Paper ID: 73207
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IAF SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – missions current and future (3A)

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USING UAVS FOR FUTURE MISSION ON MARS

Abstract

The successful tests of the NASA helicopter "Ingenuity", landed on Mars in 2021, opens the door to considering Unmanned Aerial Vehicles (UAVs) for planetary exploration. As such, this research considers the potential of UAVs playing a key role in the exploration of Mars. UAVs may overcome limitations of orbiters and Mars rovers; they may offer effective and efficient alternatives to accurate Mars surface monitoring, also allowing for detailed image data collection while surveying and navigating in wide areas, which would, otherwise, be not feasible when using surface vehicles. Several conducted studies have shown that the Mars harsh environment adversely impacts UAV conventional hardware and software performance – hardware and software is developed considering UAV functionality on earth. Thus, different criteria should be adopted for validation and verification (V&V) and performance evaluation of UAVs in space. To be specific, when flying on Mars, UAVs face a wide spectrum of challenges, for example: communication delays that do not allow for UAV remote control from a ground control station (on earth); GPS-denied environment in which the UAV operates, which affects accurate and correct navigation, and, thus, accurate task execution under uncertainties. Autonomy and autonomous functionality offers a viable alternative to overcome such limitations; thus, the objective is to consider an autonomous UAV functioning without interaction with a human operator. As such, the focus of the paper is to design and build a novel simulation environment, suitable to test and evaluate autonomous navigation of UAVs when tasked to complete and execute space missions. To achieve this goal, the Martian surface and/or area to be surveyed and monitored by the UAV will be modeled using Gazebo – a well-known and widely used dedicated software tool. UAV path planning and navigation algorithms, as well as environment mapping will be developed and integrated using the Robot Operating System (ROS) tool, following a Mars operative scenario. Simulated experiments in a Mars looking environment using a specific type of UAV with several onboard sensors will be conducted in a ROS-Gazebo setting, and results will facilitate UAV model, sensor-based navigation algorithms and planning V&V. Research outcomes will contribute to developing comprehensive navigation approaches for space exploration, as well as support tools to implement and test such approaches.