

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (3) (3)

Author: Mr. Paolo Iannelli
Sapienza University of Rome, Italy

Dr. Marco Sabatini
Sapienza University of Rome, Italy
Dr. Alessio Valentino Pelella
Scuola di Ingegneria Aerospaziale "La Sapienza", Germany
Dr. Renato Volpe
Sapienza University of Rome, Italy

OPTIMAL COLLISION AVOIDANCE STRATEGIES FOR A SWARM OF NANOSATELLITES IN A
REALISTIC SCENARIO**Abstract**

(This abstract was originally submitted and accepted for IAC2020 at the C1.1 session, but for COVID issues it was not possible to participate to the CyberSpace Edition. We are now resubmitting the abstract, aware that it will be not automatically accepted and will undergo the review process again)

CubeSats have become one of the possible solutions for several space mission scenarios because of their low realization cost and accessibility to both industries and universities. Their low mass and high manufacturing repeatability, in conjunction with their reduced capabilities, suggest the employment of a swarm of CubeSats in which each agent contributes to accomplish the global mission task. Because of their reduced mass, power and computational availability, CubeSats are usually equipped with simple systems, such as single-axis thrusters and low accuracy sensors for autonomous navigation. Those kinds of systems are more likely to present failures with respect to larger conventional platforms. Higher chances of failures translate into higher probability of collisions between satellites of the swarm and therefore the development of effective collision avoidance strategies becomes crucial. Following the importance of this aspect, this paper presents several techniques of collision avoidance purposely developed for nanosatellites swarms. The collision probability determination is achieved through the integration of the probability density function associated to the CubeSats relative positions, propagated to forecast a possible collision, over the uncertainty volume associated to the satellites position. In the presence of a possible collision (i.e., when the collision probability overcomes a certain threshold) a maneuver is performed to avoid the impact. Differently from standard scenarios, in which a satellite is asked to avoid being hit by debris, the techniques employed in formation can either take into account the single collision event and minimise the ΔV required to obtain a minimum miss distance or assess and consider the consequences of such maneuver over the formation behavior. While the former does not guarantee the optimality of any global index, the latter selects the CubeSat that must perform the maneuver and determines its intensity following a global optimal logic, which can be tailored to the specific mission architecture and requirements. The proposed study develops collision avoidance strategies purposely built for formation flying missions and tests them in several scenarios, which can also include the failure of the propulsion system of one or more satellites of the swarm, in order to assess the correct completion of the mission.