Automated Wildland Fire Detection integrated in Fire Management Systems and Procedures

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Detection Methods

Photo by: Lookout Charles White
Aircraft Surveillance Ontario
Satellite Bird by DLR

UAV California
Video Sensor (Pelco)
Forest Ranger Sensor and Control Office
Detection Performance (without Forest Ranger)

Worldwide, 60% of the fires are detected at random. This is a substantial argument for an installation of a reliable early detection system.

Examples for detection costs:
- Ontario: 3 million $ CA / Year
- Saskatchewan: 4 million $ CA / Year

Based on Canada Yearly analysis
**Specification drivers for remote sensing systems**

- Fast starting fires
- Day and night fires
- Fast moving fires
- Fast changing weather/environmental conditions
- Difficult topography (hills, mountains ….)
- No mains power available
- Fast detection, meeting initial attack requirements (< 20 minutes response)
- Provide much more functionalities and data, than only detect a fire
Automated Smoke Detection - Surveillance Requirements

Smoke is one of the first visible signs of a starting fire...

= smoke is the preferred detection parameter

Factors in the observed areas, not correlated to smoke plume shall largely eliminated

Additional information like:
- coordinates of a fire (multiple format – GPS, Lambert II, WGS84..)
- distance from the fire and
- information about the type and the size of a fire

Another important information for the fire fighter strategy:
- color and visible structure of the smoke plume

Analysis of a wide spectrum of light:

visible range (400-700nm) during daylight → near IR for night detection

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Automated Smoke Detection - Disturbing Factors

Disturbance factors – mostly dynamic:

- **Moving objects** - like cars, animals, people, aircraft, clouds, shadows, air turbulences,
- **Fixed objects** - with changing interferences like trees moving in the wind, sun reflections on various objects.
- **Visual effects** - like fog or smog which camouflage the smoke plume in long distances

These factors demonstrate, that an automated smoke detection requires more than commonly used video system and image processing software to guarantee a reliable analysis at a minimum of false alerts.
Under these aspects, the limitation of video systems become obvious.

**Smoke is visible almost in grey tints - small range of the light spectrum:**

- Detection in this spectrum range may be better performed with a b/w sensor
- Color images for the smoke classification and monitoring requires a color sensor
Automated Smoke Detection - B&W / Color sensing

Control Office   B/W Sensor
B/W sensor detected a fire in 35 mile's distance.
Identification by eyes on the panorama image
monitor an area of 5000 km² (40 km radius)

Control Office   Color Sensor
No identification possible,
high UV level limits range
Automated Smoke Detection - B&W / Color sensing

Zoomed image:

Fire was identified as a Barbeque fire.

monitored with 45images (23 minutes) as recorded in the database.

Clear verification, that did not expand in size and structure during the time of observation.

Verified distance:

34 miles from the sensor position
Automated Smoke Detection - B&W / Color sensing

B/W Sensor (Forest Ranger)
- 14bit Sensor
- 20 nm analysis bandwidth
- 20 x higher resolution
- Amplify contrast ratio
- Separation of grey scales

Color Sensor (Video)
- 8 bit Sensor
- >300 nm analysis bandwidth
- Limited filter options

Fire in 5km distance is hardly seen with a color video system.
Demands for Fire Management integration

- Color- & B/W sensing for detection
- Black & White images for smoke identification
- Color Information for smoke classification and monitoring
- Day and night visual information
- Weather / environmental information
- Geographical / topographical information (hills, mountains, slopes, POI)
- Position information (geo-referenced coordinates)
- Sensor status information
- Interactive sensor access for request of dedicated real time data by authorized users
- Database for event analysis- and training tasks
Forest Ranger – the commercial application

Forest Ranger operates with:

14bit CCD sensor, selected sensor characteristics a switchable spectral filter internal CCD cooling device.

resolution of 16,000 steps small bandwidth grey range filter capability of long range detection.

disturbing factors are mostly eliminated and excluded from the alerts sent to an operator

Forest Ranger provides procedures and technologies to optimize analysis in detection speed and quality.

The small green alert is caused by the movement of the tree in the near-field. The red small alert are the big 2006 fires near LA, in approx. 120 miles distance detected by AWFS.

(Original screenshot from USFS, Lookout Strawberry Peak, San Bernardino)
Forest Ranger - Day & Night Detection

The Automated Detection System must provide the capability for day and night detection.

For a reliable performance during a 24hr operation, the sensor shall provide the full 14bit resolution for night detection too, as shown in these images taken at 21:30h p.m.

Sensor with night vision (14,570 grey steps)

Sensor without night vision (1343grey steps)
Forest Ranger – Image Analysis

image processing pixel by pixel identify the portions of images corresponding to the smoke criteria like
– colour
– contrast
– dynamics
– expansion, and
– brightness
utilizing data and parameters from the interactive database.

The portions identified on the three images are then processed in order to analyse any variation in the targeted portions.

If the system construes it as smoke emanating from a fire, it sends an alarm signal to the control office.
Problem of error alerts, not from fire:

i.e. caused by

- clouds, moving with the wind
- vertical Cliffside reflects the shadows of the clouds like a rising smoke plume
- shadow moves on a flat area and can be identified by the SW algorithm (no alert is generated).
- strongly effected and amplified by: topography, wind, changing weather

This can make a system unusable as a detection tool.
Forest Ranger - Alert Relevant Information

Forest Ranger cover a lot of different visual weather effects by an analysis SW, Neuronal interactive collection of models with parameters and values, tuned to memorize variable situations. For the analysis of the images, the image processing SW has to consider this various database information for the detection algorithm.
Forest Ranger - Alarm Information

Utilizing such procedures, we provide a powerful tool to supply an array of goal oriented information to the operator.

In this way, the reliability and utility are proven and will be the base for a cost effective, economical investment to the customer.
Forest Ranger - Operator tools

Operator alert verification by histogram analysis
Forest Ranger data provided for Fire Management

Numeric, visual and localization information

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<th>Relève…</th>
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Forest Ranger data provided for Fire Management

Visual image b/w with analysis functions

Night detection

Colour - & incident information
(Live monitoring & database)
Forest Ranger data provided for Fire Management

Color, image, parameter and database information
Forest Ranger data provided for Fire Management

Geographic localisation

Geo-referenced information
(true azimuth & elevation related to sector and coordinates)
Fire evaluation by live observations (apr. 25-30 km)
Forest Ranger - Fire Management Tools

Fire evaluation by live observations (appr. 15 km)

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Forest Ranger - Fire Management Tools

2D/3D Position simulation:

Network integration for
2D/3D Simulation of fire position
and fire behavior simulation
Forest Ranger - Fire Management Tools

Fire management Interface:
- Data communication with dispatching system for visual data exchange
- Fire propagation
- Identification of resources
- Position of resources
- Movement of resources
- Strategic coordination of resources
- Identification of fire position
- Propagation of fire development

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Forest Ranger: System Concept for SDI S13 France

16 sensor's
2 Control Office
Radio Network
Power
FTP Storage
3D GIS communication
Fire management integration
Meteo Stations

24Hrs Service Contract
Forest Ranger - Examples of commercial installations in operation

- **Operator:** Service Départemental d'Incendie et de Secours des Bouches-du-Rhône (SDIS13) Marseille (France)

- Test phase completed: 2004 - 2006

- EU-Tender won (4-year contract): May 2007

- Planned systems: 16

- Systems installed: 8
• Control Center (CODIS) in the operation room SDIS13
Outlooks  Reganaz & Bertagne (France)
Outlook St. Croix
Sensor La Saoupe
Outlook Marseillais
Commercial installations in operation

- **Operator**: Junta de Andalucia Consejeria de Medio Ambiente Sevilla (España)

  - Test phase completed: 2008
  - Planned systems: 10 - start in 2010

  3 other projects at Spain in 3 regions with 3+6+4 systems are actual running
Outlook Cordoba Los Vilares (Spain)
Conclusion

Leave it as it is – or …
.... stop it before ...