Paper ID: 44776
oral

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Science, Instruments and Technologies (3B)

Author: Mr. Andrea Rusconi
Leonardo S.p.A., Italy

Mr. Luca Foresti
Leonardo S.p.A, Italy
Dr. Alessandro Fumagalli
Leonardo Spa, Italy
Dr. Marco MOLINA
Leonardo Spa, Italy

DELIAN ARM DEVELOPMENT AND TEST FOR MARS SAMPLE ACQUISITION

Abstract

The DELIAN (DExtrous LIghtweight Arm for exploratioN) project belongs to the robotics and rover technologies theme of the ESA's Mars Robotic Exploration Preparation Programme (MREP) and aims at developing a lightweight robotic arm that is a technology building block to enable accessibility to the Martian surface either for sample acquisition, sample retrieval or instrument deployment. Key issues of this development are the very limited resource allocation in terms of mass, power and volume as well as high performance requirements. In the DELIAN definition phase a variety of mission scenarios has been analysed and subsequently the requirements and architecture of the elements have been defined. Accordingly, several joint concepts have been studied and evaluated for suitability to the demanding DELIAN requirements. Items of specific importance for controlling a very lightweight arm are the solutions adopted for compensation of static deflection and dynamic vibrations induced by arm flexibility. Two deflection compensation algorithms have been studied. In the following phase a joint engineering model has been designed and produced to Engineering Model (EM) standards. Components have been selected/customised to achieve a compact and lightweight joint. The joint test campaign comprised functional and environmental testing in Mars-like conditions with two goals: to characterise and validate the novel joint design and to gather a set of test data that would serve as a reference for future projects/missions to assess the performance of similar designs in early stages of the development. In the frame of the incremental approach of the activity, the last phase aimed at detailed design, manufacturing and testing of a Development Model (DM) of a complete robotic arm for planetary exploration. The DM has been be obtained from one of the mission scenarios (small rover) and has been based on a 6 DoF kinematic structure, with a limb reshaping solution that allows the implementation of a spherical wrist and a very high dexterity at the same time. The arm functional performance has been tested under earth gravity within the predefined test scenarios. The estimation of flexibility and its parameterisation into the controller model are an important aspect to be duly considered in order to achieve the very demanding positioning accuracy requirements. The paper mainly presents results of the last phase, with DELIAN robotic arm DM test results.