AERIAL MANIPULATOR GRASPING PROTOCOL

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Website	For the latest versions of the protocol, please refer to: https://grvc.us.es/robotic_arms
Purpose	Evaluate the performance of an aerial manipulation robot in a grasping task, as this is one of the basic functionalities considered in the definition of more complex operations like the installation and retrieval of sensor devices in high altitude workspaces.
Task Description	Retrieve an object placed in a bench, executing the grasping method with the manipulator once the aerial platform is hovering close to the target. The task should be completed in the shortest possible time.
Setup Description	<u>List of objects and their descriptions:</u> • Aerial manipulation robot consisting of robotic manipulator of reach L integrated in aerial platform of size S_{UAV} along with the onboard systems (computer, sensors, batteries, communication devices). • Bench or support structure where the object is placed at height h_{goal} and distance d_{goal} w.r.t. the take-off position. • Object to be grasped. This can be a bar, a plastic box with a handle, or any other object that can be easily retrieved with a hook or magnetic gripper. The weight of the object to be grasped should be above the 25% of the payload capacity of the manipulator, referred to the base joint (shoulder). • Ground Control Station (GCS) laptop used to manage the operation of the robot and log the data. • Video camera used to record the execution of the test.
	<u>Initial and target poses of the objects:</u> • The aerial robot will be initially landed at position $\boldsymbol{r}_{UAV} = [0, 0, 0]$ relative to the Earth fixed frame ($\boldsymbol{X_E Y_E Z_E}$). • The object to be grasped will be located at the tool bench in position $\boldsymbol{r}_{goal} = [d_{goal}, 0, h_{goal}]$. • The initial take-off position will be $\boldsymbol{r}_{take-off} = [0, 0, h_1]$. • The value of the distances and operation heights will depend on the size of the UAV S_{UAV}, defined as the distance between opposite rotors: ○ $\{h_1, d_{goal}, h_{goal}\} = \{2, 2, 1\}$ $[m]$ if $S_{UAV} \leq 1$ $[m]$ ○ $\{h_1, d_{goal}, h_{goal}\} = \{4, 5, 2\}$ $[m]$ if $S_{UAV} > 1$ $[m]$

	Description of the environment: Indoor or outdoor testbed with appropriate security measures. Positioning system used to localize the aerial robot within the workspace with an accuracy below the 10% of the reach of the manipulator. Different technologies may be used depending on the environment: GPS-RTK, Vicon, OptiTrack, laser trackers, visual SLAM… Ground Control Station (GCS) with laptop and communication devices required by the human operator.
Robot/Hardware/Software /Subject Description	Targeted robots/hardware/software: Multirotor or autonomous helicopter platforms equipped with robotic arms or grippers capable to grasp objects.
	Initial state of the robot/hardware/subject with respect to the setup: The aerial robot is initially landed while the manipulator is in rest position above the floor (take-off/landing configuration). The object to be grasped will be placed in the tool bench. All the batteries (multirotor, manipulator, onboard computer) should be fully charged and equipped with voltage-level alarms.
	Prior information provided to the robot: Position of the object to grasp or the bench where it is located.
Procedure	1) Start timer – Take-off at the initial height h_1 and move the manipulator to the operation configuration. 2) Approach to the bench where the object is located. 3) Execute the grasping method to retrieve to object. 4) Go up to height h_1 – Stop timer. 5) Go back to the landing point. 6) Move the manipulator to the landing configuration. 7) Land. In order to avoid the use of complex finger-grippers, a simple hook or magnetic gripper can be used as end effector. A safety pilot must be present to supervise the operation and take the control of the aerial platform in case of risk.
Execution Constraints	Flight time limited by the batteries. Safety ropes should be avoided to prevent that the system dynamics and the controller are interfered.