FIGHTING FOREST FIRES

In the spring of 1993, the Department of Agriculture's U.S. Forest Service (USFS) introduced to operational use a new airborne system for imaging forest fires. Known as Firefly, it provides major advances in informational accuracy and timeliness — and therefore gives USFS firefighters a valuable tool for fire containment.

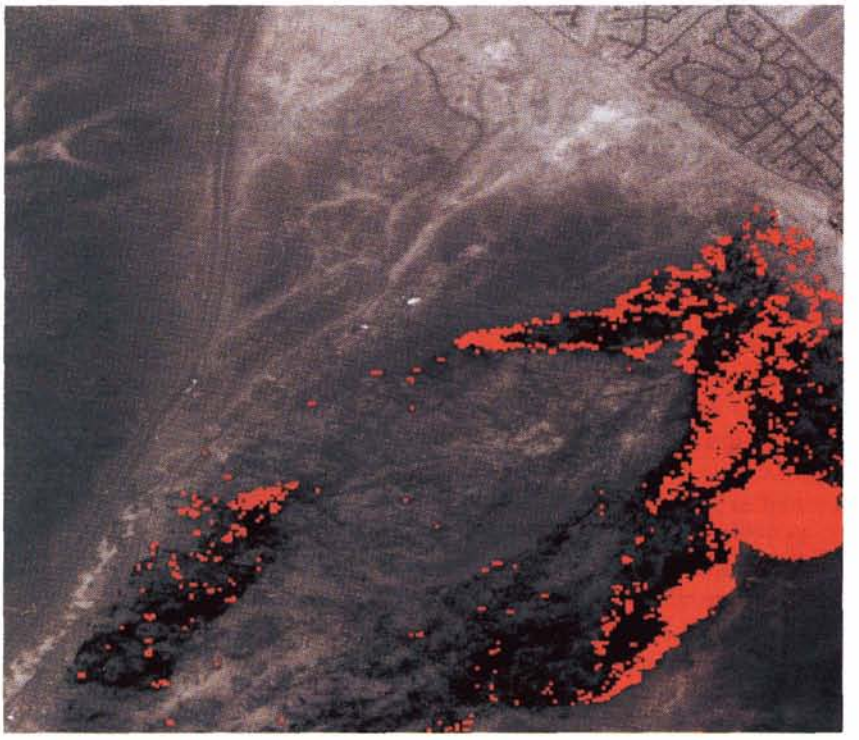
The system was developed by Jet Propulsion Laboratory (JPL) in collaboration with USFS. It draws upon NASA remote sensing technology and JPL's 25 years of experience in developing digital image processing techniques for enhancing spacecraft pictures of distant planets. USFS handled development of the associated ground terminal and air-to-ground digital communications link.

Firefly is an outgrowth of a previous JPL/USFS collaboration that spawned FLAME, an airborne fire mapping instrument that has been in service with USFS since 1984. Firefly employs advanced technology to provide two significant advancements over its predecessor: it uses satellite-based navigation to get greater positioning accuracy, and it offers increased timeliness of fire location data delivery by means of on board data processing and a direct aircraft-to-fire camp communications link.

AMONG TECHNOLOGY TRANSFERS THAT ENHANCE PUBLIC SAFETY IS A SYSTEM DESIGNED TO IMPROVE WILDLAND FIRE MANAGEMENT

Firefly and FLAME are similar in many respects. Both use an infrared line scanner to identify fire boundaries. FLAME, however, employs standard navigation methods to fix the position of a fire location on a map, and its imagery is captured on film; the plane must be landed and the film delivered to an interpreter, who performs a lengthy hand-transfer of the data to a map. As much as eight hours may elapse between fire spotting and getting the information to a firefighting camp.

The new Firefly is a near-real time system capable of processing the remotely-sensed data on board the aircraft and delivering location-plotted fire maps to a fire camp within 30 minutes. The system consists of the airborne unit, which includes a special purpose dual band infrared sensor for locating forest fire perimeters and "hot spots" (small fires), together with a ground terminal at the fire camp linked to the airborne unit by telemetry. The airborne infrared sensor system penetrates smoke to image the ground scene, correlates fire data to geographic coordinates, and transmits fire imagery and processed data directly to USFS' portable field computer at the fire camp. Precise determination of the location relative to a geographic base is made possible by use of the Global Positioning System, a Department of Defense-operated network of satellites



At right is an image of a California forest fire produced by an airborne remote sensing system known as Firefly (the black areas represent the highest temperatures). At left below is the Firefly system mounted in the U.S. Forest Service's Merlin III fire mapping airplane. The system transmits fire location information directly to a fire camp, affording valuable time saving.

that allows fixing an airplane's position — in three dimensions — within 25 to 100 meters.

Among the biggest problems in combating forest fires are 1) the fires are very difficult to pinpoint and 2) they can spread very rapidly. Firefly offers help in both areas.

"Cutting the turnaround time in getting information to the firefighters is the key," says Dr. J. David Nichols, JPL's manager of the Firefly project. "We gain time in two ways: processing the data and mapping the location information in the airborne computer, then communicating directly, computer-to-computer, with the plotting system on the ground."

Time is vital to wildland firefighters, particularly in pinpointing hot spots, small areas of high intensity flame that flare up outside the boundary of a fire and threaten to become separate large fires. If they are detected quickly enough, the USFS fire incident commander can assign people to them and extinguish them before they become full-fledged fires.

In operation, the Firefly-equipped airplane is flown over the site of a known existing fire or an area where fire activity is suspected. The infrared sensor detects radiation from the fire and converts the radiation values into electrical signals. Signal processing produces an image identifying the perimeter of an established fire or the location of a high intensity hot spot; the system is capable of mapping an area as large as 250 square miles each hour or, from an altitude of 10,000 feet, detecting a hot spot no bigger than half a square foot. Firefly is controlled by an airborne unit operator who monitors the system's performance and relays information to the pilot to optimize the airplane's flight path; he also has the capability to append messages to the data being sent to the fire camp based on his observations of the raw infrared imagery.

JPL will continue to refine the Firefly technology on the basis of its initial operational experience. Additionally, NASA and the USFS are jointly exploring other ways in which advanced aerospace technology can benefit wildland firefighting. •