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NEURAL-NETWORK-BASED WIDE-FOV CMOS SUN SENSOR

Abstract

This paper deals with the digital micro sun sensor under development at the university of Naples (UniNa), Italy. The sensor is one of the innovative technology payloads selected for the Italian Space Agency micro-satellite platform MIOsat.

In the last years micro- and nano-satellites have received great attention due to several factors: reduced costs and frequent opportunity for launch, chance for cost-effective flight validation of innovate technologies for major applications, increased on-board functionality thanks to technology progress, new concepts of distributed spacecraft/payload. This is still the current trend, while more challenging mission objectives are being conceived for these spacecraft. In this regard, a major role is played by Micro–Electro–Mechanical-System and CMOS technologies, which are evolving quickly. With regards to the reduction of platform components size, power and mass, miniature digital sun sensor are valid candidates for these modern applications since they benefit of the most recent technology advancements in electronics and photodetectors, showing interesting features in terms of performance, reliability, and on-board resource utilization. In this framework, the GNC Laboratory research team of the Department of Aerospace Engineering is developing a novel, two-axis digital sun sensor based on a CMOS photodetector. These activities are supported by the Italian Space Agency within the mission MIOsat, the first Italian micro-satellite platform for Earth remote sensing. Peculiar aspects of the project are: innovative hardware configuration for improved precision through multiple simultaneous measurements, neural calibration function, COTS-based design. This paper is focused on the tests that are being carried out to characterize and validate the adopted design and algorithm solutions, exploiting the sensor hardware model presently available. It is a fully-functional model of the sensor for the MIOsat mission, and, also, it adopts several hardware components that will be tested and adapted for space operation, in view of installation and flight validation on board of MIOsat satellite. The above mentioned test are carried out in a laboratory facility for simulation of sun illumination, accounting for variable sun-line as resulting from orbit and attitude dynamics. This paper will present novel, improved algorithms based on adaptive image processing depending on the real illumination conditions during operation. Main target of the presented tests is the validation and assessment of sensor performance by means of hardware-in-the-loop tests including, also, simulation of in-orbit experiments, as planned for MIOsat operation. Also, the compliance of sensor operation and planned experiments with the resources available on board will be analyzed.