25th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Highly Integrated Distributed Systems (7)

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SMALL SATELLITE FORMATION FLYING FOR DISTRIBUTED SYNTHETIC APERTURE RADAR

Abstract

Distributed SAR (DSAR) is defined as a Synthetic Aperture Radar (SAR) in which the signal emitted by the transmitter and scattered from the area of interest is not collected by a single receiver but by many, conveniently distributed, formation flying, receivers. The concept of distributed aperture can enable new SAR working modes, but more important, thanks to passive operations, can achieve very high performance through a series of very compact, low weight, agile, satellite platforms (e.g., in the micro- to nano-satellite class). Such a distributed space system can be regarded as a system in which the payload functionality is broken apart and distributed among the different elements of the system. Fractionation and formation flying may lead to a number of advantages, including overall system reliability, flexibility and modularity as well as enhanced responsiveness and decreased vulnerability. Indeed, single members of the system can be replaced in case of failure, thus guaranteeing graceful performance degradation and preserving mission goals. Also, it is possible to gradually update on board technologies by incrementally replacing elements of the formation, which is generally an issue for large space systems. In addition, the geometry of the distributed system can be partially changed while in orbit in order to accommodate for additional or varying scientific objectives and requirements. Finally, coupling the distributed system concept with the use of small satellites may lead to a system overall cost that is lower than that of a monolithic system.

In contrast, distributed space systems pose a number of technological and operational issues at system and subsystem level. At system level, formation acquisition after launch, control and maintenance are the biggest challenges, especially when a multiple launch approach is adopted, the various satellites operate with short separations, and the formation includes a large number of members. In this case, indeed, collision risk among the satellites of the formations shall be properly considered in system design

and formation flying operation. Also, a small satellite-based DSAR system may pose challenging requirements in terms of electrical power, communication link, and payload synchronization. However, in recent years technology upgrades have led to the development of small platforms with increasing capabilities, thus opening the way for using distributed space systems also for cost-effective operational, public and commercial services.

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