Computerized Infrared System for Observation of Prescribed Fires

Forestry Canada Forêts Canada

C.J. Ogilvie and R. Fitch

Respectively, fire research technician, Northern Forestry Centre, Forestry Canada, Edmonton, AB, and director, Compuheat Services Canada, Inc., Calgary, AB

Smoke from forest fires has always presented a barrier to efficient fire detection, mapping, and behavior research. Thermal infrared (IR) sensors mounted in fixed- or rotary-wing aircraft have been used for more than 25 years to overcome the information-gathering barrier in a smoke environment (Artsybashev et al. 1971; Green et al. 1984; Hanks et al. 1986; Lacey and Friedrich 1984; Lawson 1975; Warren and Wilson 1981). Further technological improvements and developments will no doubt continue (Nichols and Warren 1987). In response to our immediate need for a flexible, relatively inexpensive and reliable method of monitoring the behavior of large-scale prescribed fires (McRae and Stocks 1987), a new system was evaluated in northeastern Ontario during August 1987. The prescribed fires were conducted by the Ontario Ministry of Natural Resources with Forestry Canada's Great Lakes Forestry Centre (GLFC), carrying out some of the instrumentation and monitoring of the fires as well as the coordination of the numerous U.S. agencies gathering data from the fires. Forestry Canada's Northern Forestry Centre (NoFC) and Compuheat Services Canada, Inc., gathered IR data from the fires, using a high-quality, forward-looking infrared (FLIR) scanner interfaced with a computer analyzer mounted in a Bell 206L helicopter. The objective of this paper is to present a system overview and describe results obtained from the trial.

System Description and Capability

Figure 1 is a schematic of the system with the main components described below. The scanner is manufactured by Barr and Stroud, Ltd., of Glasgow, Scotland, with the following specifications:

- Field of view—38° × 25.5° (other lenses are available).
- Resolution—1.73 milliradians.
- Spectral band width—8 to 13 micrometers.
- Detector—Mulland sprite.
- Video output—standard.

The results of the 1987 trial clearly show the potential for gathering infrared data, using a high-quality, forward-looking infrared (FLIR) scanner interfaced with a computer analyzer mounted in a Bell 206L helicopter.

The scanner is cooled by compressed air and costs approximately $171,040 ($200,000 Canadian).[1] The rental costs were $4,256 ($5,000 Canadian)[1] per week. The computer analyzer is manufactured by Compuheat Services, Inc., of Calgary, AB, and is designed to convert continuously any standard video signal to digits during flight as well as perform a number of specialized functions and calculations such as follows:

- Calculating geographic areas and distances on single video frames and geographic areas continuously on successive frames.
- Storing video frames in random access memory and on floppy disk.
- Density slicing digital images to allow the selection of a single intensity level or range of intensity levels (the analyzer is capable of

[1]Foreign Exchange, New York prices ($0.8552), as of August 9, 1989.

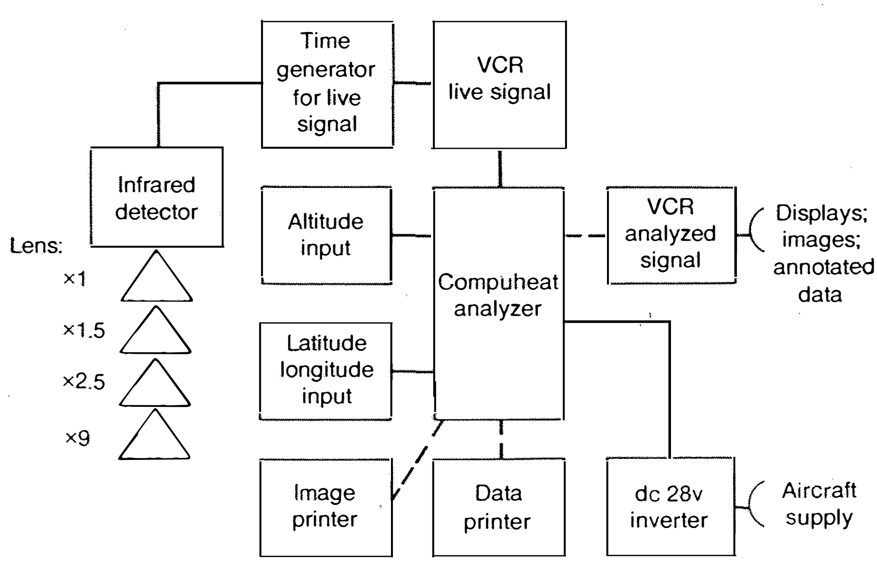

Figure 1—*Schematic of computerized infrared system.*

differentiating 128 intensity levels and calculating the area covered by each).

- Recording positional data continuously (longitude and latitude).
- Recording the time and date continuously.
- Manipulating the images in memory or on disk (by reducing, enlarging, superimposing, and presenting two images on the same screen).
- Annotating the images.

Operating Procedures

The scanner was mounted vertically on a steel plate fastened to the rear seat platform of the helicopter. The plate protruded far enough through the door opening to allow a clear field of view between the fuselage and the landing skid (fig. 2). The computer analyzer was mounted on the rear-facing seat platform of the aircraft and secured with seat belts. After the initial preparations were made, installation of all equipment could be made in 30 minutes.

The requirements for monitoring fire behavior called for hovering the helicopter within its capabilities at whatever altitude was necessary to keep as much of the actively burning area as possible in the viewing screen at one time. The scale of the displayed image was therefore controlled by aircraft altitude. It was assumed that the fire-generated condensation cap that would attenuate the IR signal would be offset from the fire due to winds aloft and that these same upper-level winds would assist in stabilizing the hovering aircraft. The live imagery was to be used by the IR team to provide ground reference to the pilot to assist him in holding a steady hover.

Performance to Date

The system was first tested on a 1,483-acre (600-ha) prescribed fire near Timmins, ON, in August 1987. At the time of ignition, there were virtually no upper-level winds. As a result, the condensation cap formed directly over the fire area, which necessitated operating the aircraft beneath the cap on the very edge of

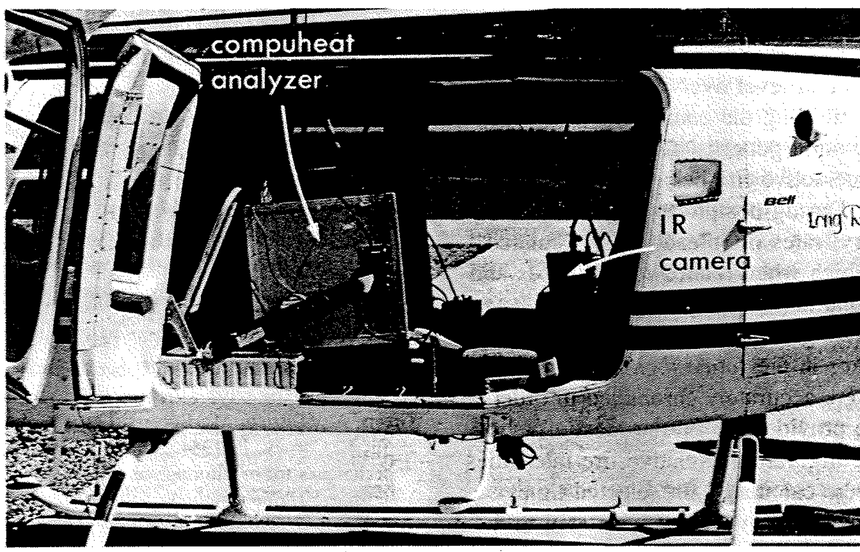

Figure 2—*Placement of scanner in the helicopter.*

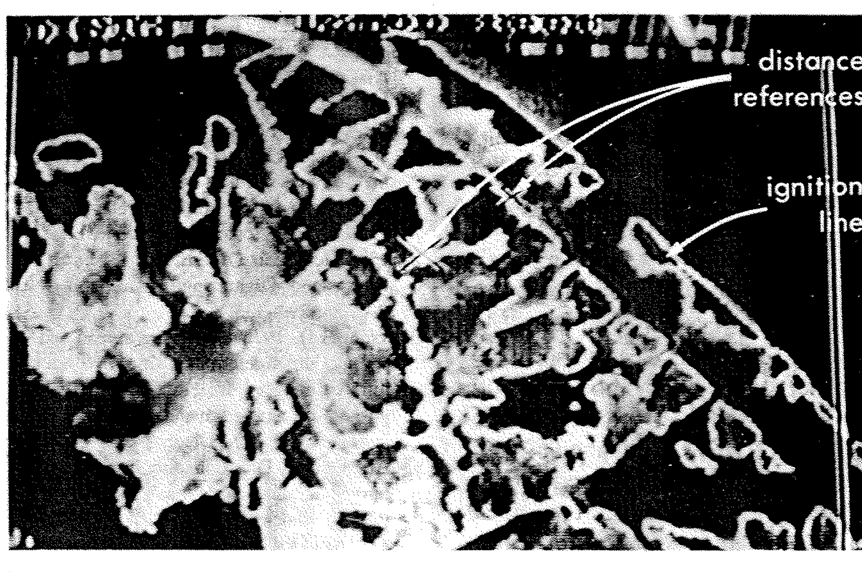

Figure 3—*Imaging of ignition patterns, fire growth, and interactive fire behavior.*

the smoke column. The strong up-and-down drafts close to the fire convection column made it somewhat difficult to hold the aircraft stationary. It was therefore necessary to record altitude changes constantly and to brief the pilot on aircraft position. In spite of these problems the helicopter was operated in a hover of up to 9,500 feet (2,900 m) above ground level over the active fire area, permitting the continuous imaging of ignition patterns, fire growth, and interactive fire behavior (fig. 3).

During postprocessing of the imagery, rates of spread were calculated, which when related to fuel loads and condition will be instrumental in predicting the growth rates of prescribed fires in the future. Ignition patterns were accurately chronicled in order to provide data on the most efficient configuration. Relative fire intensities were calculated for selected times and locations and were related to the smoke content monitoring that was also taking place during the fire. This involved isolating and determining the extent of the areas that were actively flaming, smoldering, or unlit. In addition, a large fire whirlwind tracking through the fire for up to 1.5 minutes was noted on the imagery during postprocessing.

Conclusion

The 1987 trial was of an exploratory nature and has clearly shown that the system and method of application has great potential for applications such as calculating rate of spread, recording ignition pattern, determining change in fire intensities, and evaluating fire suppression activity. The continuous real-time aspect ensures that no activity is missed, while the analyzer can be used to thoroughly investigate any moment in time. For 1988, the equipment and methods were developed further by incorporating a aeronautically approved camera pod and a radar altimeter (Hall and Walsh 1986; Spencer and Hall 1988), an 87° lens, and a separate monitor for the pilot. ■

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Fire Management Notes

An international quarterly periodical devoted to forest fire management

United States Department of Agriculture

Forest Service

Volume 50, No. 3
1989

Contents

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Fire Management Notes is published by the Forest Service of the United States Department of Agriculture, Washington, DC. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Subscriptions may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

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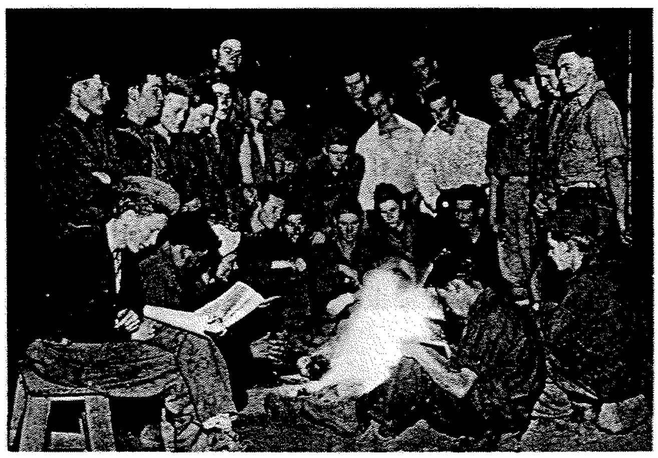

Enrollees gathered around campfire on the Lassen National Forest in California. 285391

Front Cover: CCC enrollees during rest period at Poverty Ridge Fire camp on the Siskiyou National Forest in Oregon (E. Lindsay, 1936). 391965

Back Cover: Region 1 highway fire prevention signs manufactured by CCC sign shop. Tenant, E. 1941. Highway fire-prevention signs. Fire Control Notes. 5(2): 98-99.