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SYNOPTES - PRECISE GNSS TIMESTAMPING DEVICE FOR SPACE SURVEILLANCE AND TRACKING OBSERVATIONS

Abstract

Space applications as varied as observation of asteroid occultation, monitoring for near-Earth objects, space debris or reentering space debris observations require precise time stamping of events in order to compute the Track Data Messages (TDM) files. The existing timestamping solutions are either based on Network Time Protocol or GNSS based dedicated time servers. They are not sufficiently precise or require an internet connection, hence they are also not suited for remote areas. Due to the latencies and bias in the event trigger line, time server solutions do not support applications that demand sub millisecond timing precision. The research provides a new method for astronomical observations using SST. Synoptes, the proposed solution, uses a timing GNSS receiver module that is directly activated by the camera trigger out port instead of a time server. The highest absolute error is reduced to less than 100 nanoseconds using this method. A specific software integrates the collected timestamps into the header of the FITS file generated by the image acquisition system. In its different configurations, the device can handle tens of thousands of timestamps per second, and the hardware can be easily modified to the user's needs in terms of required precision and rate of image acquisition. Furthermore, the integrated system is capable of performing a self-calibration protocol, which involves calculating the time latency between the shutter command and the image acquisition's start time. The solution comes with a PC-friendly user interface that gives complete control over the hardware and its functionalities across all operating systems. This paper describes the compact hardware module's design as well as the results of in-field testing that were conducted to evaluate its performance. The publication also discusses the EUSST collaboration's qualification effort at two telescopes that provide astrometry outputs. The novelty in the scientific approach is the use of the observation sensors as part of the calibration process which involves timestamping observations taken on GNSS satellites. The calibration loop uses the difference in position between the "Observed" as determined by astrometrical tools and the "Calculated" as determined by GNSS - IGS Final Products.