AN AIRBORNE MULTISPECTRAL TELEVISION SYSTEM

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Abstract.—Airborne multispectral television images were obtained in the visible and near-infrared ($<2.2\mu$) region of the spectrum and recorded on videotape in a light aircraft. The images are of lower spatial resolution than aerial photographs from equivalent altitude but have the advantages of allowing quite narrow bandpass filtering and instant reproduction of the images for use by interpreters. Such imagery may be quite useful for fast coverage of dynamic events, such as floods, where aerial data are needed quickly but not to the photogrammetric precision of aerial photographs. The use of airborne television imagery by field scientists also will prepare them to use similar but smaller scale data from earth-orbiting satellites.

In November 1966 an airborne multispectral television system was constructed in the Phoenix, Ariz., office of the U.S. Geological Survey, under the direction of H. E. Skibitzke, and flown in a light aircraft. The objectives and purpose of this experiment were:

1. To obtain television imagery from an aircraft and to determine the quality of imagery that can be collected and processed.
2. To determine the lens and filter combinations that should be used with the television system to obtain the maximum clarity of image.
3. To determine the usability of relatively narrow bandpass filters for increasing the contrast of imaged features.

This report describes some preliminary results of the experiments.

Television imagery may be significantly useful in the field of hydrology or in any other fields where aerial imagery is needed and information must be received quickly by persons on the ground. For example, when major floods occur and it is necessary to map the area inundated at the peak of the flood, it would be possible to obtain television imagery from aircraft over the flooded areas and return the videotape records immediately to ground-control parties who could then use them to aid in surveying the inundated areas.

The time usually required for photographic processing would be eliminated because videotapes are immediately usable on television monitors at the site.

DESCRIPTION AND FUNCTIONS OF EQUIPMENT

All the equipment was installed in a high-wing, single-engine aircraft that is well suited for this type of work because of its fairly slow cruising speed of about 105 knots, and its ceiling of about 20,000 feet. Figure 1 is a block diagram of the airborne multispectral television system consisting of cameras, monitors, power supplies, and videotape recorder; the system is simple and uses off-the-shelf-equipment.

Three television cameras were mounted in an aerial photographic camera mount in the belly of the plane. They pointed downward, and the top of the image on the video monitor was toward the front end of the aircraft. Image motion on the television monitors was from top to bottom. The cameras were equipped at various times with three types of 1-inch-diameter vidicon tubes, ML6198, ML7735B, and N156. The spectral response curves for these three tubes are shown in figure 2, and the captions on the imagery shown in figures 6–9 refer to the vidicon tubes and filters used to obtain them. A matched set of three 12.5-millimeter lenses was used on the cameras.

Dichroic absorption filters were used on one of the cameras. Graphs of the selected filter combination used are shown in figure 3. A second camera was used unfiltered; the third camera with the N156 vidicon tube, which is useful to about 2.2 microns in the infrared region was equipped with an 89A red filter which cuts off all wave lengths below about 680 millimicrons.

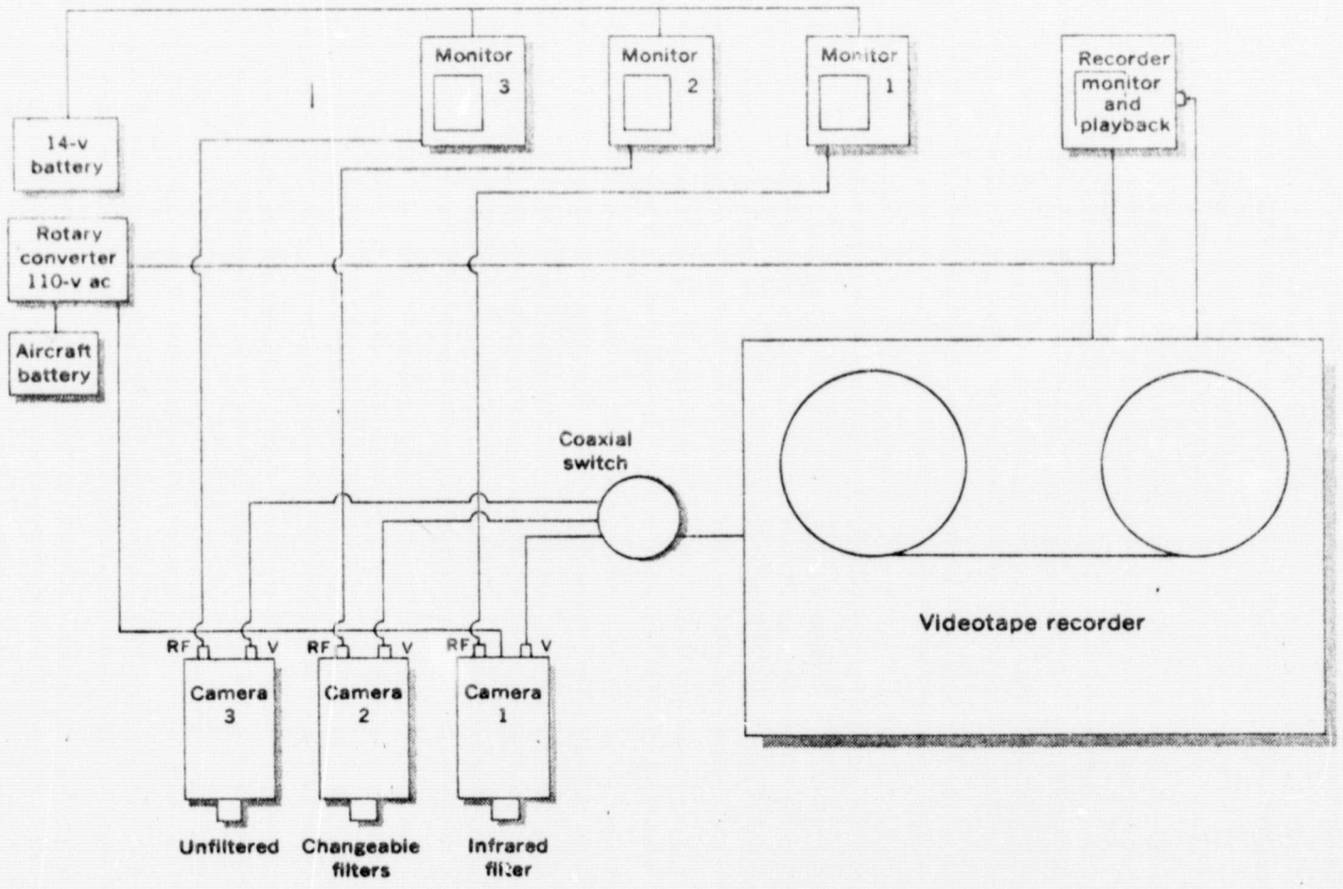

FIGURE 1.—Block diagram of airborne multispectral television system.

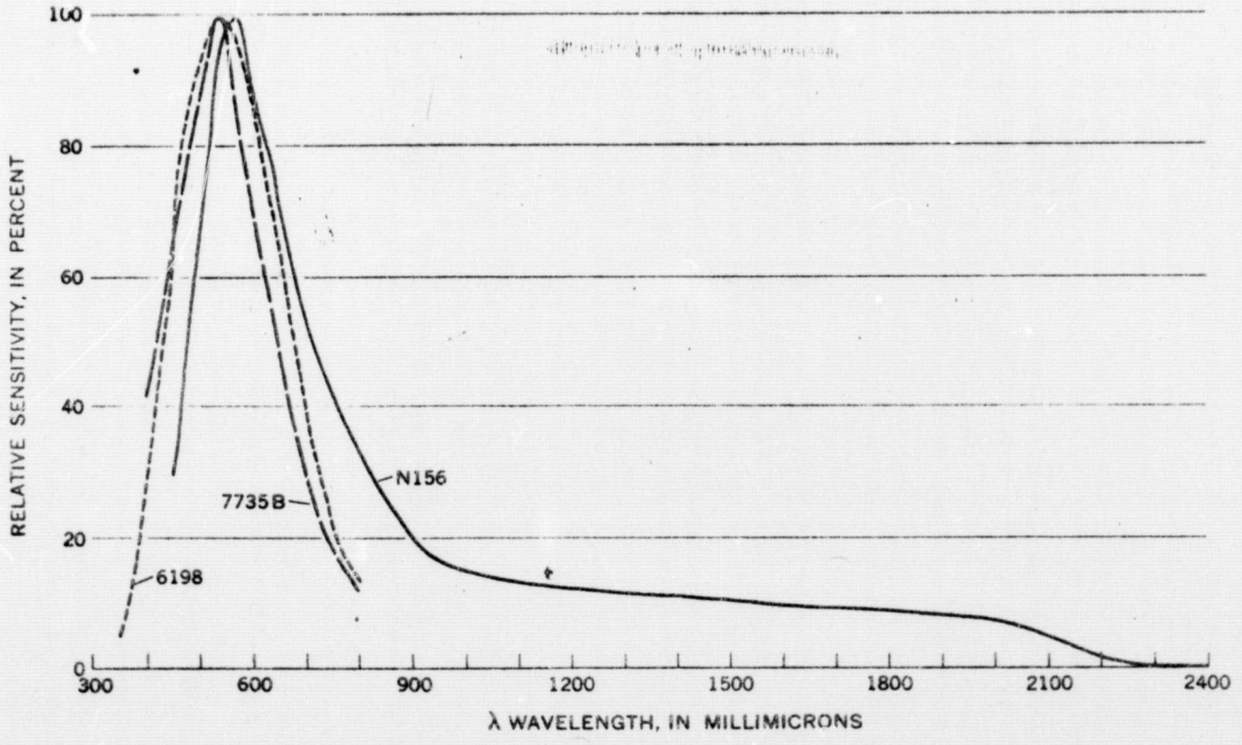

FIGURE 2.—Spectral sensitivity of vidicon tubes (6198, 7735B, and N156) used in airborne multispectral television system (data from manufacturer's specifications).

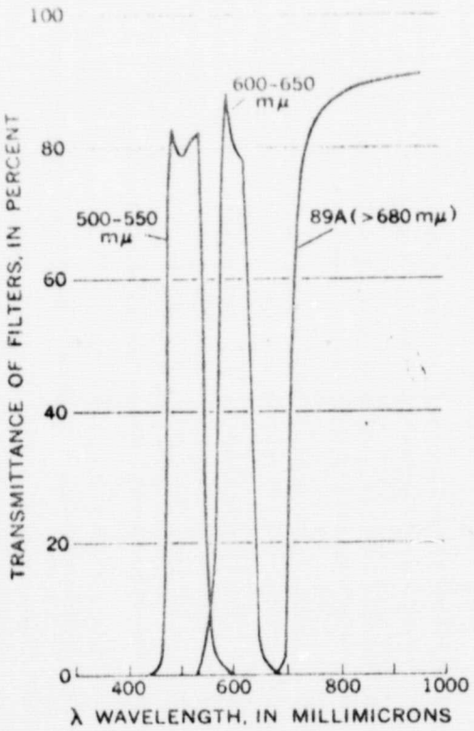

FIGURE 3.—Transmission characteristics of filters used in airborne multispectral television system (data from manufacturer's specifications).

Three standard television monitors with 5-inch picture tubes were used to monitor the in-flight images from each of the three cameras. A fourth monitor was used to view the input to the videotape recorder to assess how well the image was being recorded, and was also used for playback of the videotapes. Figure 4 shows the monitoring and taping equipment and cameras in the aircraft.

A standard videotape recorder was used. The image from any one camera could be recorded at any time by switching a coaxial switch to the desired camera. In addition, an audio channel allows the operator to record comments on the altitude, heading, and terrain conditions.

EXPERIMENTS IN IMAGERY

Three separate flights were made with the multispectral television system--one over the Salton Sea near Brawley, Calif., the second near the coastline of San Diego and LaJolla, Calif., and the third in Eureka County, Nev. All three flights were moderately successful. Some good television imagery was obtained, and it is our hope that the television systems may ultimately obtain almost the operational reliability of aerial camera systems. Figures 5 through 7 illustrate some of the imagery obtained with this system over the three areas. Interpretation criteria for such imagery is identical with that used for aerial photography with the only exception that the spatial resolution of the television systems is limited by the line-scan system.

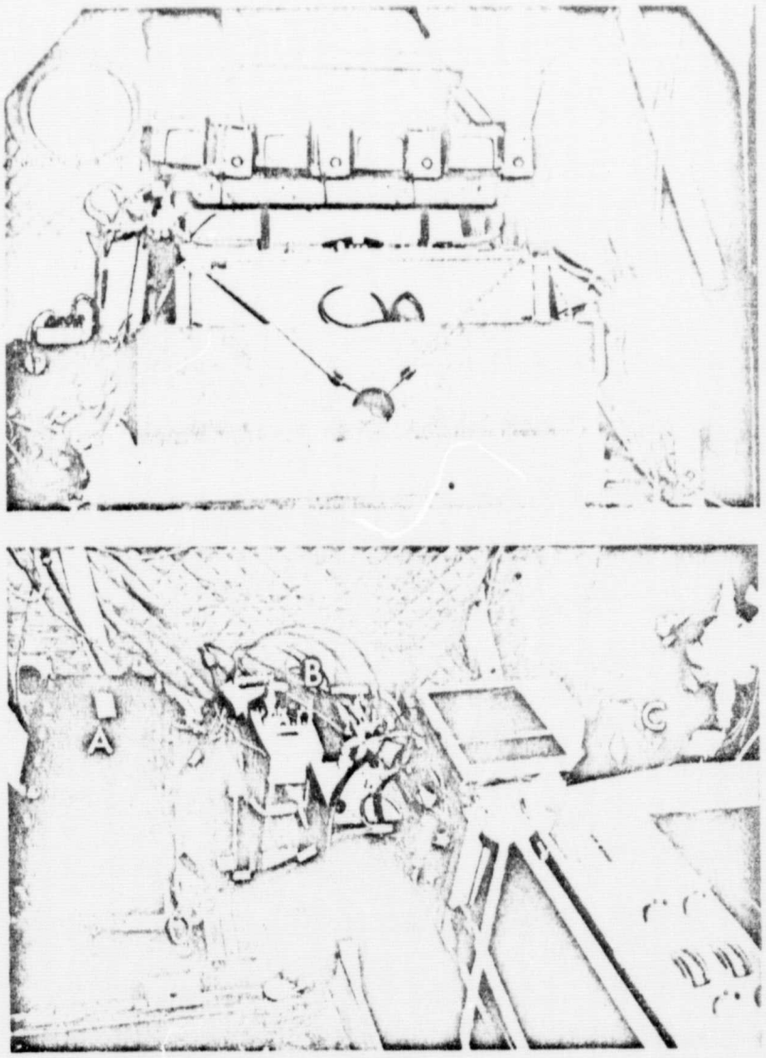

FIGURE 4.—Views of equipment in aircraft. Top, videotape recorder (in box) and television monitors for the three cameras and the recorder. Bottom, battery (*A*), cluster of three television cameras in aerial camera mount (*B*), and rotary converter power supply (*C*).

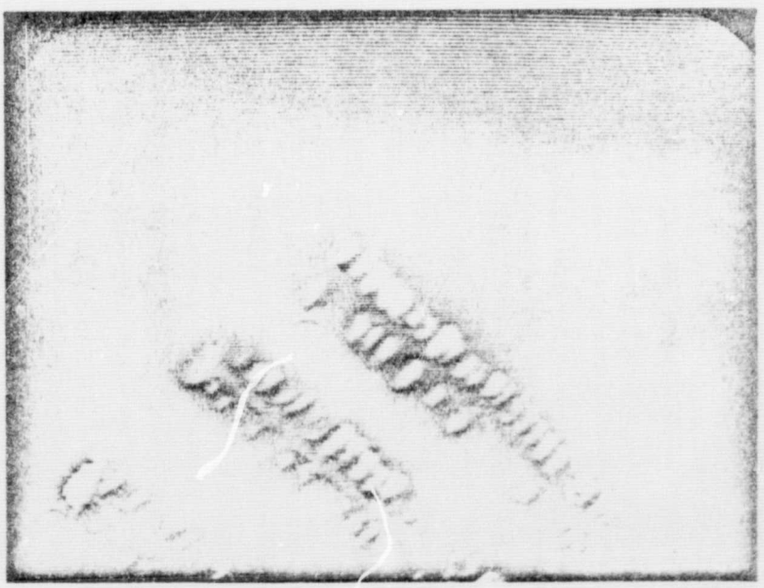

FIGURE 5.—Television images of marina in lagoon near San Diego, Calif. (7735B vidicon tube, 89A filter, altitude 2,000 ft.).

FIGURE 6.—Stereotriplet of television images on the west side of the Tuscarora Mountains, Eureka County, Nev. (7735B vidicon tube, 600–650-mμ filter, altitude 5,000 ft.).

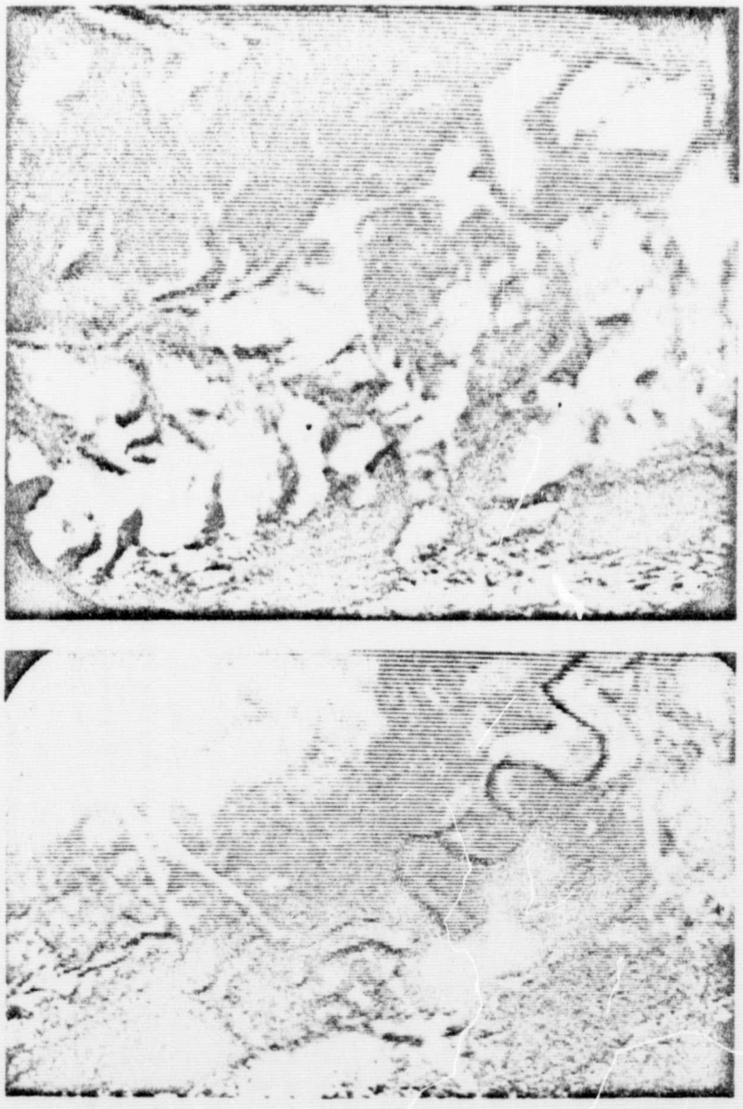

FIGURE 7.—Television images of (top) area west of Elko, Nev. (N156 vidicon tube, 89A filter, altitude 5,000 ft.), and (bottom) Humboldt River, west of Elko, Nev. (7735B vidicon tube, unfiltered, altitude 5,000 ft.).

CONCLUSIONS

1. Multispectral airborne television systems are workable and may be installed and used in light aircraft quickly when needed.
2. The system has the advantage of providing imagery on videotape instantaneously.
3. Recorded comments with the imagery aid the interpreter when looking at the subsequent playback.
4. The exposure and resolution of the imagery may be checked immediately in flight, and the area can be reflown without landing if the imagery is not up to the required standards of clarity.
5. Narrow bandpass filtering is usable for enhancing the contrast of desired features.

Because of some advantages of the airborne multispectral television system over aerial photography it may eventually become a widely used system for identification and mapping of terrain features. It is believed that this is a precursor of television systems for studying the engineering and cultural-resource aspects of natural resources from spacecraft. Such low-altitude use of television systems will prepare scientists to use similar data from earth-orbital satellites.

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