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ZEPHYR: A LANDSAILING ROVER FOR VENUS

Abstract

With an average temperature of 450 C and a corrosive atmosphere at a pressure of 90 bars, the surface of Venus is the most hostile environment of any planetary surface in the solar system. The longest-lived mission to land on the surface of Venus has been a stationary lander that survived for only 2 hr. Exploring the surface of Venus would be an exciting goal, since Venus is an unknown planet, a planet with significant scientific mysteries, and a planet larger than Mars with equally interesting geology and geophysics. A valuable goal would be to operate a rover on the surface of Venus with capability comparable to the rovers that have been sent to Mars. Such a rover would push the limits of technology in high-temperature electronics, robotics, and robust systems. Technology to operate at the environmental conditions s of Venus is under development, at NASA Glenn and elsewhere. Electronics and motors that will continue to function even at 450 C have been developed. However such a rover would require the ability to traverse the landscape with on extremely low power levels. We have analyzed an innovative concept for a planetary rover: a sail-propelled rover to explore the surface of Venus. Such a rover can be implemented with only two moving parts; the sail, and the steering. The four Venera landers that measured surface wind speeds found average wind speed of 0.3 to 1.3 m/sec. Although these winds speeds are low (under 1 m/s), at Venus atmospheric density even low wind speeds develop significant force. Under funding by the NASA Innovative Advanced Concepts office, a conceptual design for such a rover has been done. The design and the conceptual operations plan to operate it on the surface will be presented. Total landed mass of the system is 265 kg, somewhat less than that of the MER rovers, with a 12 square meter rigid sail. The rover folds into a 3.6 meter aeroshell for entry into the Venus atmosphere and subsequent parachute landing on the surface. Conceptual designs for a set of high-temperature scientific instruments and a UHF communication system were done. The mission design lifetime is 50 days, allowing operation during the sunlit portion of one Venus day. Although some technology development is needed to bring the high-temperature electronics to operational readiness, the study showed that such a mobility approach is feasible, and no major difficulties are seen.