Panel Discussion -- “Disaster Technologies: Problems and Solutions With a Focus on Fire Response

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Mark Rosenberg -- GIS Specialist, California Department of Forestry and Fire Protection, Fire and Resource Assessment Program, Sacramento CA

Douglas Stow -- Professor, Department of Geography, Co-Director, Center for Earth Systems Analysis Research, San Diego State University
Discussion Topics

• Wildfire Response Information Derived from TIR Imagery

• Current Thermal Infrared Fire Monitoring Programs
  ➢ Challenges for Operational Wildfire Monitoring Using TIR

• Other (Non-TIR) Imaging Systems
Near Real Time Objectives

• Provide a Near Real Time Processing System to deliver MODIS and AMSR-E data to users in 3 hours of observation

• Leverage existing capabilities
  • Utilize MODAPS expertise to modify MODIS algorithms to run in near real time
  • Obtain and utilize NOAA provided AMSR-E algorithms that have already been modified to run in NRT

• Provide high availability while minimizing operations costs
  • Two independent systems running in parallel
  • Utilize separate existing Networks

• Keep User Interfaces Simple
  • Provide a Web interface
  • Distribute data to users via subscription as well as allowing user pulls
  • Utilize existing user services

• Provide a test bed for testing new products, new algorithms
  • Provide developmental capability for the prototyping of new and innovative products
  • Support the examination, establishment and coordination of NRT production for other satellite sensors

• Establish a User Working Group to guide the system development and operation
Wildfire Management Information
Derived from TIR Imagery

• Hot spot locations
• Flaming front (location & spread)
• Near real-time burned/not burned areas
• Fire intensity & temperature
• Smoldering areas
Current Thermal Infrared Fire Monitoring Programs

- US Forest Service -- National Infrared Operations (NIROPS)

- US Forest Service -- Firewatch

- NASA Goddard Space Flight Center & US Forest Service Remote Sensing Application Center -- Rapid Fire & FIRMS

- NASA Ames Research Center -- Wildfire Research and Applications Project (WRAP)

- National Technical Means -- Firehawk
NASA “Ikhana” UAV
The Ikhana is a derivative of the Predator B (MQ-9) “Reaper” UAV, designed as a NASA science and research platform. “Ikhana” is a Native American Choctaw-nation word meaning: “Intelligence, Conscience or Aware”

Length: 36 feet,
Wingspan: 66 feet
Operations: ~50K ft;
Endurance: ~24-hours
Speed: 170-200 kts
Payload: 2400 lbs of instruments
Max T/O weight: 10,500 pounds
C&C and sensor telemetry: C-band (local) & Ku-band (global)
Sensor System:
AMS-Wildfire Instrument

AMS Wildfire Sensor

<table>
<thead>
<tr>
<th>Band</th>
<th>Wavelength μm</th>
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<tbody>
<tr>
<td>1</td>
<td>0.42-0.45</td>
</tr>
<tr>
<td>2</td>
<td>0.45-0.52 (TM1)</td>
</tr>
<tr>
<td>3</td>
<td>0.52-0.60 (TM2)</td>
</tr>
<tr>
<td>4</td>
<td>0.60-0.62</td>
</tr>
<tr>
<td>5</td>
<td>0.63-0.69 (TM3)</td>
</tr>
<tr>
<td>6</td>
<td>0.69-0.75</td>
</tr>
<tr>
<td>7</td>
<td>0.76-0.90 (TM4)</td>
</tr>
<tr>
<td>8</td>
<td>0.91-1.05</td>
</tr>
<tr>
<td>9</td>
<td>1.55-1.75 (TM5)</td>
</tr>
<tr>
<td>10</td>
<td>2.08-2.35 (TM7)</td>
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<tr>
<td>11</td>
<td>3.60-3.79 (VIIRS M12)</td>
</tr>
<tr>
<td>12</td>
<td>10.26-11.26 (VIIRS M15)</td>
</tr>
</tbody>
</table>

Total Field of View: 85.9 degrees
IFOV: 2.5 mrad
Altitude: 25000’
Spatial Resolution: 20m (at sea level)
On-Board Fire Algorithms

- Fire spectral band combinations for different collection scenarios (day / night):
  - **DAY**: $b_{12}$ (10.26 - 11.26 um), $b_{9}$ (1.55 - 1.75 um), $b_{11}$ (3.60 - 3.79 um) as R-G-B;
  - **NIGHT**: $b_{12}$ for night ops

- **Real-time “hot-spot detect algorithm”:**
  - Modified CCRS algorithm:
    
    Fire = If $b_{11}$ (3.60 - 3.79 um) brightness temp > $380^0$ K; and $b_{12}$ (10.26 - 11.26 um) brightness temp > $240^0$ K; and $b_{11} - b_{12} > 12K$; and Band 7 (0.76 – 0.90 um) < .22 (screen high reflectance commission errors).

- **Real-time BAER spectral band combinations:**
  - $b_{10}$ (2.08 – 2.35 um), $b_{9}$ (1.55 - 1.75 um), $b_{7}$ (0.76 – 0.90 um) as RGB

- **Real-time post-fire, calibrated NBR data:**
  
  $b_{7} - b_{10}$  
  $b_{7} + b_{10}$
Wildfire - Collaborative Decision Environment

- **Google Earth**
- **Weather**
  - NWS, NRL, MIT
- **MODIS**
  - USFS, NASA/UMD
- **Fire Incidents**
  - NIFC, USFS, USGS
- **Airspace Restrictions**
  - FAA, NASA

**Satellite track prediction**

**Internet**

**Visualization**

**Satellite**

**Streaming Video**

**Group IM**

**Ikhana UAS**
## 2005-2008 UAS Wildfire Imaging Mission Summation

<table>
<thead>
<tr>
<th>PLATFORM</th>
<th>YEAR</th>
<th>AIRCRAFT</th>
<th>FLIGHTS</th>
<th>HOURS</th>
<th>FIRES FLOWN</th>
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<td>Small UAS Demo 1</td>
<td>2005</td>
<td>various (3)</td>
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<td>2 (test fires)</td>
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<td>Small UAS Demo 2</td>
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<td>10</td>
<td>15</td>
<td>1 (prescribed fire)</td>
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<td>Altair</td>
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<td><strong>TOTALS:</strong></td>
<td></td>
<td></td>
<td><strong>33</strong></td>
<td><strong>196</strong></td>
<td><strong>58</strong></td>
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Challenges for Operational Wildfire Monitoring Using TIR Systems

• “Seeing through” cloud and thick smoke cover

• Platform Deployment
  ➢ timeliness of mobilization
  ➢ spatial coverage and production rate
  ➢ airborne interference with suppression operations
  ➢ satellite repeat frequency

• Sensor saturation and blooming

• Coarse spatial resolution of satellite TIR imagery

• Determining temperature relationships
  (temperature of what – soil, vegetation, flame)?

• Real-time image processing

• Platform-to-ground data downlink

• Data dissemination; need for web portals
Other Imaging Systems

• Visible/NIR/SWIR
  - fuel type, mass, and moisture
  - burn extent and severity
  - fire temperature (SWIR)

• Low-light level V/NIR/SWIR
  - hot spot detection
  - night-time evacuation

• Lidar (active V/NIR)
  - fuel type and mass

• Radar (active microwave)
  - fuel type and mass
  - burn extent

• Passive microwave radiometers
  - fire temperature, location & spread
NEOS LTD. Light Sport Aircraft

w/ FLIR or FireMapper TIR sensors
NEOS LTD. GT-500 Light Sport Aircraft & TIR Sensor
NEOS LTD. GT-500 Light Sport Aircraft & TIR Sensor -- Color Enhancement
Wildfire Perimeter Imaging
FireMapper 2.0

Approximately 1900 acres burning.

Jack White Range, AK
July 15, 2004
1:05 pm ADT
151 06 30 W
66 56 37 N

Temperature (°C)
30 40 50 60 70 80 90 100 110 120 130 140 150 160

TEAM MOSQUITO MEMBER

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