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Small UAS Demonstration by NASA and the US Forest Service

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Issue

This collaborative effort utilized a series of small Unmanned Aerial Systems (UAS's) integrated with cutting-edge thermal imaging, autonomous flight control, and GIS-compatible technologies, to provide real-time images and analysis of forest fires.

Background

In November 2005, the two agencies issued a "Request for Participation" to the unmanned aeronautics community to provide suitable aircraft and imaging capabilities for a demonstration and capabilities evaluation. Six vendors were chosen from a field of 13 respondents. Of the six vendors who were issued invitations, four vendors were able to attend (3 for thermal image acquisition, 1 for communications relay). During the demonstration at Fort Hunter Liggett, the USFS was able to assess the systems capabilities and evaluate UAS's for possible future inclusion into the day-to-day wildfire monitoring arsenal. Currently, the fire management agencies rely on both rotorcraft (helicopters) and fixed-wing aircraft equipped with thermal-detection devices to assess fire conditions on wildfire events.

Key Points

Fire-fighting teams will benefit from this emerging technology by having tactical assets capable of loitering over fire activity during the crucial times of sunset to sunrise or when other assets are not available (for reasons of crew safety).

Small UAS platforms, equipped with thermal imaging systems, can fill a critical niche in fire monitoring and mapping. Small UASs have long-duration capabilities, allow crew risk-reduction from hazardous operations found within major fires (blinding smoke, excessive wind sheer, and unfamiliar terrain), and should be less expensive than current systems.

Another technology showcased at the demonstration was a ground portable radar system developed by the UAS Collaborative (NASA-ARC Research Park). The Sense-and-Avoid Display System (SAVDS) was able to provide situational awareness capabilities for the LALE (low altitude, long endurance) UAS's deployed at the demonstration.

The successful completion of this demonstration allowed for a careful assessment of capabilities, leading to follow-on testing and, potential integration and use of these technologies in the fire management community.

Figure 1. A panoramic photo of assembled observers, participating vendors, and two UAV aircraft taken by Fran Stetina (retired NASA) on 7 June 2006.

Summary

At this demonstration, we were able to successfully demonstrate the following:

1. Safety – All air and ground operations were conducted with safety as our main focus.

2. Day flights over fires – the four UAS systems were flown during the day out of line of sight, and loitered over the controlled burns set by the Fort Hunter Liggett fire crew.

3. Night flights over fires – Three of the UAS systems were launched and retrieved after dark, and each flew to and loitered over the controlled burn for a period of 20 minutes. As in the day flights, the fires were out of line of sight from the airfield, and the aircraft flew autonomously to and from the fire locations.

4. Thermal image acquisition over fires – During the course of this demonstration, there were 6 sorties over actively burning fires. The three aircraft equipped with thermal sensors were able to locate the fires and accurately map the hotspots with GPS coordinates. One vendor provided a post incident map showing the location of thermal hotspots.

5. Real Time Tactical Imagery – All three thermal mapping aircraft were able to downlink the acquired imagery back to the ground stations at the airfield in real time. This capability provides situational awareness to the incident command which can be miles from the active fire.

6. Long duration flight – One aircraft flew continuously for a period of six hours to demonstrate the capability for long duration flight, and to demonstrate autonomous loitering over an area of interest.

7. Transpeater – One aircraft was equipped with radio transpeater equipment and successfully demonstrated the capability of acting as a “radio communications relay in the sky”. The crew on the fire was able to communicate directly with the assembled personnel at the airfield. Direct line of sight radio communications was impossible due to steep terrain between radios.

8. See and Avoid Display System (SAVDS) – The SAVDS system was deployed at the TUSI Airfield and was used to display the location of the UAS aircraft while in flight relative to other aircraft transiting the area. The ability to maintain aircraft avoidance is critical to the operation of UAS in the National Airspace.

9. Launch and Retrieval Capabilities – The aircraft selected for this demonstration were selected specifically to illustrate various means of launch and retrieval in less than ideal circumstances. The Vector P aircraft can be launched and retrieved on an improved surface. The Aerovironment Puma is hand launched and easily retrieved by flying the aircraft into a grassy field. The Institu ScanEagle is launched by catapult and retrieved

10. Cessna Caravan / 12 Channel Overflights – During the course of the event, a manned aircraft (Cessna Caravan operated by Sky Research) equipped with a NASA designed 12 channel sensor overflew the controlled burns at a higher altitude to serve as a check of the thermal imagery provided by the UAS thermal sensors.

Table 1. Participating aircraft and the capabilities exhibited at the demonstration.

Vendor	**Aircraft**	**Capability**
Intellitech	Vector P	Real time image acquisition
Aerovironment	Puma	Real time image acquisition
Insitu / Evergreen	ScanEagle	Real time image acquisition
Advanced Ceramics Research	Silver Fox	Late withdrawal
RnR	APV3	Comm Relay

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