A Small Unmanned Aircraft System for Ecological Research

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Introduction

Aerial imagery serves as a fundamental intermediary between satellite imagery and ground-based observations. Unmanned aircraft provide a method of obtaining aerial imagery without the added risk of putting a human life in the air. An interdisciplinary team of researchers at the University of Florida (UF), with funding from the U.S. Army Corps of Engineers (USACE), have developed the Nova 2 small Unmanned Aircraft System (sUAS) designed specifically as a low-cost, autonomous, aerial imaging tool for ecological research and monitoring (Fig. 1).

Operational Area

Through a Certificate of Airworthiness from the Department of the Army, and a Memorandum of Agreement between the Department of Defense and the Federal Aviation Administration (FAA), the Nova 2 research team has achieved clearance to fly low altitude (<366 m) missions throughout large portions of the south Florida National Airspace System (Fig. 2). Mission sites in and around Lake Okeechobee and the greater Everglades are ideal places to conduct low altitude aerial missions because they contain significant ecological targets, are largely uninhabited by people, and are fairly uniform in elevation. As our program moves forward, we intend to apply for clearance to fly additional operational areas.

Airframe and Payload

The 2.51 m wingspan, electric-powered Nova 2 is hand constructed of carbon fiber and fiberglass, and weighs 6.21 kg fully loaded. Capable of being hand-launched and recovered amphibiously, the Nova 2 is an ideal platform for mission sites lacking runways or other large open spaces. Our standard optical payload consists of a commercial off the shelf 10 megapixel Olympus ™ E-420 digital single-lens reflex camera with a 25 mm ‘pancake’ lens. The optical payload is outfitted with its own GPS-aided Inertial Navigation System (GPS/INS) for improved direct georeferenced imagery. Synchronization of the camera and the GPS/INS is achieved with a custom circuit board to timestamp each acquired image with a navigation data packet. Telemetry files and images generated during a flight are stored onboard the aircraft via a 1.0 GHz Microsoft Windows XP™ micro form factor computer with a 30 GB solid-state hard drive. The entire payload system is integrated with a series of USB 2.0 bus interfaces (Fig. 3A).

Autopilot

Autonomous flight control is achieved with a Procerus® Technologies Kestrel™ 2.2 autopilot system aboard the Nova 2 which is linked by a 900 MHz wireless modem to Virtual Cockpit™ 2.5 autopilot software on the ground (Fig. 3B). Pre-planned flight paths are uploaded and autonomously executed by the aircraft with a level of precision rivaling that of a human pilot. The autopilot system allows instantaneous flight plan changes, a user-friendly interface, and an abundance of failsafes to ensure positive aircraft control and promote the safety of other objects in the air as well as on the ground.

Results and Future Developments

The Nova 2 sUAS has completed missions to assess the efficacy of herbicide treatments on invasive vegetation (Fig. 4, 5A), and nesting inventory of white wading birds (Fig. 5B). Our georeferenced solutions continue to improve, and we are routinely achieving a relative accuracy of better than one meter between images. We intend to increase the number of potential Nova 2 applications by installing near infrared and thermal infrared sensors to the platform, and seek clearance to fly additional operational areas within the near future.

Point of Contact

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Figure 1. The Nova 2 small unmanned aircraft system.

Figure 2. The current Nova 2 operational area.

Figure 3. A) The Nova 2 optical payload, GPS/INS, onboard computer, USB 2.0 hub and 18.5 V flight battery; B) Virtual Cockpit™ 2.5 ground control software with orange lines illustrating an intended Nova 2 flight path.

Figure 4. Mosaic strip of georeferenced images collected during a Nova 2 flight.

Figure 5. A) Herbicide-treated invasive vegetation; B) White wading birds nesting in a tree island; C) American alligator basking on vegetation; D) Great Blue Heron in flight.