ABSTRACT

Titan Inflatable Aerovehicle/Rover/Boat

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A novel, robotics vehicle is presently under development at JPL that will have the capacity to fly, drive and float, as well as conduct submersible studies on Saturn's largest moon, Titan. Other than the Earth, Titan is the only other body in our solar system that is believed to contain large quantities of surface liquid, which is presently believed to be constituted of liquid methane and ethane. With a primarily nitrogen atmosphere at 1.4 bar surface pressure and about 93K surface temperature, the density of the atmosphere at Titan's surface is about four times that of Earth's, thus making the atmosphere ideal for ballooning. The novel robotics vehicle under development takes advantage of these unusual characteristics to allow it to morph from a controlled altitude aerovehicle to an inflatable surface rover, and to a paddle-wheeled type of floating boat that carries a tethered submersible vehicle.

The 20-kg inflatable rover currently under development at JPL (Figure 1) was originally intended for use on Martian rocky terrains, and it contains three spherical wheels that are 1.5m in diameter. This allows the rover to easily climb over 0.5m rocks, or to traverse over 99% of the Martian surface. With raised treads, this same vehicle has been found to have excellent liquid traversability on calm lakes, similar to those anticipated on the low sunlit surface of Titan. By filling the tires with helium, approximately 25 kg of lift is provided at the Titan surface, or alternatively, a separate helium balloon can provide lift. A recent study at JPL has shown that a preferred method of altitude control for helium balloons on Titan is to use the waste heat from small radioisotope thermal generators (RTGs) to provide additional buoyancy during ascents.

One mission scenario under consideration is to have numerous near-surface descents of the rover while controlling altitude of an attached balloon with RTG waste heat. The combination vehicle would always travel below the upper hydrocarbon clouds, thus providing the first clear, global images of the Titan surface. After approximately one month of imaging, the rover would be gently landed in a preferred location and the tow balloon cut free. The rover would explore both solid and liquid surface areas while the balloon continues imaging. When traversing liquids, the surface vehicle would tow a small submersible imaging /science vessel in search of anticipated thermal vents. A primary goal of this mission is to explore all aspects of Titan's atmosphere and surface, which is believed to be similar to primordial Earth. The mission will also search for simple extraterrestrial life forms, possibly similar to those that we know exist in heated hydrocarbon fluids on Earth.