TWO-INCH RETURN BEAM VIDICON (RBV) MULTISPECTRAL THREE-CAMERA SUBSYSTEM

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The two-inch Return Beam Vidicon (RBV) multispectral three-camera subsystem (Figure 1) was developed and built as one of the two principal sensor payloads for the ERTS-A and -B missions. The performance of the cameras on ERTS-1 has been excellent, meeting or exceeding all expectations, especially in the area of geometric fidelity and stability.

The three cameras are coaligned in the spacecraft to view the same nominal 190 kilometer square ground scene but in different spectral bands. When the separate images are processed and superimposed in their respective colors, they provide a single false-color image containing the radiometric and cartographic information required for the ERTS system. The three spectral regions covered by the RBV subsystem are the blue-green (475 to 575 nanometers), red (580 to 680), and the near infrared (690 to 830). The three cameras are exposed simultaneously to facilitate registration of the three separate images into the final color composite.

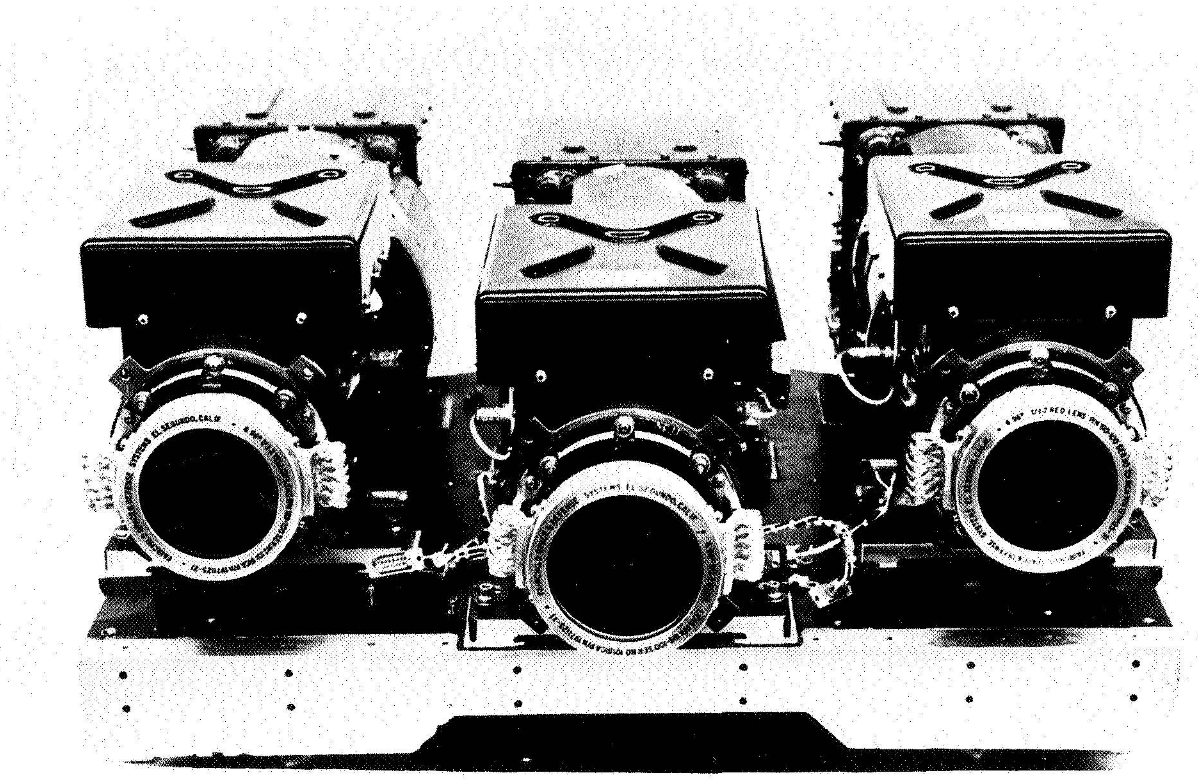

Figure 1. ERTS camera system.

Analyses of typical scenes obtained with the RBV cameras on ERTS-1 (Figure 2) indicate that resolution is in the order of 90 meters for small targets (such as small bodies of water, piers, building structures) and 50 meters or better for extended targets (roads, rivers, bridges, etc.). In terms of geometric fidelity and stability, data evaluation shows that simple computer corrected RBV pictures can show any point on the ground scene within 150 meters rms from its true location. This combination of high resolution and geometric fidelity allows the generation of maps at 1:250,000 scale. The ERTS-1 mission objective is to obtain maps at 1:1,000,000 scale. In addition, we expect to utilize this capability to generate ground control points over areas outside the United States where no such information is presently

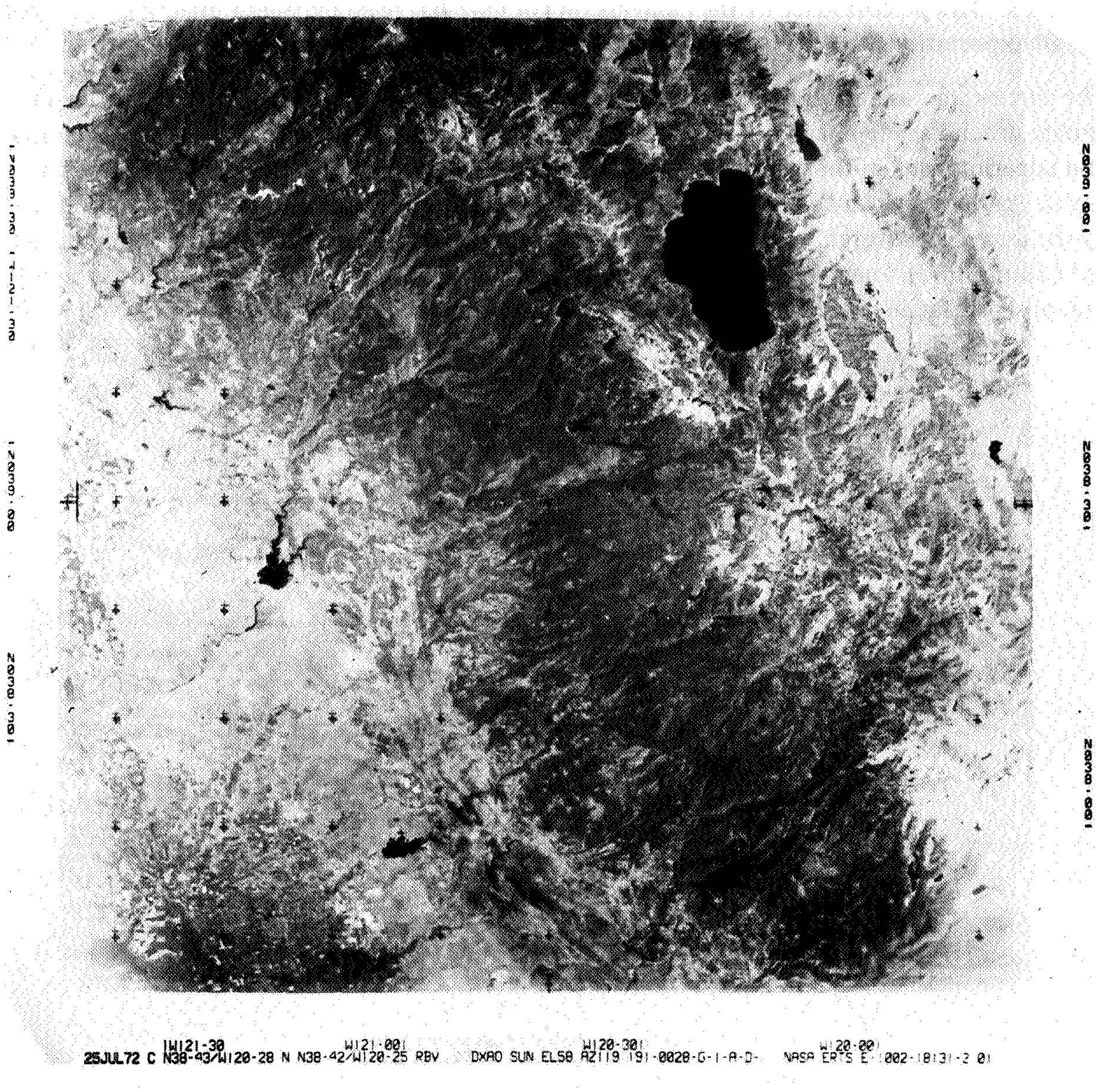

Figure 2. RBV composite image of the Lake Tahoe area. Source: NASA ERTS, E-1002-18131. Original in color: can be ordered from EROS Data Center Sioux Falls, S. D. 57198.

available. This data can then be used to facilitate accurate global mapping with any other imaging system.

Translated in terms of laboratory performance, the RBV camera subsystem, with 4500 TV lines resolution and 33 dB signal-to-noise at 0.8 $\mu\delta/cm^2$, represents a factor of five improvement over any previously flown television camera subsystem. Its geometric stability, better than 0.1 percent, represents an order of magnitude improvement.

As shown in block diagram form (Figure 3), the subsystem consists of three RBV cameras, and a camera controller combiner (CCC). Each camera includes a sensor unit and an electronics package. The three cameras are basically identical except for the spectral transmission of the lens and the readout interval delay. The three sensors are mounted on a base-plate which serves both as a precise alignment reference and as a thermal control element. Each sensor contains a Return Beam Vidicon and its associated electronics plus some of the most critical circuitry. The rest of the circuits for each camera are contained in the electronics package.

The CCC performs two basic functions: First, it develops all the subsystem timing signals, and second, it accepts the three parallel video outputs and combines them into a serial stream, injecting at the same time the required horizontal and vertical composite sync and the spacecraft time code to generate the final composite video signal. The complete subsystem dissipates 172 watts average and weighs 88.5 kilograms (195 lb) including the baseplate.

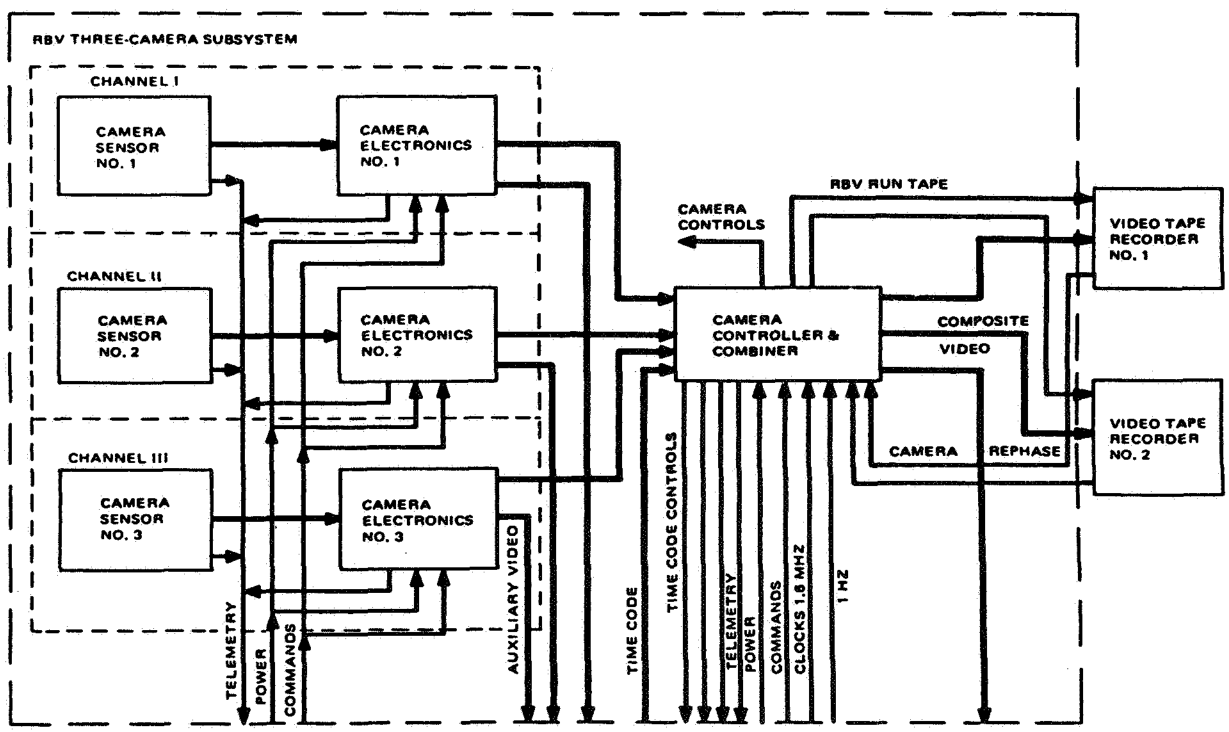

Figure 3. Three-camera subsystem, block diagram.

The heart of the camera is the Return Beam Vidicon. This tube employs an ASOS (antimonium sulfide oxysulfide) long storage photoconductive surface, and a unique electro-optical configuration to achieve high resolution and signal-to-noise performance. The high resolution is achieved by using a four-node nonuniform focus field; high signal-to-noise is obtained by amplifying the modulated return beam with a five-stage electron multiplier. A nine-by-nine reseau pattern deposited on the tube faceplate serves as a very accurate geometric reference for the correction and registration of the three separate images.

Two other significant improvements contributing to the camera's high quality performance are a thermally compensated lens system with extremely low distortion and high MTF; and a versatile two-bladed focal plane shutter system capable of being commanded to five different exposure times to accommodate variations in scene radiance.

Two RBV camera subsystems have been built to date: one is presently operating in the ERTS-1, and the second one is scheduled to be used aboard ERTS-B late next year.