Supporting RxCADRE Fire Measurements
Unmanned Aerial Systems

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RxCadre 2011

- RxCADRE – Prescribed Fire Combustion Atmospheric Dynamics Research Experiments
- Eglin AFB February 3-6, 2011.
- 3 UAS – USGS Raven, Prioria Maveric, G2R
- Flights were successful, demonstrated that sUAS is capable of collecting scientific measurements over controlled burns
3 Types of UAS

Additional aviation assets
- Cessna 337 – Smoke Sampling
- Piper Navaho – Fire Imaging
- EPA Tethersonde – Smoke Sampling

Scout

G2R

Scan Eagle
Rx-CADRE Active Fire Measurements – Large Units (500-1000 acres)

Active fire measurements

- Ground-instrument cluster
- 10 m met tower
- 30 m met tower
- UAF Scout – LWIR, Flight 1 HIP-3, Flight 2 as directed
- EAFB Test Wing G2R1, G2R2 – LWIR smoke sensor, wind, T, and RH sampler, F1 HIP-1, HIP-2; F2 MAPPs
- U. Alaska ScanEagle – LWIR synoptic view
- Piper Navajo – WASP sensor (LWIR/MWIR/SWIR and visible fire mapping at zenith)

NOTE: Cessna 337 smoke sampling aircraft is downwind following plume ~1000 - 8000 ft AGL
1000 Launch Weather Balloon 1
1000 Get MAPPs and Tethersonde coordinates.
1100 Launch Scan Eagle (SE)—1500 AGL
1115 Launch Low Manned (LM) (Urbanski, Smoke Sampling)
1130 Launch High Manned (HM) (Kremens, WASP)
1150 Low Manned begins sampling over B70L2G once SE Upwind LG1
1220 IGNITION
   - Launch Scout
   - Raise Tethersonde to 300 ft. AGL
   - Launch G2R1
   - Launch G2R2
   - LM Cleared to Orbit as desired North of Range Downwind
   - HM Orbit 6000 – 10000 ft. AGL over L2G
   - SE Orbit 1100 – 3000 ft. AGL over L2G
   - G2R1 – G2R2 Orbit 600/650 ft. AGL, 500 ft. lateral separation over HIP 2 – 3
   - Scout Orbit 50 – 100 ft. AGL HIP – 1
1235 Retrieve Scout once HIP – 1 is burned over
1235 Focus SE imagery over MAPPS
1240 Re-launch Scout (As needed / Directed)
1242 Satellite Overpass VIIRS
1243 Satellite Overpass MODIS
1245 Retrieve G2R1
1300 Retrieve G2R2
1305 Burnout Complete
   - Retrieve SE once LM confirms it is clear of B70 (Tree Line) or above 5000 ft. AGL
   - Retrieve G2R1
   - Release HM
1330 Lower Tethersonde
   - Confirm LM has departed
   - Confirm HM has departed B70
   - Confirm SE has landed
   - Confirm no RxCadre Aircraft Manned/Unmanned are airborne
1400 Launch Weather Balloon
1430 Release Airspace
B70L2G Air Plan 10Nov12

Test Area B-70

Tethersonde Balloon

Scout Launch \ Recovery

30 meter tower (MAPPS)

UAS Launch \ Recovery

LM profile (Approximate)

B-75

B-82
G2R Video
Sarnoff TerraSite

Hot Targets
S5_18:15:58 – 5210 M², 1.28737 Acres
Delivered as kmz, shapefiles, txt???
Identification and Significance of Innovation

An autonomous airborne imaging system for earth science research, disaster response, and fire detection is proposed.

The primary goal is to improve information to researchers and operations personnel at reduced cost. By operating autonomously and with higher spatial resolution, the system will deliver a 3X to 4X reduction in operating costs compared to current systems.

The system uses a two color Quantum Well Infrared Photo detector (QWIP) to improve the accuracy of energy release from wildfires, thereby improving our understanding of the carbon cycle.

Expected TRL Range at the end of Contract (1-9): 7

Technical Objectives and Work Plan

1) Detect 8-inch diameter, 600°C hot spots, while imaging the day and night ground terrain through smoke from an altitude of 30,000 to 40,000 feet.
2) Generate fuel loading and burn area classification maps.
3) Locate the image pixels to a map accuracy of 10 meters.
4) Image terrestrial features with dimensions of around 2 meters in order to observe natural and man-made fire barriers.
5) Transmit geometrically corrected and classified imagery in near real time to a centralized spatial data base.
6) The airborne system must be capable of autonomous or remote operation.
7) The airborne instrument must small enough for light aircraft or UAV installations

NASA and Non-NASA Applications

NASA:
• Unmanned Airborne System and Sensor Development
• Fire Detection and Mapping Research
• Research into the Development of Automated Sensors
• Carbon Cycle Research

US Forest Service:
• Reduced cost of National Infrared Operations
• Real Time Fire Detection and Mapping

DHS:
• Disaster Response
• Border Patrol

Firm Contacts

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In this scenario the 0.6 milliradian 2 band LWIR/MWIR sensor will image a 14 foot square pixel from an altitude of 23,000 feet. As the aircraft orbits at 23,000 Feet the Staring Wide Area Imager scans the entire 80 degree by 80 degree Field of Regard, imaging the entire 8 mile diameter area once every 60 seconds -- acquiring, geo-rectifying, and mosaicing in near real time, approximately 100 images to cover the entire area once every 60 seconds. This calculation includes 50% overlap on all image frames.

- LWIR (8 to 9 um)
- MWIR (4 – 5 um)
- SWIR 1.6 um
- 600 urad instantaneous field of view
- ground sample distance of approximately 14 feet from our notional operating altitude of 23,000 feet.
- At this altitude the system will be capable of detecting a 6 inch by 6 inch 600 degree C fire.
- 8 Mile Diameter Field of Regard
In this scenario the 0.6 milliradian 2 band LWIR/MWIR sensor will image a 5 foot square pixel from an altitude of 6000 feet. Each individual image frame contains 320 by 240 pixels.

As the UAS orbits at 6,000 Feet the Staring Wide Area Imager scans the entire 80 degree by 80 degree Field of Regard imaging the entire 11,000 ft X 11,000 ft area once every 60 seconds.

The system will acquire, geo-rectify, and mosaic in near real time, approximately 100 images to cover the entire area once every 60 seconds, including 50% overlap on all image frames.
Comments/Questions

Thank you to JFSP for funding this endeavor.