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MISSION CONCEPT AND PRELIMINARY SPACECRAFT DESIGN FOR RESOURCE MINING ON MAIN BELT ASTEROIDS

Abstract

In the past years, the interest in commercial space mining increased significantly. With the goals declared by companies such as Planetary Resources or Deep Space Industries to prospect, harvest and process materials in space, the development of necessary technologies to reach that goal has already begun.

Within this context and in the frame of the project KaNaRiA, the Institute of Space Technology and Space Applications (ISTA) of the Bundeswehr University Munich is working on a Phase A study of an autonomous asteroid mining mission. ISTA is responsible, among other aspects, for the mission planning and the system design of the KaNaRiA spacecraft.

In this paper, we first present a general mission concept for a main belt asteroid mining mission. Four tasks associated with the mining mission have been identified: the asteroid Mapping, Characterization and Resource Determination task (MCRD), the Resource Extraction and Exploitation task (REaE), the Maintenance and the Logistics. For each mission task, various mission architectures have been analysed, compared and traded off with respect to phase-specific criteria. The selected results for the KaNaRiA mission concept include a KaNaRiA Mining Spacecraft (KMS), several Potential Target Characterization Modules (PTCMs), a PTCM Carrier and a Service Carrier as well as maintenance modules such as an Operational Centre (OC) and Repair- and Refuel-Elements (RP, RF). All mission architecture elements, their main functionality and responsibilities are described in detail.

Subsequently, the reference mission scenario targeting the main belt asteroids is described. The mission scenario originates in a stable Parking Orbit at 2.8 AU from the Sun, which has been selected as part of a preliminary target asteroid restriction strategy. A mission profile allocating the major events on a time-line is shown.

With regards to the system design, the work presented focuses on the design of the PTCMs spacecraft. The impact of the mission concept and resulting mission analysis is discussed. From this, the key architectural elements are derived and a preliminary spacecraft system is shown with a short overview on the relevant subsystems.