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STABLE: MARS SAMPLE RETURN MISSION BREADBOARD DEMONSTRATION

Abstract

One of the most technologically challenging space missions in the upcoming years will be the Mars Sample Return (MSR). Within this mission, the rover Perseverance has already started to prepare the samples so that mankind can finally bring soil samples from the Martian surface back to earth for analysis. To successfully accomplish this mission, additional highly autonomous robotic systems will be needed. Therefore, ESA has launched a breadboard study to develop a Sample Transfer Arm for the Mars Sample Return Mission (STABLE), which should be able to 1) pick up samples from a rover, 2) inspect the samples and 3) load the samples in the rocket that will bring them back to earth. The DLR has picked up this challenge as part of an OHB led consortium. This paper presents the robotic arm developed within STABLE project as well as the results of the demonstration scenario. The robotic system was based on the modular torque controlled robotic arm TINA, previously presented by the German Aerospace Center. The STABLE arm has 7 degrees of freedom with a total length of 2,20 m. Each joint is built with a brushless DC motor combined with a harmonic drive and a planetary gear stage. A hall sensor commutation is used to detect the motor position, and a link side resolver for the absolute arm position sensing. To maintain stable positions, a break is added and each joint incorporates a torque sensor to perform highly sensitive tasks. The communication between the joints and the Robot Control Unit is realized with Spacewire and is located in the FPGA as well as the Spacewire-Router. A vision system, provided by DTI, on the robotic arm allows detection of sample orientation and position as well as the recognition of the rover and lander. The gripper, designed by OHB, on the last arm joint provides the capabilities and interfaces to properly interact with the sample tubes enabling the complete sample transfer process. The gripping status of the end effector is derived by feedback of force and position sensors. The capabilities of the developed

system were showcased in a final realistic scenario, where all the required tasks have been successfully accomplished.