TELEMETRY APPLICATIONS IN WILDLAND FIRE CONTROL

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Summary. Telemetry will be coming into wider use in wildland fire control because it provides the real-time information needed in decision-making. Two applications are described: transmission of airborne infrared imagery of the fire scene, and the relaying of meteorological data from remote stations. Experimental systems using these types of telemetered data are being developed at the USDA Forest Service's Pacific Southwest Forest and Range Experiment Station. Also under development are computerized models using telemetered and other information for predicting fire behavior.

Introduction. Like other fire protection organizations, wildland fire control agencies are becoming increasingly cost-conscious. They recognize that one way to reduce the cost of fire suppression is to improve the means of acquiring and transmitting data necessary for decision-making.

Fire researchers at the Pacific Southwest Forest and Range Experiment Station are investigating ways of speeding up the dissemination of fire information. They are studying the use of telemetry in transmitting (a) infrared (IR) imagery of the fire perimeter, fire intensity, and spot fires outside the perimeter; and (b) meteorological data from remote stations that would be useful in fire control.

Infrared Imagery. Airborne infrared line-scanning systems for detecting and mapping forest fires are used on an operational basis by the Forest Service (1, 2). But until recently, the Forest Service lacked means of relaying the imagery from the aircraft to the place where tactical decisions are made except by physical transfer. What has long been needed is a system for telemetering the information from the patrolling or mapping aircraft to centralized fire dispatching headquarters or camps established at the location of large forest fires or both (3).

At Boise, Idaho, the Forest Service operates three aircraft equipped to record infrared imagery. All three are able to drop the IR imagery to the ground, where it is picked up and delivered to the fire boss. This technique is satisfactory in many situations. Where dropping is not feasible, the plane lands and the imagery is then transported by ground

vehicle to the user. This procedure often causes unreasonable delay and limits the value of the imagery to fire officers.

The telemetry technique requires only the establishment of a communications link. It also provides a high degree of freedom in the positioning of the aircraft. It can be used at night or under restricted flight or visibility conditions. The receiving equipment may be located at a fixed operations facility or in a vehicle at the fire camp or command post. The use of telemetry does require the addition of one or more receiving sites with image recorders. The additional tape recording and transmission equipment needed increases the cost of obtaining the imagery.

The telemetering of IR imagery from a fire-mapping aircraft to a fire camp was successfully accomplished for the first time at the Prospect Fire, in the Angeles National Forest, September 21, 22, 1974. The equipment and procedures were integrated and tested in Montana only 3 weeks earlier, following prior systems and equipment design. The aircraft and IR equipment used were a Beechcraft B-50 King Air* airplane (Fig. 1), airborne IR scanner, image recorder, encoder, tape recorder, S-band telemetry transmitter, and antenna. The ground system was housed in a mobile van on assignment to the Forest Service from the State of California for experimental and developmental purposes (Fig. 2). The van houses its own 120VAC auxiliary power supply and communications equipment. The telemetry equipment (S-band receiver and antenna) was supplied by McDonnell-Douglas under contract to the Forest Service. The decoder was especially designed and built, as was the airborne encoder. The receiving antenna was mounted on a pole atop the van with a horizontal (360°) rotor and controller. The airborne and ground equipment constitute the total telemetry and data processing system (Fig. 3).

Before this equipment could be used, it was necessary to conduct integration tests. The purpose of this testing was to determine antenna pattern constraints, pilot/navigation constraints, maximum usable distances, and minimum signal levels; and to develop air and ground crew procedures and terminology. There had been no previous antenna range measurements to define the antenna pattern. Also unknown were the effects of protrusions from the plane because of existing equipment and electromagnetic interference conditions. A method of finding the van and knowing its location from the plane had to be developed. The distance, plane attitude, and minimum usable signal levels had to be determined to verify calculations and to define operational limitations and restrictions. Finally, with new equipment and crews, training and development of procedures were required. All the objectives were achieved during the integration testing.

*Trade names and commercial enterprises or products are mentioned solely for information. No endorsement by the U.S. Department of Agriculture is implied.

This first successful telemetering of infrared imagery from an aircraft to a fire camp represents a step forward for the Station's FIRESCOPE program--an ongoing research, development, and application program headquartered at the Forest Fire Laboratory in Riverside, California.

In the experimental system under development, infrared imagery and other data on fire location and conditions would be telemetered by a central operations center to any one of a series of command posts in the field. The center would be a permanent fixed facility. The location of the field command posts would be selected from one of many predesignated sites at the time of fire occurrence. Equipment would be dispatched to the fire scene, and a command post activated on its arrival.

The operations center would include computer capability for predicting fire behavior. Expansion of the fire perimeter would be forecast by using a rate-of-fire-spread model with appropriate inputs, including fuel characteristics, slope, terrain, and weather conditions (4). These parameters would be stored, catalogued, and updated by the computer.

Meteorological Data. Wind speed and direction, temperature, relative humidity and other meteorological data would be telemetered from a preestablished network of remote stations. Additional information could be transmitted from portable weather stations set up nearer to the fire.

An example of telemetry in research will be found in the network of experimental remote stations now operating in the mountains of California. Research meteorologists are developing toposcale models for wind, temperature, and humidity that would produce predictions useful in fire management. The network is designed to provide the data needed in these models.

With the necessary parameters available in real-time or stored in memory, the computer can predict future fire location. A computerized grid system used with orthophoto maps will facilitate entry of fire coordinates into the model and in transferring the information to other locations. The knowledge of exact fire location and probable location at various future times, coupled with knowledge of fireline resource locations, conditions, availability, and capability, will greatly assist the fire control manager in planning and directing suppression operations.

Future Plans. The plans for the near future include moving from the temporary S-band . assignment to the 902-928 MHZ frequency band, which is potentially the permanent operational frequency home. Two-way transmission of information from the fire camp to the operations center through facsimile and other means will be tested. This testing will establish feasibility of and adequacy of methods for using telemetered imagery in more

than one location without a retransmission from the aircraft. Voice grade links rather than wide-band channels will be tried for the ground transmissions. Methods for identifying pertinent information contained in the imagery and quickly transferring it to maps by manual or computer-aided means will be developed.

Conclusion. The use of computers for real-time monitoring, analysis, and prediction should and can be extended into fire suppression operations, especially as an aid in selecting strategy and tactics, resource inventory and scheduling, as well as in general fire suppression decision-making (5). Such extensions would require the application of telemetry to relay the essential data in a timely manner. All aspects of telemetry--acquisition, conditioning, transmission, reception, processing, and display of data are expected to play key roles in fire control and suppression activities in the future.

References

1. Hirsch, Stanley N. Applications of infrared scanners to forest fire detection. Int. Remote Sensing Workshop, Ann Arbor, Mich., pp. 1-18, May 1971.

2. Hirsch, S. N., and F. H. Madden. Airborne infrared fire scanners for forest fire surveillance. SPIE l4th Annu. Tech. Symp. Proc., Vol. 2, PP. 51-57, San Francisco, Calif., 1969.

3. Hirsch, S. N., F. H. Madden, and R. F. Kructeberg. The bispectral forest fire detection system. Proc. 7th Symp. Remote Sensing Environ. Ann Arbor, Mich., pp. 2-9, May 1971.

4. Rothermel, Richard C. A mathematical model for predicting fire spread in wildland fuels. USDA Forest Serv. Res. Paper INT-115, 40 p. Intermountain Forest and Range Experiment Stn., Ogden, Utah, 1972.

5. Chandler, Craig C., and Charles F. Roberts. Problems and priorities for forest fire research. J. Forestry 71(10):625-628, 1973.

Fig. 1 - Forest Service fire mapping plane

Fig. 2 - Communications and status unit

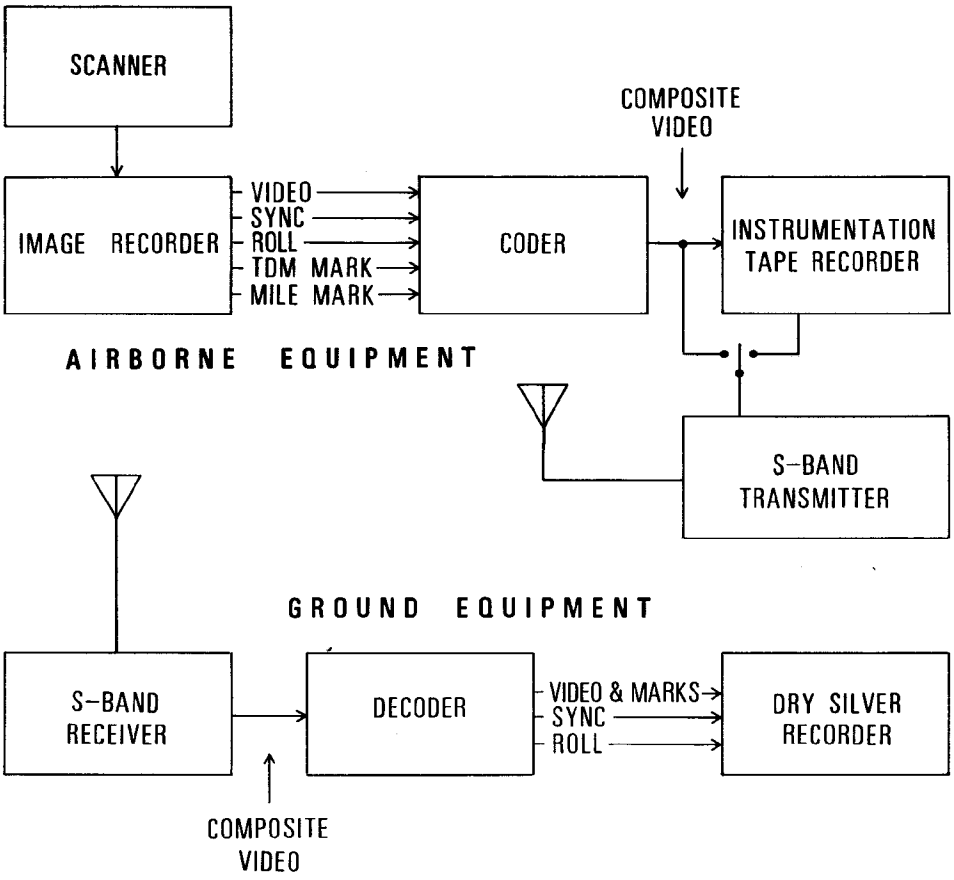

Fig. 3 - Diagram of infrared scanning, telemetry, and recording system