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SAMPLE TRANSFER ARM FOR MARS SAMPLE RETURN MISSION

Abstract

Since the first observations from Earth, Mars has always attracted the interest of scientists for its peculiarities. At the beginning of the space exploration, reaching the red planet was identified as a key goal for scientific purposes and several missions can be recalled starting from the sixties. So far, the study of Mars and its characteristic has been possible only with in-situ analyses performed by instruments carried by the systems sent to the planet. Bringing sample to Earth is the next big step, which would allow deeper analyses with more sophisticated equipment impossible to take to Mars. This is the goal of the Mars Sample Return Mission (MSR).

MSR campaign, led by NASA and ESA, is composed of three phases. The first one started with Mars 2020 Perseverance rover, which is currently exploring the surface of the planet and collecting rocks and dust in sample tubes. These samples are partially retained in the rover for delivery to a future lander and partially laid down on the surface. In the second phase, a Sample Retrieval Mission will be launched

including a Sample Retrieval Lander equipped with a Sample Transfer Arm and a Mars Ascent Vehicles. The objective is to collect the samples directly from Perseverance as primary option, and as a backup from the terrain. The tubes are then loaded in the Mars Ascent Vehicle which will perform the first liftoff from Mars and carry the container in orbit, which will be captured by the Earth Return Orbiter in the third phase and brought to Earth.

This paper presents the design and operations of the Sample Transfer Arm, which is developed by a European consortium led by Leonardo S.p.A. under an ESA contract. This system is in charge of retrieving the sample tubes from both the Perseverance rover and the terrain, and storing them on the container to be brought back to Earth.

The Sample Transfer Arm system is composed by:

- 7-dofs robotic arm with revolute joints
- End-Effector performing two types of grasping of the tubes
- Cameras to perform vision tasks
- Force/torque sensor to implement compliance control
- Flex harness routing along the arm to provide power and signals
- Servo Control Unit for the control of the joints and End-Effector
- Remote Center of Compliance Mechanism to provide passive compliance
- Hold Down Release Mechanisms to fix the arm during launch