A NOVEL AERIAL DRONE PLATFORM FOR EXPLORATION OF TITAN

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Brief Presenter Biography: Dr. Benjamin Cameron is a Research and Development Engineer at Creare LLC in Hanover, NH, where he leads the autonomous systems group. He conducts research across a wide range of technology areas including fluid thermal systems, aerodynamics, hydrodynamics, autonomous systems, computational fluid dynamics, and mass and heat transfer. He also develops aerial drones, rovers, and underwater vehicle autonomous systems for specialized applications in Earth observations, planetary exploration, and terrestrial commercial markets.

Introduction: Long-term monitoring of Titan's atmosphere and planetary surface requires a robust autonomous vehicle capable of interacting with Titan's heterogeneous surface and profiling its chemically dynamic atmosphere. Creare is developing the Titan Ringlet, a fixed-wing vertical takeoff and landing drone, to extend mission capabilities of a larger lander. Compared to a pure rotorcraft (vertical flight), the fixed-wing cruise flight mode of Creare's drone increases maximum range by more than three times, increases maximum endurance by more than two times, and increases maximum altitude by more than three times.

Missions: The primary role of the current Titan Ringlet Drone design serves as a companion system to a larger mobile lander, similar to the Dragonfly spacecraft. The primary mission roles that can be achieved or supplemented by the use of the Titan Ringlet Drone can be summarized as follows:

1. Providing air scouting support to the prime lander, providing advanced aerial surveying and imaging to allow the prime lander to make longer, better target jumps between landing sites.
2. Extending the aerial surveying capabilities of the base lander, allowing remote sensing of regions beyond those directly visited by the prime lander.
3. Sample retrieval from remote sites for analysis by the prime lander.

The Titan Ringlet Drone design concept focuses on the first two objectives above, which can be accomplished through optimizing the drone design around multiple high-resolution cameras specifically targeted to the unique low-light and spectral challenges involved in high-resolution imaging on Titan. The design also includes payload allowance for potential sample retrieval capabilities.

Drone Platform: The drone platform (Figure 1), which weighs between 20 and 35 kg and has a wing diameter of about one meter depending on mission requirements, utilizes a quadrotor propeller configuration combined with a novel ring-wing design to achieve the maneuverability and control in of a multirotor drone in vertical flight and the long range and endurance of a fixed-wing aircraft in horizontal flight. A central pod connects to the ring wing and contains batteries to achieve a range of hundreds of kilometers, radioisotope heater units to maintain the batteries and electronics near room temperature, mission sensors, and supporting electronics and avionics. The Titan Ringlet Drone design does not include a radioisotope power source, requiring periodic recharging from the prime lander.

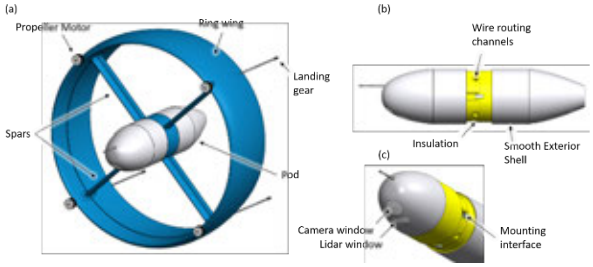

Figure 1. Titan Ringlet Drone Design

To achieve the imaging mission objectives, the Titan Ringlet Drone is designed with a pair of high-resolution, 12 megapixel, high-sensitivity cameras: one located in the tail of the Ringlet Drone pointing aft, optimized for high-resolution imagery and landing site identification and approach during hover; and one located with a downward-canted orientation at the forward end of the Ringlet Drone optimized for image collection and navigation during forward flight.

As part of the current development effort, we have fabricated and demonstrated performance of a motor at conditions similar to the surface of Titan, about 90 K. We have also developed a flight controller for vertical, transitional, and horizontal flight and demonstrated control and measured power consumption through flight testing (Figure 2).

Figure 2. Titan Ringlet Drone in Hover (left), Transition Flight (center), and Cruise Flight (right).