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ON ORBIT INSPECTION WITH CUBESATS: STATE OF THE ART AND FUTURE PROSPECTIVE

Abstract

A system performing on orbit inspection could represent an opportunity to increase reliability and safety of future space missions. A constant monitoring of the external conditions of a target could indeed enable great enhancements throughout all the critical operations within innovative missions. Activities involving orbit debris management, reusable Space Transportation Systems and orbital stations are currently pursued by Space Agencies programmes and could represent interesting applications. Since the introduction of the CubeSat standard in the early 2000s, there has been a proliferation of nanosatellites in Low Earth Orbit, pushing towards even more advanced missions. It has been verified that CubeSats can efficiently support a wide range of space missions: several studies have been already conducted and are ongoing. For example, the CubISSat mission to inspect the International Space Station has been developed within SysNova ESA framework with interesting results. Other examples are the e-Inspector CDF study, a mission targeted at gathering data about Envisat to prepare the removal mission and the ESA SROC study, a mission targeted at the observation of the new-born Space Rider. Design solutions for CubeSats equipped with stereoscopic vision system and hyperspectral camera payloads are presented in this paper. Different CubeSat configurations and mission concepts are analyzed and compared. For each solution, advantages and challenges that impact both on payload performances and system requirements are identified and discussed. Multispectral system performances are preliminary analyzed with respect to distance from the target, spectral bands involved, relative velocity and spectral resolution. Similarly, stereoscopic information in relation to spatial resolution of the camera, field of view, image size and complexity of the algorithms for data processing are evaluated. All these parameters impose constraints on the CubeSat design and assembly in terms of features such as pointing accuracy and stability, precise attitude control and navigation, data storage capability, processor throughput and data rate. A baseline feasibility analysis of an inspection mission is then traced, taking into account the most promising COTS CubeSat-based technology but facing the state of the art towards more effective future missions. As a result, a technology development roadmap is suggested, highlighting critical accomplishments to fulfill in order to improve reliability and performances of inspection missions. Giving an overview of current and future capabilities of CubeSats for inspection missions, this paper aims to put the basics for future CubeSat applications development in this field.