Figure 2 is a block diagram of the electronic system of the instrument. The system includes an onboard processor, plus an external personal computer (PC) for further processing of the acquired data and displaying resulting depth maps. The processor is capable of generating 3D data in real time, eliminating the need for both onboard memory and post-processing to generate 3D data. The 3D data output of the onboard processor is sent to the PC via a high-speed serial data-communication link. By reducing the computational burden on the PC, onboard preprocessing enables the PC to create and display 3D images in real time during scanning.

This work was done by Joseph Lavelle and Stefan Schuet of **Ames Research Center**.

Further information is contained in a TSP (see page 1).

This invention is owned by NASA and a patent application has been filed. Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-14652-1.

⚙ Electro-Optical Imaging Fourier-Transform Spectrometer
Size, weight, and vibration are reduced by eliminating moving parts.

NASA's Jet Propulsion Laboratory, Pasadena, California

An electro-optical (E-O) imaging Fourier-transform spectrometer (IFTS), now under development, is a prototype of improved imaging spectrometers to be used for hyperspectral imaging, especially in the infrared spectral region. Unlike both imaging and non-imaging traditional Fourier-transform spectrometers, the E-O IFTS does not contain any moving parts. Elimination of the moving parts and the associated actuator mechanisms and supporting structures would increase reliability while enabling reductions in size and mass, relative to traditional Fourier-transform spectrometers that offer equivalent capabilities. Elimination of moving parts would also eliminate the vibrations caused by the motions of those parts.

Figure 1 schematically depicts a traditional Fourier-transform spectrometer, wherein a critical time delay is varied by translating one the mirrors of a Michelson interferometer. The time-dependent optical output is a periodic representation of the input spectrum. Data characterizing the input spectrum are generated through fast-Fourier-transform (FFT) post-processing of the output in conjunction with the varying time delay.

In the E-O IFTS, the Michelson interferometer optics and the bulky, slow translation mechanism are replaced with a solid-state time-delay/interferometer assembly. Included in the assembly (see Figure 2) are an input polarizer, an input passive quarter-wave plate (phase shifter), a series of N liquid-crystal-based electro-optical achromatic half-wave switches (S_1, S_2, . . . S_N) interspersed with a series of (N + 1) passive birefringent wave retarders (Γ_1, Γ_2, . . . Γ_N), and an output polarizer.

The assembly can be regarded as consisting largely of a series of overlapping building blocks, each consisting of two of the passive wave retarders and the achromatic half-wave switch between them. By electro-optically rotating the orientation of the switch to an angle of either 0° or 45° with respect to the input polarization, one can cause the total retardation of the waves passing through the unit to be either the difference or the sum, respectively, of the retardations introduced by the individual retarders. Each retarder following the first one is made twice as thick as (to introduce t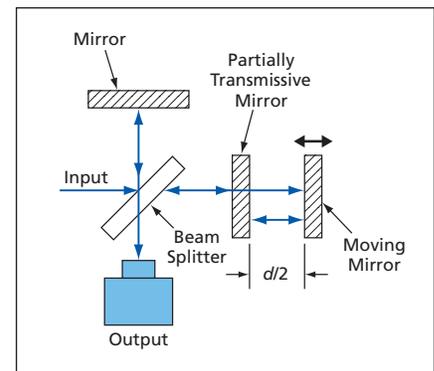wice the retardation of) the one preceding it. Hence, by means of binary actuation of the switches among all combinations of sums and differences, it is possible to obtain 2^N different retardation values in increments of the smallest such value and thereby to obtain an arithmetic progression of small time-delay steps.

Figure 1. A **Traditional Fourier-Transform Spectrometer** includes a Michelson interferometer in which a time delay d/c (where c is the speed of light) is varied by varying the distance $d/2$ between two mirrors.

This work was done by Tien-Hsin Chao and Hanying Zhou of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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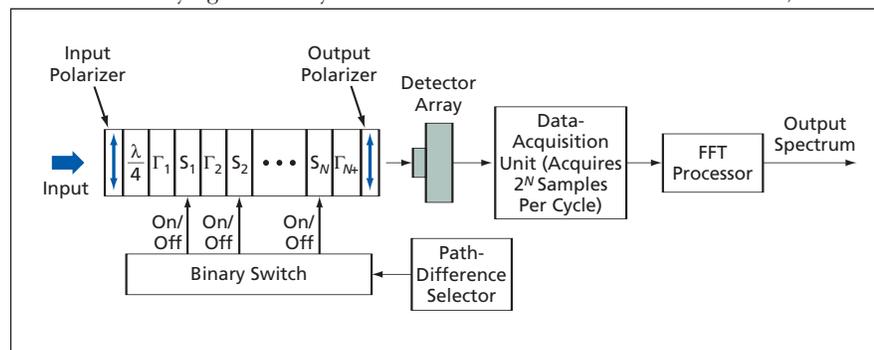

Figure 2. The **E-O IFTS** is built around a solid-state time-delay/interferometer assembly that contains no moving parts.