

IAF SPACE SYSTEMS SYMPOSIUM (D1)
Cooperative Systems (4)

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RECENT ADVANCES IN IN-ORBIT SERVICING TECHNOLOGIES AT THE UNIVERSITY OF
PADOVA**Abstract**

With the growing interest of the space community in In-Orbit Servicing missions, the Space System Group at the Department of Industrial Engineering, University of Padova, Italy, has been developing several technologies to enable such mission scenarios, including GNC systems, sensors, mechanisms and testing facilities. Among GNC systems, the group has developed several navigation algorithms based on Kalman Filters, that employ the measurement of a set of sensors to estimate the relative pose and velocity between two satellites. The employed sensors include: navigation cameras that operate in conjunction with patterns of fiducial markers; Time-of-Flight distance sensors; custom position sensors based on a matrix of phototransistor; and others. Regarding docking/capture interfaces, the group has successfully designed and tested several technical solutions. Among them, DOCKS is a smart docking interface under development for the SROC mission (Tyvak International, Politecnico di Torino and Stellar Project, under contract with ESA). SROC has the main objective to perform inspection manoeuvres on Space Rider and will dock back with it at the end of the mission and in preparation of the controlled atmospheric reentry. SMACK, instead, is a capture interface developed to be mounted on the manipulator of a space robot with the purpose to build large space structures composed by elementary units. Both these

interfaces are standalone systems with minimum requirements from the hosting bus, are equipped with dedicated sensors and a computer to perform the estimation of the relative state of the target, to allow the host to perform approach and docking. All the above technologies are validated through numerical simulations and hardware experiments. A detailed simulator of close-proximity operations scenarios has been developed in the framework of the GNC Robotic Arm Combined Control (GRACC) project in collaboration with Politecnico di Milano, University of Naples Federico II (ESA contract). It consists of a Functional Engineering Simulator that fully represents the physic phenomena relevant for the mission scenario and can test GNC algorithms under different conditions. The hardware validation experiments are executed at the space systems laboratory that is equipped with a six degrees of freedom robotic arm coupled with vehicles floating on a low-friction plane. This facility allows to emulate the dynamics of close-proximity operations, e.g. the capture (with the robotic arm) of a defunct or collaborative satellite (the vehicle on the frictionless plane) with the purpose to tests capture interfaces, GNC algorithms and sensor suites.