AERIAL MANIPULATOR FORCE CONTROL BENCHMARK

Reference No / Version	RAL-SI-2020-B-19-0826_AM_Force_Control-V1.0
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Website	For the latest versions of the benchmark, please refer to: https://grvc.us.es/robotic_arms
Adopted Protocol	Aerial Manipulator Force Control Protocol (RAL-SI-2020-P-19-0826_AM_Force_Control-V1.0)
Scoring	The performance of the aerial manipulator force controller is measured in terms of the following metrics: • Maximum position deviation of the aerial platform during the contact phase $\|\boldsymbol{\varepsilon}_{UAV}\| = \|\boldsymbol{r}_{UAV}^{ref} - \boldsymbol{r}_{UAV}\|$ in [mm], taking as reference the position of the UAV at the contact instant. • Dimensionless index $\rho_{UAV} = \|\boldsymbol{\varepsilon}_{UAV}\|/L$ obtained dividing the maximum position deviation by the reach of the arm, considered for comparison purposes. • Time required to reach the 90% of the reference force since the contact is detected in [s], maintaining the contact force for at least 1 [s]. • Maximum overshoot of the contact force controller in %. • Maximum time that the aerial robot is able to maintain the contact force, limited to 5 minutes. The robot fails if 1) the elapsed time in contact is below 1 second, 2) a risky situation involving a potential crash arises.
Details of Setup	• Aerial manipulation robot. • Wall or structure to support the contact force. In order to make the aerodynamic effects negligible, the operation height will be 2 [m] for aerial platforms smaller than 1 [m], and 4 [m] height for sizes above 1 [m] (the size of the UAV is defined as the distance between opposite rotors). • If available: force sensor attached to support structure. • Positioning system (GPS-RTK, vision, Vicon, OptiTrack…). • Ground Control Station (GCS) laptop.
Results to Submit	• Date and time of the experiment. • Description of the aerial manipulation robot: aerial platform, on-board systems, flight time, maximum take-off weight (MTOW). • Main specifications of the manipulator: kinematic configuration, joint limits, maximum joint/Cartesian speed, link lengths, lift load capacity. • Description of the testbed: dimensions, measurement devices and its main features, position of the objects in the testbed. • Scores obtained in the test, as indicated above. • Graphical results showing the trajectory of the multirotor

	(position and attitude) the position and force/torque of the arms along with the corresponding references and ground truth. • Video illustrating the execution of the benchmark. • Identification of the factors determining the success rate, accuracy and reliability. • Comments about the required / convenient improvements.