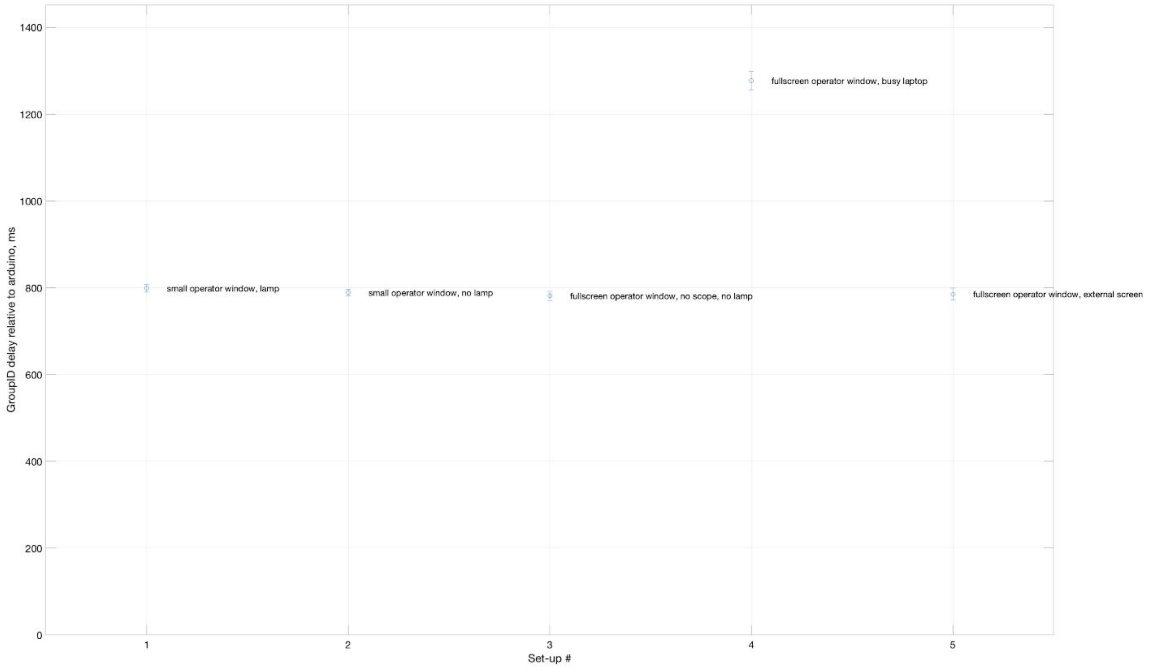

Fig.3. GroupID delay when recorded on the Lenovo-480 (the newer laptop). The delay is stable except for the busy laptop set-up.

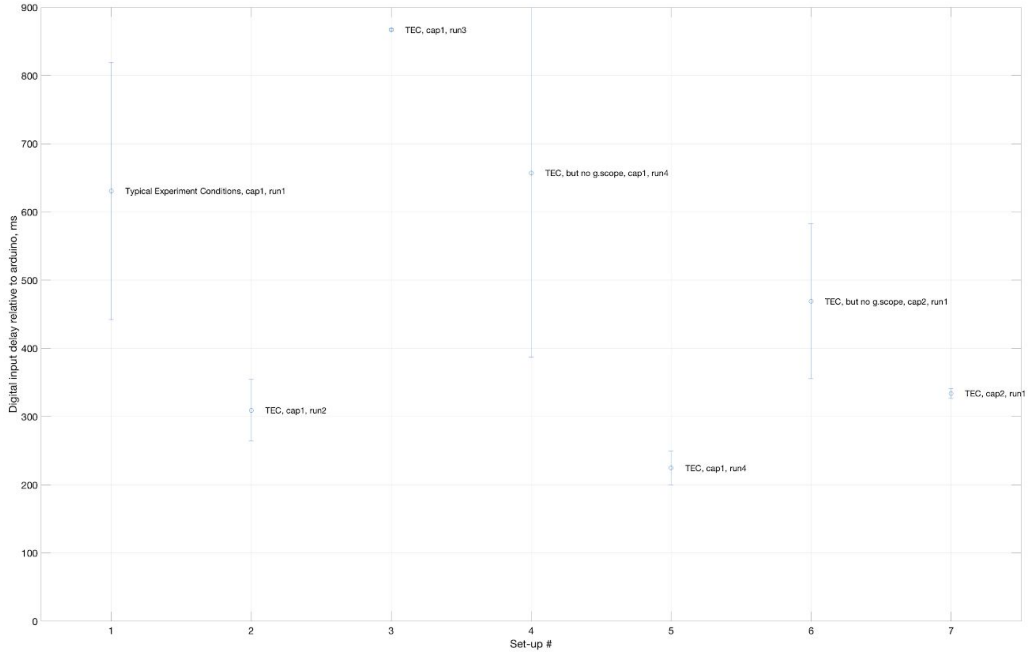

Fig.4. Digital Input delay when recorded on the Lenovo-440 (the old laptop). The delay is not stable.

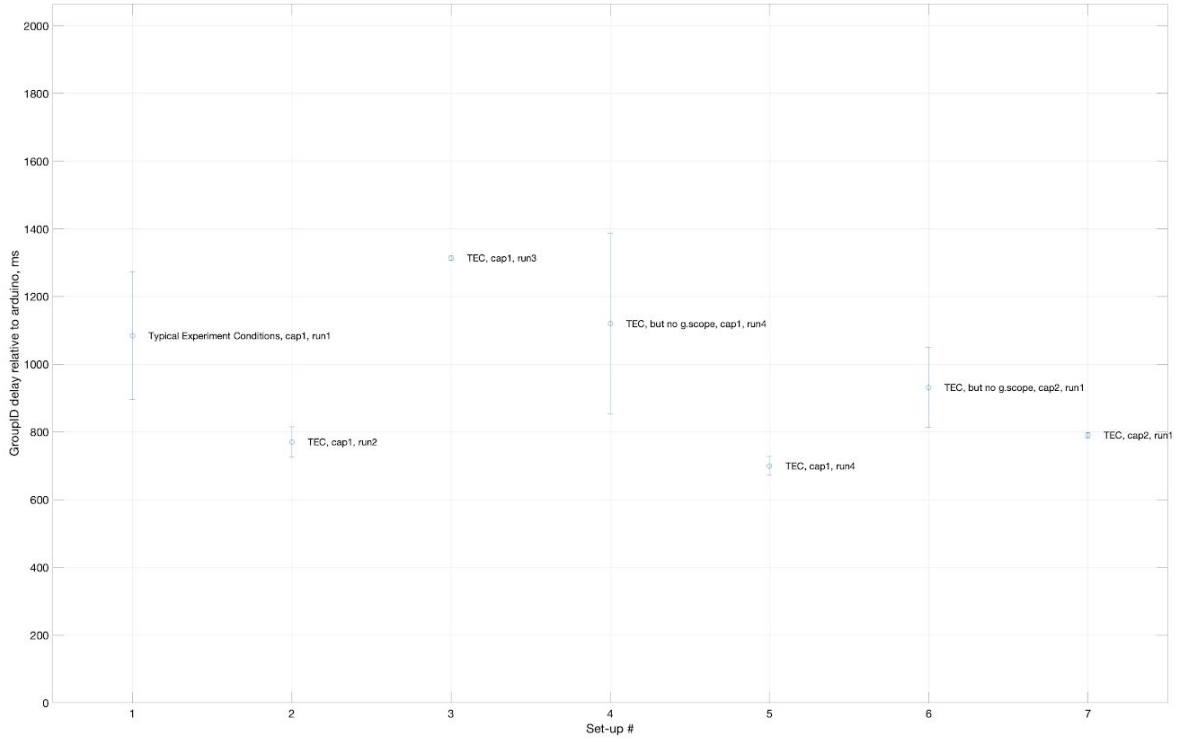

Fig.5. GroupID delay when recorded on the Lenovo-440 (the old laptop). The delay is not stable.

4. ERPs recorded during the eSports experiments

The question occurs if it is possible to use the data from the CS:GO experiments taking into account that (1) there were two types of the delays and (2) these delays were most likely not stable, because only the old laptop was available to record data (Lenovo 440).

One of the suggestions was to extract features from the calculated ERPs that are not dependent on the onset time. For instance, the difference between max and min values of the ERPs (1), longitude of the peak (2) (number of time points where the amplitude is higher than mean).

Feature (1) was not found to be significant with the non-parametric Wilcoxon signed rank statistical test (ANOVA can't be used because of the small number of subjects - 16).

Feature (2) was found to be significant with $p<0.05$ with the non-parametric Wilcoxon signed rank statistical test in the experiment 2_2_4 (pictures from the CS:GO video-game were displayed on the screen, and the subject was asked to count the number of images with a CS:GO character in it, see Fig. 6).

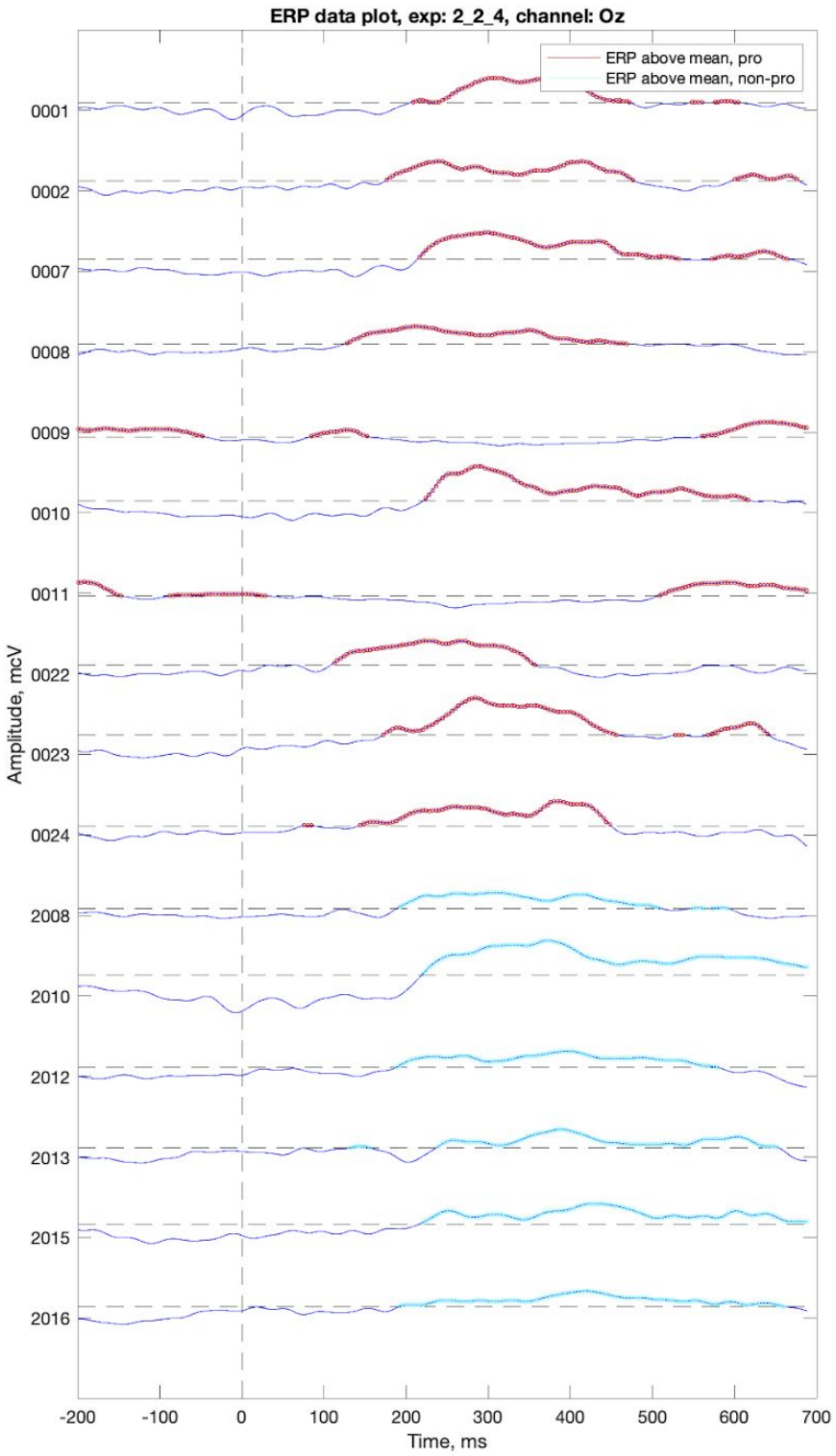

Fig.6. ERPs recorded during an experiment where pictures from the CS:GO video-game were displayed on the screen, and the subject was asked to count the number of images with a CS:GO character in it.