MEASUREMENT OF THE ACQUISITION DELAY OF A DIGITAL CAMERA

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Abstract. The acquisition delay is a key parameter to get, within a few milliseconds of accuracy, precise measurements of timestamps for occultations of stars by asteroids or other minor bodies in the Solar System. An experimental setup to measure it under Windows 10 is summarised here.

Keywords: occultations, asteroids, digital camera, acquisition delay, Windows

1 Introduction

The acquisition delay was defined by Pavlov and Gault and graphically detailed in their Fig. 1 (Pavlov & Gault 2020). It is the difference in time between the date of the end of exposure of an image and the date when this image is timestamped by the video acquisition software.

2 Experimental setup

The equipment[*] used is listed here:

- a GPS module with PPS signal, presently an Uputronics uBLOX MAX-M8Q Breakout[†], on which is connected a GPS antenna

- a 3 mm diameter LED, associated with a protective resistor of 4.7 to 22 kΩ

- two or three 1.5 V batteries, depending on the voltage of the GPS module

- a standalone NTP stratum 1 time server based on a Raspberry Pi[‡], on which is connected the GPS module

- a Asus N750J computer (i7 + SSD) under Windows 10, on which is connected the Raspberry Pi with a crossed RJ45 (Ethernet) cable

The plus pole of the LED is connected to the TP of the GPS module, the minus one to the GRND, the assembly is shown on Fig. 1. Two digital cameras were tested: a ZWO ASI174MMC (global shutter), and a QHY 224C (rolling shutter). An example of measurement is shown of Fig. 1 and detailed as follows. The 1PPS signal from a GPS module is used to power the LED. The light flow is recorded with the digital camera and analyzed with Tangra (see below). The times T1 to T4 are the end-of-frame timestamps made by the video software, the blue area corresponds to the fluxes measured by Tangra for each frame. The 1PPS signal with a duration of 100 ms appears towards the end of frame 1 and lasts 15 ms. The light intensity of the LED being constant, the flux is proportional to the duration of the 1PPS signal in the four frames.

The software used comprised:

- the Meinberg NTP software to synchronise the Windows system clock[§], and its NTP Monitor software to monitor the NTP regulation of the clock[¶]

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[*]More details are available on my web page (in French) at `http://nocturno.fr/`
[†]`https://store.uputronics.com/index.php?route=product/product&path=64&product_id=84`
[‡]See Marquette & Le Cam, this book.
[§]`https://www.meinbergglobal.com/english/sw/ntp.htm`
[¶]`https://www.meinbergglobal.com/english/sw/ntp-server-monitor.htm`

- SharpCap version 4.0.8395.0 for video recording[||], and Tangra version 3.7.0.3 for video file reduction[**]

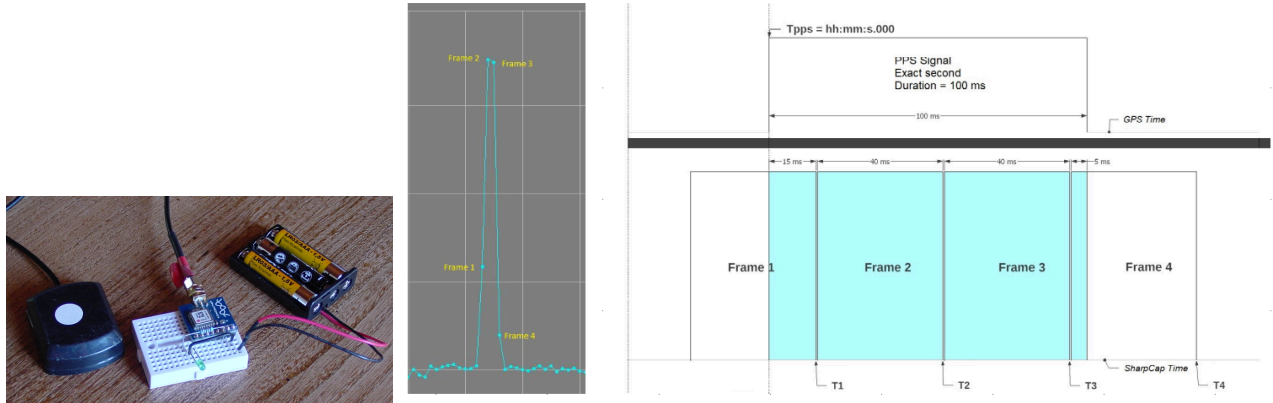- a LibreOffice spreadsheet[††] to exploit the .csv files exported from Tangra

Fig. 1. Assembly of the experimental setup (left) and principle of measurement (right).

3 Results

It is not possible here for lack of room to give a detailed view of the results obtained, the reader is invited to download the corresponding on-line slides[‡‡].

4 Conclusions

The parameters influencing the value of the acquisition delay of a digital camera are: (i) the capture area on the camera sensor; (ii) the USB transfer rate between the camera and the PC; (iii) the binning of the camera sensor. A good solution it to adopt only one or two sets of those parameters.

For a rolling shutter camera, it is necessary to position the LED (or star) always on the same line of the sensor, the easiest way is to centre it on the sensor. It is not necessary to know the direction of the scan with the method used.

After ANY change, either software (for example an upgrade of SharpCap) or hardware (for example a change of PC or camera), in the acquisition chain, it is strongly recommended to verify that the value of the acquisition delay has not been changed by new measurements following the method exposed here.

References

Pavlov, H. & Gault, D. 2020, Journal for Occultation Astronomy, 10, 10

[||]https://www.sharpcap.co.uk/sharpcap/downloads
[**]http://www.hristopavlov.net/Tangra3/
[††]On my web page at http://www.nocturno.fr/scripting/acqd.html
[‡‡]On my web page at http://www.nocturno.fr/acquisitiondelay/AcquisitionDelayMeasurement_EN_220915.pdf