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HYBRID SPACE-AIRBORNE BISTATIC SYNTHETIC APERTURE RADAR FOR AVOIDANCE, LANDING AND OBSERVATION OF UNMANNED AERIAL SYSTEMS

Abstract

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This paper presents the idea of a hybrid bistatic synthetic aperture radar (SAR) formed by a constellation of spaceborne illuminators and receiving-only airborne forward-looking SARs. The study aims at identifying and developing new imaging techniques for avoidance, landing, and observation, able to guarantee forward-looking real-time, all-weather, day and night, high geometric and radiometric resolution images for Unmanned Airborne Systems (UAS). Nowadays, UAS Navigation is mainly performed with satellite navigation systems (GPS, Galileo) which offer accurate and reliable navigation data, but no information about the surrounding environment. A vision-based navigation system can greatly improve UAS autonomy with an additional beneficial impact on obstacle avoidance capability. SAR systems have been already experienced on-board aircrafts of different classes. However, such sensors have been only used as remote sensing payloads in side-looking geometry. For navigation purposes a forward looking geometry is preferable, but it has been rarely experienced due to major limitations (left/right ambiguity and poor Doppler resolution) which can be only partially mitigated at the cost of strong complexities. These limitations can be overcome by the proposed space airborne bistatic system provided that specific requirements on the acquisition geometry are satisfied. In addition, the airborne receiver can be much more compact and lightweight, with a reduced power request thus complying with typical UAS requirements. Preliminary feasibility assessment and definition of strawman system concept have been conducted under ESA contract [1] considering UAS vision-based navigation as main application even if further uses, e.g. remote sensing or surveillance, have been envisaged. Indeed, UAS navigation presents clearly the most stringent requirements: the aircraft has to carry out its mission and follow its flight plan, therefore satellite transmitters have to illuminate its flight path, anytime and anywhere it is needed, from the proper relative position. This requirement has a strong effect on satellite constellation design. On the contrary, as far as surveillance and remote sensing applications are concerned, the airborne receiver can be provided with information on the available satellite illuminators (such as GPS almanac data) and therefore it can be scheduled to fly along the best achievable flight path thus also attaining higher performance.

References

[1] M. D'Errico et al., "Satellite-unmanned airborne systems cooperative approaches for the improvement of all-weather day and night operations", ESA contract 22449/09/F/MOS, Final Report.