GEOSPATIAL THERMAL MAPPING WITH THE SECOND GENERATION AIRBORNE FIREMAPPER® 2.0 AND OILMAPPER SYSTEMS

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ABSTRACT

Geospatial thermal mapping with high accuracy is now possible by means of the advanced FireMapper® 2.0 and OilMapper airborne imaging systems. The systems are designed to image in up to three spectral bands and to automatically calibrate all the images in real time before recording the data on hard drives. The temperature resolution of the sensor is 0.01 degree C and the dynamic range goes from 0 to 1200 degrees C. This large dynamic range allows the system to be used to accurately map everything from environmentally sensitive wetlands to high intensity wildfires. The sensor is operated remotely from a small, hand held tablet PC and the images are displayed in real time on the tablet screen. Selected images of interest can be saved in a temporary buffer and examined by the operator without interfering with the recording of the entire data stream. Examples of different types of geospatial thermal data from the Firemapper® 2.0 and OilMapper systems will be presented to illustrate the wide range of applications it is currently being used for.

INTRODUCTION

The FireMapper® and OilMapper systems utilize the same hardware for different sets of applications. The thermal sensor images in three spectral bands – one wide band from 8.5µ to 12.5µ and two narrow bands centered at 9µ and 12µ. A single uncooled microbolometer detector array is used in a snapshot mode of operation for all three bands. For normal wildfire applications, the 12µ band, with a dynamic range up to 800 degrees C, is used. The 9µ band, with a dynamic range up to 1200 degrees C, can be used for extremely hot fires or volcano lava flows. For all other applications, the wide band is used. The optical field of view is 63 degrees in the cross flight direction. In the flight direction, overlapping images can be obtained for whatever flight distance is desired.

For most applications, the Mapping mode is used where one, two, or three bands are selected and a multispectral set of images is obtained every 4 seconds. For low altitude operations, the Tactical mode is used to obtain images in a single band at a rate of 6 images per second. In this mode, overlapping images can be obtained at altitudes down to 50 feet at speeds of up to 120 knots. This fast imaging Tactical mode is used, for example, in wildfire suppression operations. For this use, a lead aircraft equipped with the FireMapper® 2.0 will fly at several hundred feet AGL and lead airborne tankers on retardant dropping runs. It is also used for low altitude helicopter operations for environmental mapping and electrical power line monitoring. For oil spill detection and cleanup operations, low altitude imaging can also provide high resolution thermal images for ship identification. A photograph of the thermal sensor, with the door open, and the operator’s tablet PC is shown in figure 1.
SYSTEM APPLICATIONS

The primary applications for the FireMapper® 2.0 and OilMapper systems are listed in table 1. Images can be obtained at any time, night or day. The thermal sensor easily sees through dense smoke and haze, which makes it ideal for fire, volcano, and disaster operations. Even when a thick layer of smoke and ash prevents the pilot and operator from seeing the ground, the sensor produces razor sharp images. Some single frame examples of these applications are shown in figures 2 through 7. These images are courtesy of the Pacific Southwest Research Station of the U.S. Forest Service. In each case, the image shown is from a single frame, similar to what would be seen in real time on the operator display. Along with the image, the GPS time, date, latitude, longitude, altitude, velocity, and heading are also displayed on the tablet. The temperature of any pixel in the image can be read by touching the handheld stylus to that pixel.

Figure 8 shows a 3-D mosaic of a large wildfire. The fire was imaged from the BLM King Air A200 lead aircraft during wildfire suppression operations in 2004. In this mosaic, all of the individual images have been orthorectified with respect to a USGS topographic map, stitched together, and then overlaid on a Digital Elevation Model.

Table 1. Primary applications

1. **Fire detection and mapping**
   - Detect spot fires (Fig. 1)
   - Map wildfires for firefighting operations (Fig. 8)
   - Allow lead aircraft to see through smoke and position retardant drops
   - Map burn areas for replanting

2. **Oil spill detection and mapping**
   - Detect oil spills near coastlines, ships, and drilling platforms (Fig. 3)
   - Map oil spills for cleanup operations and identify ships (Fig. 3)

3. **Water quality and coastline monitoring**
   - Monitor warm water power plant outflows that effect marine life (Fig. 4)
   - Detect chemical leaks and fertilizer runoff into rivers and streams

4. **Urban and harbor surveillance and monitoring (Fig. 5)**
   - Rooftop heat loss detection and mapping (Fig. 6)
   - Oil and gas pipeline leak detection
   - Electrical power line and transformer hot spot detection

5. **Volcano and lava flow mapping**
Figure 2. Hotspot fire detection.

Figure 3. Oil spill detection and cleanup.

Figure 4. Power plant warm water outflow.

Figure 5. Harbor and urban surveillance.

Figures 6/7. Environmental and rooftop heat losses.
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FireMapper® is a registered trademark of Space Instruments, Inc.

REFERENCES


