Paper ID: 22618
student

25th IAA SYMPOSIUM ON SPACE ACTIVITY AND SOCIETY (E5)
Space Architecture: Designing Human Systems Interaction (3)

Author: Mr. Luca Levrino
Politecnico di Torino, Italy

Mrs. Margherita Rossana Censi
Politecnico di Milano, Italy
Mr. Alessandro Ciani
Politecnico di Milano, Italy
Mr. Alessandro Cingoli
Politecnico di Milano, Italy
Ms. Chiara Gastaldi
Politecnico di Torino, Italy
Mr. Paolo Maggiore
Politecnico di Torino, Italy
Mr. Ricardo Repenning
Technische Universität München, Germany
Dr. Maria Antonietta Viscio
Politecnico di Torino, Italy

NEA ROBOTIC FRIEND: AN INNOVATIVE AND VERSATILE VEHICLE TO SUPPORT HUMAN MOBILITY AROUND ASTEROIDS

Abstract

The paper deals with the conceptual design of a manned target-independent vehicle to support human exploration of a Near Earth Asteroid (NEA) for the most suitable and safe close approach, and especially to foster important exploration capabilities in order to maximize the scientific return of such missions. The focus is on a concept of space vehicle capable of actively supporting humans during the asteroid exploration and commute phases of an Extra-Vehicular Activity (EVA), and particularly on overcoming some of the issues in human space exploration, regarding for instance psychological aspects (e.g. fear of pushing out into the void) and spacecraft assembling procedures. The resulting design corresponds to a small unpressurised vehicle able to support mobility, maximizing human agility, but always considering safety as the main driver: for these reasons it has been named NEA Robotic Friend (NRF).

The asteroid 1999-RA 32 has been chosen as reference for this paper, even though the proposed concept is intended to be suitable for other targets, being versatility one of the main mission drivers, in addition to reliability, simplicity, and the abovementioned safety. The proximity operations within this mission last 8 days: on each day the NRF carries two astronauts and the required exploration equipment from the Deep Space Habitat (DSH) to several asteroid sites until the end of the EVA, when they return to the mother ship.

The central role of the human being in such a mission led to consider psychological aspects as key design points, since mission success will be mostly dependent on astronauts' performance. Accordingly, to shape and size the NRF, an ergonomic design is then proposed, and indeed enriched by the study of the concept of operations, pursuing a multidisciplinary approach for most design trade-offs.

The paper starts from the motivations for a small spacecraft such as the NRF, and then describes the applied methodology to perform the present study. Through functional analysis, requirements generation

and high level decisions, preliminary configuration and budgets are deduced. The NRF configuration is shown to be preferable to other solutions like Manned Maneuvering Unit (MMU) and Man-in-Can. Moreover, the docking/landing option is evaluated and finally discarded, because the limited data available about asteroid soil properties could spoil mission reliability and safety. The main criticalities (docking with the DSH or assembling for instance) and benefits of this solution are finally discussed in the conclusions.