Fire Imaging

USDA Forest Service

Fire and Aviation Management

Overview of USFS Use of Imagery

- Two broad categories:
  1. Conventional non-time sensitive remote sensing (i.e. forest health monitoring, vegetation mapping, landscape-scale, etc.)
  2. Operational time sensitive "need-it-right-now" to support tactical and strategic decisions

- Focus on Operational fire imagery
  - Time sensitive, multi spectrum band IR imagery, high fidelity/resolution
  - Map products generally preferred over raw imagery or FMV
  - Situational Awareness, Assessment, and decision support

- Discovering that there isn't a silver bullet solution
  - Different requirements depending on the application

Where We Have Been

- Last 40 years have primarily used National Infrared Operations (NIROPS)
- NIROPS comprised of two manned aircraft equipped with IR line-scanners
    - Map large fires at night, once per 24 hour period
    - Generate perimeter maps
    - Calculate acres, stratify areas of intense, scattered, isolated heat
    - Develop GIS map products (vector files and KMZ)
    - Products are distributed to IMT for further exploitation
    - NIROPS is managed by FS, available to all fed, state, and local govt cooperators
- Demand for fire imagery is going up (1,300 requests per year → 2,600 per year)
- NIROP's Busiest Night: mapped 49 fires in one night
- Demand increasing for other fire imaging products to support fire operations

What We Are Doing -Aircraft

- Cooperating agencies and private sector are providing capabilities:
  - National Guard Distributed Real Time IR (DRTI)
  - National Guard MQ-9 Reaper UAV
  - Colorado State Multi-Mission Aircraft (MMA)
  - USFS Night Watch Air Attack
  - USFS Fire Watch Helicopter
  - Private sector vendors under contract to state and fed agencies (manned and UAS)
- Mix of aircraft and sensor systems
  - Aircraft: UAS, helicopter, single & multi-engine piston, multi-engine turbine, and jet
  - Sensors: Camera-ball and Step-Stare IR camera systems
- Different capabilities and services

What We Are Doing -Satellites

- MODIS and VIIRS

- National System satellites

- Commercial satellites
  - 2018 FS experimented with imagery from WorldView3 and other commercial satellites for mapping

Where We Are Going

Categorized Four Broad Mission Types:

1. Detection (wide area)

2. Perimeter Mapping (50-70 fires / day or more)

3. Persistent and Periodic Intelligence/Surveillance/Reconnaissance (ISR)

4. Dashboard (common operating display of national fire situation)

FS has identified requirements for each mission type:
- Mission profile & intent
- Standards for data and products
- Aircraft and sensor specifications
- Right tool for the job (best use)

Detection Mission

- Aircraft or satellite systems that can cover a large area
- Detect new fire starts
- Early-warning to support rapid response and public safety
- Have used aircraft post-lightning storms to detect new fire starts
  - Northern California, Oregon/Washington, Western Montana/Northern Idaho
  - EO/IR camera ball system can scan wide area either side of flight path
- Ignition Point (IgPoint) in Enterprise Geospatial Portal (EGP)
  - Use of satellites to detect new heat signatures
  - Human and natural caused fires
  - Algorithms to discriminate false positives (campfires, ag burns, sun reflections, etc.)
  - Differentiate from known static heat sources (energy plants, oil & gas, etc.)

Fire Perimeter Mapping Mission

- NIROPS: 85% Aircraft, 15% satellite → increase role of satellites in future?
  - Satellites: Require sufficient resolution, angle of coverage (nadir +/-), right thermal bands, post-processing of imagery
- National System satellites have the technical capability
  - CAC approval for civil use
  - Number of analysts is limiting factor → options to automate post-processing?
- Commercial and civil satellites have limited capability
  - Proposing pilot project to expand use of commercial satellite imagery
- Expanding role of private sector aircraft vendors
  - Use of contractors to augment NIROPS in 2019
  - Stay current with market research and current gen IR systems

Persistent or Periodic ISR Missions

- Some fires need more than once/day imagery to support tactical and strategic decisions
  - Dynamic fast moving fires, close proximity to communities or infrastructure
  - Monitor fire progression, see through the smoke plume
  - Impingement on trigger points (evacuations, mgmt. action points)
  - Detect spot fires before they get established
- Persistent ISR: One platform per fire, available 12-18 hours per day
  - Large UAS, manned aircraft
  - Downlink capability: FMV and/or map products
- Periodic ISR: One platform for multiple fires, 1-2 hours per day per fire
  - Manned aircraft have speed and ability to cover multiple fires
  - Downlink or upload capability: FMV and/or map products
- Private sector expanding capability
  - UAS and manned aircraft

Dashboard

- Provide national Common Operating Picture of wildfires in EGP
- Use thermal detection from satellites to provide situational updates
  - Raster or point vectors
  - Strategic application, non-tactical
  - Lower fidelity requirements
- Provide strategic intelligence
  - Visual display of fires in CONUS and Alaska
  - Maintain situational awareness and inform decisions
  - Prioritization of resources at national and regional scale
- Currently using VIIRS, MODIS (375-500m GSD, 4 updates/day)
- Goal: Reduce return interval (i.e. every 15 minutes) and improve GSD

Summary

- Demand for fire imagery is increasing as we learn how to exploit
- No single source solution. Mix of resources and capabilities
- Have identified requirements for different mission types
- Matching requirements to available systems, integrating workflows
- Gaps in satellite technology or capability that is available to USFS
- Can offset with agency and private sector aircraft systems
- UAS also able to help fill the gaps (single fires)
- Goals:
  - Establishing operational requirements (what we need)
  - Seeking standardized solutions that can be implemented on a large scale
  - Long term: mix of airborne and space-based collection platforms