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Drone Related Work

https://www.creare.com/r-d-services/fluid-and-thermal-systems/#1562590575981-62dddd44-e1dd

Autonomous Meteorological Measurement System. On a NOAA-funded effort, Creare is developing an autonomous meteorological measurement system, the Drone Sonde System, to obtain vertical provides of atmospheric data. NOAA and the National Weather Service maintain an immense network of automated maritime, surface, and upper-air observing stations throughout the world and at great expense. These automated stations provide regularly updated data for both short-term weather prediction and long-term climate models. Maritime and surface observations occur as frequently as every 10 to 20 minutes, and upper-air observations often occur only once or twice per day. Despite this vast network, NOAA requires more weather observations to realize significant improvements in weather and climate models, especially in data-sparse regions. Creare's Drone Sonde System is rapidly deployable to establish a geographically dense network of ground and upper-air observation points. The Drone Sonde System comprises a lightweight, low-cost unmanned aircraft system (UAS) with vertical takeoff and landing (VTOL) capabilities and a base station for autonomous recovery and recharging of the UAS. The UAS carries an array of sensors and regularly profiles the atmosphere from the surface to 25,000 feet. [NOAA Contract No. 1305M218CNRMW0034]

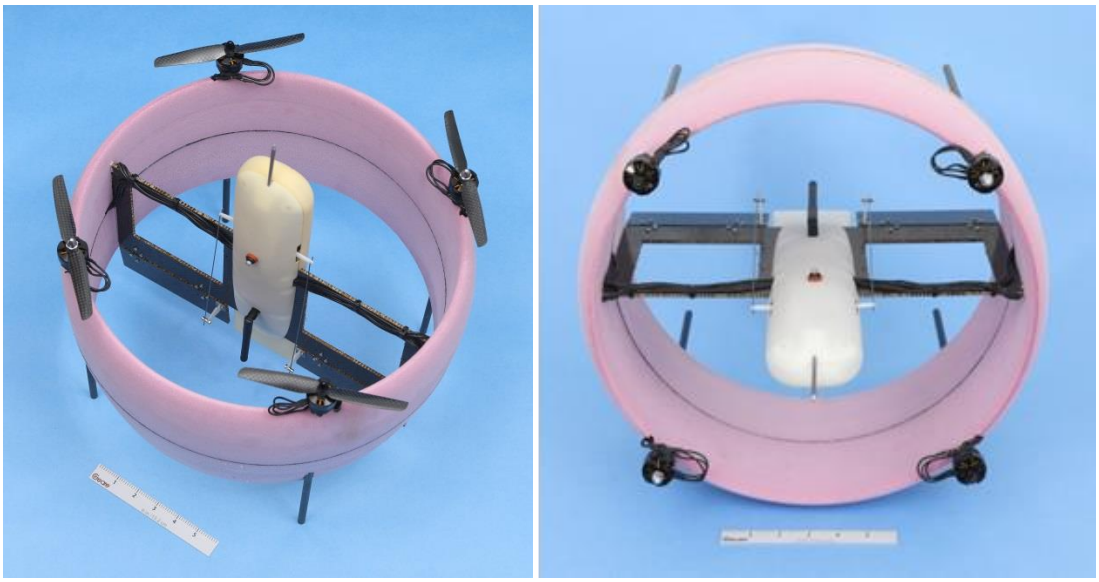

Figure 1. Creare's Drone Sonde UAS Prototype (14 inches in diameter and 700 grams)

Autonomous Unmanned Aerial Vehicles (UAVs) for Navy Ship Airwake Measurements. On a Navy-funded project, Creare is developing a small UAV to measure the aerodynamic wake behind large Navy ships (Figure 2). The aerodynamic wake is important to operation of manned and unmanned aircraft operating in the vicinity of the ship. Measurement surveys of full-scale ship airwakes are needed to validate CFD models of these wakes. Airwake computations guide the design of ship superstructures, improve the fidelity of flight simulators, and save time and reduce risk during flight tests to define launch and recovery envelopes for ship and aircraft combinations. Current full-scale test techniques involving mast-mounted anemometers are costly, time consuming, and do not extend to the critical region aft of the ship's stern. We are developing an autonomous ship airwake measurement system that is man portable and may be set up and operated by a single person. The system is based on a 5 kg hexacopter UAV developed by Creare. The system is watertight and designed to float, should it need to land on the water. Detailed measurements of the air velocity vectors above the flight deck and far into the wake region aft of

the ship's stern are possible with this system. We have demonstrated the feasibility of our proposed approach with tests of critical aspects of the system both in our laboratory and in the field. We are currently finishing a complete prototype of the system for demonstration onboard Navy ships, starting with the Freedom Littoral Combat Ship. [Navy Contract No. N00014-15-C-0060]

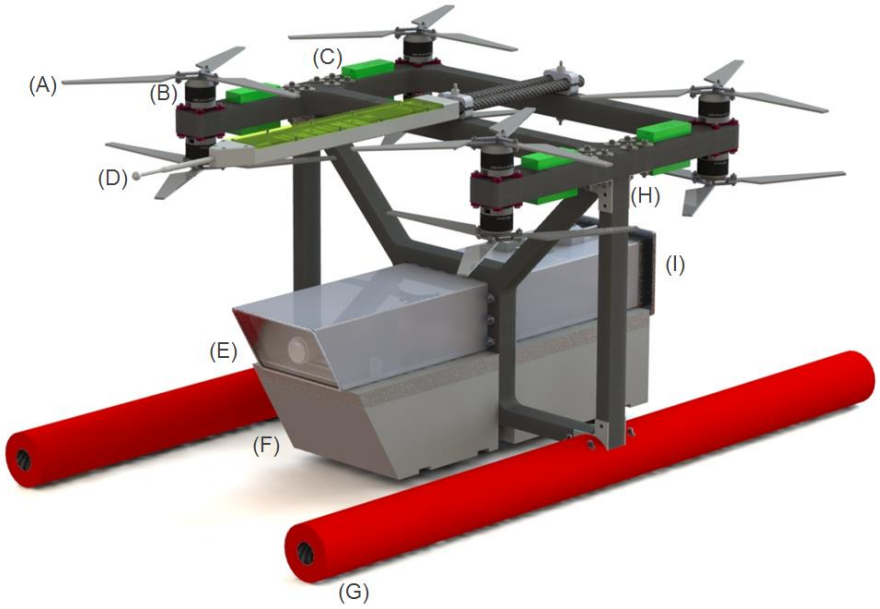

Figure 2. Aerowake Drone Design. Features include (A) propellers, (B) motor, (C) ESC, (D) Omniprobe wind sensor, (E) polycarbonate window, (F) foam hull containing batteries, (G) floatation skids, (H) composite foam board frame with joint reinforcements, and (I) removable bulkhead plate.

VTOL UAS for Shipboard Operations. On a NOAA-funded project, Creare developed the Quad-Biplane (Figure 3), a VTOL system UAS based on a variable-pitch control system with a biplane wing configuration. The Quad-Biplane system addresses NOAA's need for a well-designed atmospheric measurement UAS platform that is capable of deployment from ships, long endurance, and low cost. The biplane configuration improves flight performance in a compact system capable of landing on a ship deck and carrying up to over 15 lbs of payload. Existing fixed-wing systems offer improved endurance and payload capabilities but are expensive and have not been optimized for shipboard deployment and recovery. Existing systems that are deployed from ships require significant support hardware and require high-risk recovery tactics, such as catching the aircraft in a net or by a wingtip-mounted arrester hook. [NOAA Contract No. WC133R17CN0079]

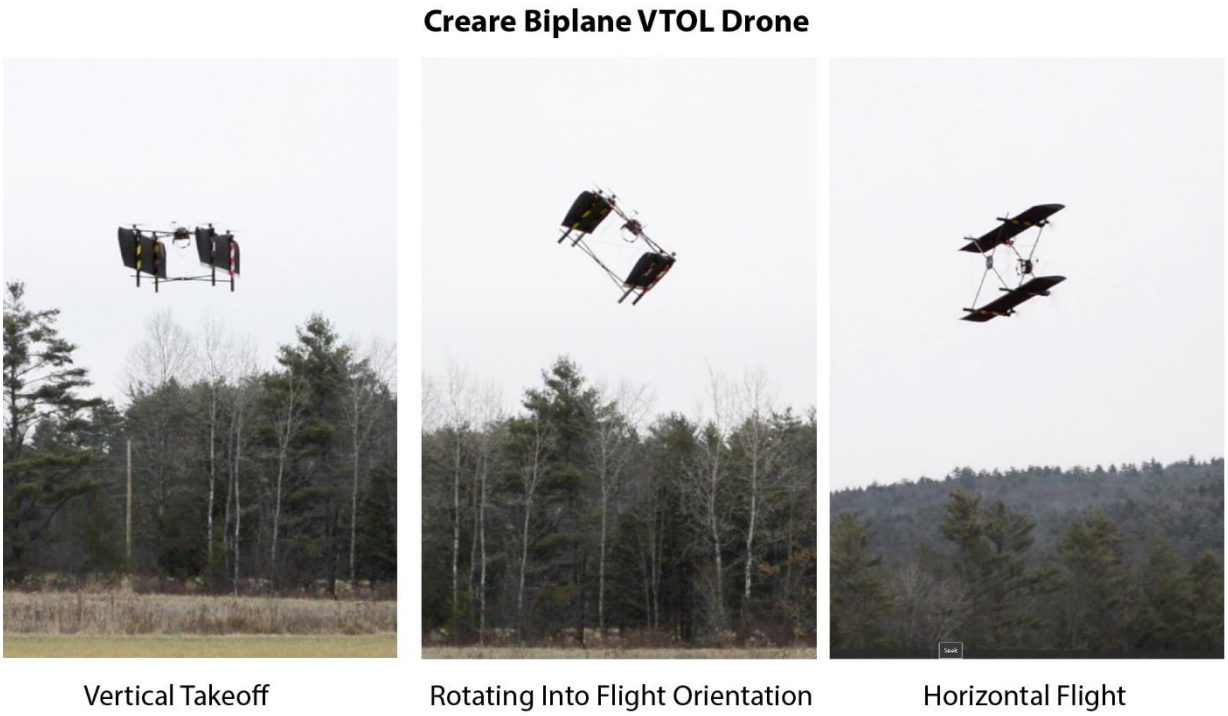

Figure 3. Prototype Quad-Biplane Flight Test Video Snapshots

Autonomous Mobile Marine Meteorological Measurement System. On a Navy-funded project, Creare developed a prototype system to perform atmospheric profiling of pressure, temperature, relative humidity, and aerosol measurements using an autonomous UAS. Timely and accurate characterization of the air-sea boundary layer (up to 1,000 meters in altitude) is needed to improve the DoD's operational capabilities. Characterization of the air-sea boundary layer is an important input into forecasting weather patterns, understanding electro-optical propagation effects on communication and data transmission, and predicting the operation of ballistic weapons such as the EM railgun over water targets. Air-sea flux measurements are also a key input into a large number of other important sea processes, including hurricane formation, climate change, and CO_2 transport; therefore, these measurements are highly sought after by a large number of academic research groups. We developed a prototype system based on a marine hardened hex-rotor UAS that deploys from a Navy ship and then autonomously navigates around the ocean while profiling the atmosphere from the surface of the ocean to at least 3,000 feet. The UAS then returns to the water surface for recharging using an energy harvesting system. [Navy Contract No. N00014-17-P-7012]

Small, Low-Cost Navigation System for UAVs. In a DARPA-funded effort, Creare develop an advanced navigation system for UAVs that takes advantage of recent developments in small, low-power, and low-cost sensor technology and improved performance of computer hardware, and combines these with the latest developments in vision-aided navigation, adaptive terrain mapping, vision-based obstacle avoidance, and bio-inspired flight control algorithms. UAVs are being used extensively by the military for operations in the theater, but they are largely utilized in a remotely piloted mode as opposed to an autonomous mode. In particular, for smaller UAVs, added autonomy would make them much more useful. Furthermore, current FAA regulations make commercial operation of UAVs very difficult and expensive, and a prerequisite for changing the status quo would be added autonomy. The development of small, low-cost, low-power navigation systems that can impart key functions necessary for a UAV to safely navigate an unknown, diverse, and potentially congested airspace is needed. Key functions include obstacle avoidance, dynamic mapping and navigation, and automated takeoff and landing. In this project, we are developing a small, lightweight, low-power, and low-cost navigation suite that is able to provide

navigation in an a priori, unknown, dynamic environment to allow safe autonomy for small UAVs. [Dept. of Interior Contract No. D16PC00110]

Agile Laboratory Transport. High Throughput Screening (HTS) is a critical part of the drug discovery process, allowing biological agents to be tested against tens of thousands of compounds to identify promising therapies and estimate dose-response curves. At present, HTS relies on the use of robotic handling systems to move micro-well plates between dispensers and instruments. Creare is developing an agile aerial platform to extend the reach and flexibility of these automated systems. Using a novel multi-copter architecture, tailored control strategies, and a customized gripper design, our aerial vehicle will perform precision pick-and-place operations to transport well plates between arbitrary locations within a laboratory. [Department of Health & Human Services/NIDA Contract No. HHSN271201700030C.]

Figure 4. Prototype Agile Laboratory Transport Drone. The system utilizes a novel hex-copter configuration with rotors canted slightly off from the vertical lift access. This decouples translation and attitude dynamics and allows the drone to remain horizontal while translating, which is a requirement of the plate pick-up and insertion maneuvers.