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Author: Prof. Giovanni B. Palmerini
Sapienza University of Rome, Italy

Dr. Marco Sabatini
Sapienza University of Rome, Italy
Mr. Francesco Basile
Italy

FORMATION FLYING NAVIGATION EXPLOITING INTER-SATELLITE RADIO LINK STRENGTH MEASUREMENTS

Abstract

Formation flying missions invariably require relative navigation, or the determination of the position and velocity of the spacecraft involved. This task requires adequate sensors' suites, and different solutions do exist, both in conventional radio-frequency and in visible bands (and even some studies in the infrared band). Also, both passive – i.e. based on signal sources external to the formation – as well as active architectures – signals purposely generated on board – are possible. The range of the attained accuracy can be extremely varied and all the solutions need to take into account the strict requirements in terms of mass, volume and power typical to satellites. The overall impact of this avionic subsystem, which is not directly part of the payload, needs to be minimized, and this requirement is especially important when the dimensions of the satellites are minimal. The specific case of cubesats, an emerging small platform with the standard size of a 10cm side cube, represents a clear example of a kind of platform that introduces severe constraints. On the other hand, cubesats – as easily affordable satellites – are interesting candidates for experiments in formation flying, and therefore require the relative navigation performance typical of these missions. In such a scenario, this paper aims to discuss and evaluate the performance attainable by means of a simple solution for the relative navigation of the formation, especially suitable for moderate cost, moderate performance missions (like the ones exploited by cubesats). The solution builds on the radiofrequency inter-satellite link. A field strength meter onboard the chief-satellite can provide the level of received signal power, which is an observable, even if poor and inaccurate, related to the relative distance. An extended Kalman filter including a suitable dynamical model can exploit these measurements in order to estimate the formation kinematic state at a very limited cost, with reduced additional specific hardware. The combination of the two elements makes up for a technique which is accurate enough even in the phases immediately following the release from the launcher, where the spacecraft are in close proximity. The numerical simulations presented prove the valuable performance of such a simple system, also useful as a possible back-up solution at a limited cost in terms of spacecraft requirements.