and personal computer would perform the image capture and processing to determine the shock location.

This innovation consists of a linear image sensor, analog signal processing circuit, and a digital circuit that provides a numerical digital output of the shock or negative edge location. The smart camera is capable of capturing and processing linear images at over 1,000 frames per second. The edges are identi-fied as numeric pixel values within the linear array of pixels, and the edge location information can be sent out from the circuit in a variety of ways, such as by using a microcontroller and onboard or external digital interface to include serial data such as RS-232/485, USB, Ethernet, or CAN BUS; parallel digital data; or an analog signal. The smart camera system can be integrated into a small package with a relatively small number of parts, reducing size and increasing reliability over the previous imaging system.

This work was done by Norman F. Prokop of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steven Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18816-1.

Optical Communications Channel Combiner

NASA's Jet Propulsion Laboratory, Pasadena, California

NASA has identified deep-space optical communications links as an integral part of a unified space communication network in order to provide data rates in excess of 100 Mb/s. The distances and limited power inherent in a deep-space optical downlink necessitate the use of photon-counting detectors and a power-efficient modulation such as pulse position modulation (PPM). For the output of each photodetector, whether from a separate telescope or a portion of the detection area, a communication receiver estimates a log-likelihood ratio for each PPM slot. To realize the full effective aperture of these receivers, their outputs must be combined prior to information decoding.

A channel combiner was developed to synchronize the log-likelihood ratio (LLR) sequences of multiple receivers, and then combines these into a single LLR sequence for information decoding. The channel combiner synchronizes the LLR sequences of up to three receivers and then combines these into a single LLR sequence for output. The channel combiner has three channel inputs, each of which takes as input a sequence of four-bit LLRs for each PPM slot in a codeword via a XAUI 10 Gb/s quad optical fiber interface. The cross-correlation between the channels' LLR time series are calculated and used to synchronize the sequences prior to combining. The output of the channel combiner is a sequence of four-bit LLRs for each PPM slot in a codeword via a XAUI 10 Gb/s quad optical fiber interface. The unit is controlled through a 1 Gb/s Ethernet UDP/IP interface.

A deep-space optical communication link has not yet been demonstrated. This ground-station channel combiner was developed to demonstrate this capability and is unique in its ability to process such a signal.

This work was done by Kevin J. Quirk, Jonathan W. Gin, Danh H. Nguyen, and Huy Nguyen of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47733

Development of Thermal Infrared Sensor To Supplement Operational Land Imager
The application is for the Landsat Data Continuity Mission.

Goddard Space Flight Center, Greenbelt, Maryland

The thermal infrared sensor (TIRS) is a quantum well infrared photodetector (QWIP)-based instrument intended to supplement the Operational Land Imager (OLI) for the Landsat Data Continuity Mission (LDCM). The TIRS instrument is a far-infrared imager operating in the pushbroom mode with two IR channels: 10.8 and 12 µm. The focal plane will contain three 640×512 QWIP arrays mounted onto a silicon substrate. The readout integrated circuit (ROIC) addresses each pixel on the QWIP arrays and reads out the pixel value (signal). The ROIC is controlled by the focal plane electronics (FPE) by means of clock signals and bias voltage value. The means of how the FPE is designed to control and interact with the TIRS focal plane assembly (FPA) is the basis for this work.

The technology developed under the FPE is for the TIRS focal plane assembly (FPA). The FPE must interact with the FPA to command and control the FPA, extract analog signals from the FPA, and then convert the analog signals to digital format and send them via a serial link (USB) to a computer. The FPE accomplishes the described functions by converting electrical power from generic power supplies to the required bias power that is needed by the FPA. The FPE also generates digital clocking signals and shifts the typical transistor-to-transistor logic (TTL) to ±5 V required by the FPA. The FPE also uses an application-specific integrated circuit (ASIC) named System Image, Digitizing, Enhancing, Controlling, And Retrieving (SIDECAR) from Teledyne Corp. to generate the clocking patterns commanded by the user. The uniqueness of the FPE for TIRS lies in that the TIRS FPA has three QWIP detector arrays, and all three detector arrays must be in synchronization while in operation. This is to avoid data skewing while observing