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ESS: A SETTLEMENT SITE SELECTION TOOL FOR A MANNED MARS BASE

Abstract

In recent years, private entities have joined the race to send humans to the Red Planet. While Mars is well defined as the next frontier for human space flight, little work has been done towards identifying possible settlement sites on its surface. The current site proposals use a bottom-up approach, that is focusing on *one* settlement site and then investigating if and why this site fulfils all requirements considered relevant to a human outpost. Here, we present the *Expert System: Settlement (ESS)*, a tool that follows the inverse, top-down approach in which initially the entire Martian surface is considered. From there, the set of possible settlement sites is reduced stepwise for various criteria, discharging those sites not fulfilling the specified criteria. Examples of these site requirement are the max. MOLA elevation, the solar power available on the surface, and the water concentration in the subsurface. To cover the different criteria included in our research, the ESS was assembled of the three sub-expert systems *Expert System: Engineering Constraints (ESE)*, *Expert System: Climate (ESC)*, and *Expert System: Resources (ESR)*. The ESS was successfully verified using the engineering constraints defined for the landing site selection of the NASA InSight mission, returning, inter alia, the mission's selected landing site. With view on manned missions, settlement selection constraints were derived from literature to provide input to the ESS. The ESS identified possible settlement sites fulfilling the requirements in Xante Terra/Lunae Planum and West of Elysium Planitia. Other qualifying sites were located in the Northernmost part of Noachis Terra, in Vastitas Borealis between 40°N and 50°N latitude and in Arcadia Planitia, Northwest of Olympus Mons. The ESS is built completely generic, allowing to run the expert system for a variety of possible and diverse mission architectures. Moreover, the code architecture allows to simply add further selection constraints and corresponding planetary data sets required for future selection processes. The ESS is capable of investigating both landing ellipses (as has been done for the NASA InSight mission) and circular exploration zones around a nominal site. Next to settlement site selection, the code developed is therefore also suitable for landing site selection. With suitable data available, the code can be adapted to any celestial body. The current application of the tool regarding site analysis is directly dependent on the available data sets' coverage and maximum resolution; where the latter controls the computation time of the ESS.