HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
New Technologies, Processes and Operating Modes Enabling Future Human Missions (7)

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RESEARCH ON POWERED DESCENT GUIDANCE AND CONTROL FOR MANNED MARS HAZARD AVOIDANCE AND SAFE LANDING

Abstract

Autonomous safe landing is an important capability required to ensure mission success for future Manned Mars landing missions. Future manned landing missions will target scientifically interesting features that lie in areas far more hazardous than those attempted by previous unmanned landers. For these sites, hazard avoidance during landing cannot rely solely on rock abundance statistics derived from on-orbit observations at currently available resolutions. To avoid hazards and land safely, future landers must be capable of detecting hazards in the landing zone, designating a safe landing site, and maneuvering to the selected safe site. This requires autonomous, onboard trajectory and attitude planning and execution. A typical Manned Mars entry and landing vehicle consists of a lander with cabin, an aeroshell, and a parachute. During atmospheric entry, the lander is contained within the aeroshell, which protects the lander from aerodynamic loads and heating as the vehicle enters the atmosphere at high velocity and decelerates. When aerodynamic loads and heating are small and the entry vehicle has descended to an appropriate altitude and velocity, a parachute is deployed to further slow the vehicle. The aeroshell is then separated, and the parachute extracts the lander from the aeroshell. Subsequently the parachute turns the lander's flight path so that it is falling nearly vertically at a terminal velocity of about 50m/s. When the lander reaches 500 1000m altitude, the parachute is jettisoned, and the lander uses its propulsion system to perform final maneuvers and land safely on surface of Mars. Prior work in autonomous guidance for the Apollo lunar module was done for the moon missions. The autonomous guidance and control (GC) design under consideration here for Mars landing consists of onboard capabilities for he terminal descent phase of flight, which starts once the parachute is deployed and ends at touchdown on the surface. During terminal descent, the vehicle must determine its position, velocity, and attitude; determine the available landing zone; generate terrain maps; survey them for hazards; select the best landing site; and maneuver to land safely at the selected site. The entire system must operate autonomously. This paper will focus on the algorithm design for the trajectory guidance, attitude commanding, and the six-degree-of-freedom control of the landing vehicle with thruster selection logic.