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ATMOSPHINDER ROBOT - FUNCTIONAL PROTOTYPE AND SYSTEM DESIGN

Abstract

Atmosphinder's mission is to investigate the geomorphic processes of seasonal eruptions in the south polar region of Mars to determine their role in the climatic system and dust storms. An experimental prototype robot was created for testing in an analogous environment at the Mars Desert Research Station on a two week mission. Given the unstructured terrain features, the approach to locomotion is that the robot is an all-encompassing singular wheel that traverses by rotating. The construction methodology combined compliant and rigid structural components for adaptability where the robot would be operating. Measuring 1.25 meters in diameter, the wheel structure is comprised of 1/2 inch diameter tubes joined together with 3D printed pieces for ease of disassembly and reassembly. Material intended for tobogganing was repurposed to make two sails extending from the side faces, measuring 43.5 centimeters x 72 centimeters. Along the central axis of rotation were three sealed ball-bearings with a waterjet cut 1/8 inch aluminum container for the electronics sensor payload bay. The electronics included a custom circuit board with environmental sensors. The firmware programming enabled the sail trim servo motor control to respond dynamically to present anemometer (wind sensor) readings. Bright 3 watt lights, visible in the daylight, indicated to the analogue astronauts the current mode of the firmware state machine. An embedded computer vision camera system was used for human-robot interaction with the analogue astronauts while in fully donned spacesuits. Crucial factors to the design of the robot included: 1) Design for operational use and manipulation with spacesuit gloves; 2) Design for ease of repair with limited materials in the Mars analogue habitat; 3) Design for disassembly and reassembly. Incorporating those design elements at the initial stages lead to success on the analogue astronaut mission. Atmosphinder endured testing during 7 extravehicular activities throughout the two week analogue astronaut mission at the Mars Desert Research Station, with valuable lessons learned to be incorporated in the next version.