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THESIS SUBMITTED FOR OBTAINING THE DEGREE OF MASTER IN AEROSPACE ENGINEERING

IMPROVEMENT OF AN END-TO-END PERFORMANCE MODELING INTERFACE FOR OPTICAL SYSTEMS (EMIOS) AND APPLICATION TO THERMO-ELASTIC SENSISITIVITY OF HYPERSPECTRAL INSTRUMENTS

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"Man must at all costs overcome the Earth's gravity and have, in reserve, the space at least of the Solar System. All kinds of danger wait for him on the Earth... We are talking of disaster that can destroy the whole of mankind or a large part of it... For instance, a cloud of bolides [meteors] or a small planet a few dozen kilometers in diameter could fall on the Earth, with such an impact that the solid, liquid or gaseous blast produced by it could wipe off the face of the Earth all traces of man and his buildings. The rise of temperature accompanying it could alone scorch or kill all living beings... We are further compelled to take up the struggle against gravity, and for the utilization of celestial space and all its wealth, because of the overpopulation of our planet. Numerous other terrible dangers await mankind on the Earth, all of which suggest that man should look for a way into the Cosmos. We have said a great deal about the advantages of migration into space, but not all can be said or even imagined. "

— *Konstantin E. Tsiolkovsky*, father of cosmonautics.

Abstract

As a part of the New Space development in industry, this research pursues the development of an end-to-end performance modeling interface for optical systems (*EMIOS*). The interest of managing performance prediction with computer-aided technologies for space instrument are huge. It is primordial for companies to supply reliable instrument to customers and to be compliant with standards. This study demonstrates the robustness of this kind of software by giving a detailed analysis of the sensitivity of optical instruments, especially hyperspectral instruments.

This work is based on a deep understanding of different theoretical and practical concepts happening along the design lifetime of hyperspectral instruments. By managing the optical design processes, engineers can have an overview of the future operation of hyperspectral instruments. The thermo-elastic perturbations have to be evaluated and the resulting image deformations too. Therefore, it is important to define the different quality criteria that will be used to sense the optical aberrations coming from these deformations. Naturally, an enhancement of the end-to-end performance tools is performed beforehand in order to upgrade the software and achieve the sensitivity analysis afterwards. Finally, this sensitivity study gives the main tendencies in terms of mirrors deformations and motions that will allow engineers to better understand the behavior of hyperspectral instruments in operation. Several recommendations about the future reliability of the developed optics are also provided.

Keywords: Optical performances · Sensitivity analysis · Hyperspectral · EMIOS

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