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COMBINED GROUND-BASED AND IN-FLIGHT CALIBRATION PROCESSES FOR STAR TRACKERS

Abstract

Advanced performance allowed by satellite on-board subsystems and payloads are, and even more will be in future, granted by accurate calibration. Ground-based calibration processes are long and expensive, as they require specialized equipment and highly skilled personnel, and cannot obviously manage the small variations induced by the stress at launch, and later by the space environment, as well as follow the changes in the behaviour during the operational lifetime. To cope with these issues, in-flight calibration can be a challenging but effective solution, and this is an approach which attract increasing interest. Notice that in order to avoid workload increases at the ground station, this in-flight calibration needs to be autonomous, too.

Star trackers are a good example for these calibration needs. They are extremely accurate devices, and actually require a careful calibration. In many cases, this calibration (for high class instruments) is fully accomplished in state of-the-art facilities far before final integration of the satellite. Only relatively less accurate instruments follow a more economically viable process, with really coarse calibration (maybe better “validation”) at the factory, and then an in-flight calibration process within the limits of the mission requirements as the mission itself goes on.

The aim of the proposed paper is to discuss the possible extension of this second method to a general rule, valid also for precise star trackers. In fact, extension to precise equipment of the low-cost approach would allow a reduction in cost, and above all a larger, quicker availability of accurate sensors. The main issue is the identification of the components of a minimum set of parameters actually requiring measurements at the ground facility to provide a good enough guess solution leading later to a successful in flight calibration. This identification moves through a correct modelling of the sensor behaviour, an estimate of the relevant contributions to the global error of the different sensor’s characteristics, and the assessment of the easiness of their measurement (i.e. the so-called ”observability” in terms of control literature). The results obtained for a standard sensor with a process involving a least squares method analysis in the ground-facility, and then combining the least squares analysis and an extended Kalman filter on-board will be presented. Notice that the coupling between coarse test on Earth and accurate process in the real space environment can be an approach useful not only to star trackers but to additional categories of spacecraft sensors and equipment.