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SUITABILITY OF RE-USABILITY FOR A LUNAR RE-SUPPLY SYSTEM

Abstract

The proposed paper intends to present the design of a re-usable lunar SSTO (single stage to orbit) vehicle called RLRV (Re-usable Lunar Resupply Vehicle). This vehicle should be able to be refueled in Moon orbit or on the Moon surface and reused. In its baseline version, it should be able to land payload masses up to 9 metric tons on the Moon and perform re-supply missions. It should also have the capability to launch payloads from lunar surface into lunar orbit in contemplation of their return back to Earth.

These requirements are the results of the preliminary design of a set of missions and of the definition of the corresponding mission scenarios in the frame of the ROBEX (Robotic Exploration under Extreme Conditions) project. One important aspect of the ROBEX project is to consider modularity and reconfigurability for the design of the ground infrastructure in order to increase its sustainability. This characteristic should also be considered for the choice of the architecture and the design of the transportation system in order to perform a large range of missions with the designed vehicles.

It has been chosen to consider liquid oxygen and liquid hydrogen as propellant for the RLRV, despite the difficulty to keep these propellants at cryogenic temperatures for the duration of the mission. Oxygen can be extracted from the Moon regolith. One of the missions pre-sized for ROBEX considers the robotic settlement and operation of an ISRU (In-Situ Resource Utilization) plant to extract O_2 from ilmenite. On the fuel side, the mass of liquid hydrogen required is relatively limited, compared to those of other fuels such as kerosene or methane. The fuel cannot be gathered or synthetized on the Lunar surface and will have to be brought from Earth, increasing the interest to limit as much as possible the fuel mass. A preliminary sizing of the vehicle including for instance the design of the structure and of the feed and propulsion systems, as well as trajectory simulations has been performed. In order to assess the advantages and drawbacks of the re-usability of the RLRV, it is compared to a classic expendable vehicle for different mission scenarios. The influence of the re-usability of the lunar re-supply system on the whole Earth-Moon transportation system will then be discussed.