gling an output pin creating a square wave signal. If the system hangs completely prior to reporting its health status, the square wave is no longer generated. This absence of the square wave, whether intentional or because the Health Manager is hung, indicates bad health, analogous to a deadman switch. This is done by creating a Health Manager Reporting Task, which loops and pends on a semaphore. A timer Interrupt Service Routine gives the semaphore that allows the Health Manager to run. When the Health Manager Reporting Task receives the semaphore, it reads the system health status. If the status is good, an output pin is toggled. If the status is bad health, it latches the system’s bad health variable so it can never switch back to good health and stops the square wave. 

This work was done by Roger Zoerner of Kennedy Space Center. Further information is contained in a TSP (see page 1). KSC-12809

**Stereo Imaging Miniature Endoscope**

This endoscope can be used in minimally invasive surgery, in geological resource exploration, and in miniature analytical tools.

NASA’s Jet Propulsion Laboratory, Pasadena, California

Stereo imaging requires two different perspectives of the same object and, traditionally, a pair of side-by-side cameras would be used but are not feasible for something as tiny as a less than 4-mm-diameter endoscope that could be used for minimally invasive surgeries or geolocation through tiny fissures or bores. 

The proposed solution here is to employ a single lens, and a pair of conjugated, multiple-bandpass filters (CMBFs) to separate stereo images. When a CMBF is placed in front of each of the stereo channels, only one wavelength of the visible spectrum that falls within the passbands of the CMBF is transmitted through at a time when illuminated. Because the passbands are conjugated, only one of the two channels will see a particular wavelength. These time-multiplexed images are then mixed and reconstructed to display as stereo images.

The basic principle of stereo imaging involves an object that is illuminated at specific wavelengths, and a range of illumination wavelengths is time multiplexed. The light reflected from the object selectively passes through one of the two CMBFs integrated with two pupils separated by a baseline distance, and is focused onto the imaging plane through an objective lens. The passband range of CMBFs and the illumination wavelengths are synchronized such that each of the CMBFs allows transmission of only the alternate illumination wavelength bands. And the transmission bandwidths of CMBFs are complementary to each other, so that when one transmits, the other one blocks.

This can be clearly understood if the wavelength bands are divided broadly into red, green, and blue, then the illumination wavelengths contain two bands in red (R1, R2), two bands in green (G1, G2), and two bands in blue (B1, B2).

Therefore, when the objective is illuminated by R1, the reflected light enters through only the left-CMBF as the R1 band corresponds to the transmission window of the left CMBF at the left pupil. This is blocked by the right CMBF.

The transmitted band is focused on the focal plane array (FPA). Here, the FPA does not include color filter array (black and white); hence, the image sensors only measure light intensities. Similarly, when the object is illuminated by R2, it is.

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Schematic showing the principle of the **Stereo Imaging Endoscope** using CMBFs. (a) The first illumination band passes through the left CMBF to cast an image at the focal plane, but is blocked by the right CMBF. (b) The second illumination band passes through the right CMBF to cast an image at the focal plane, but is blocked by the left CMBF.
transmitted only through the right-CMBF and is blocked by the left-CMBF. This continues over other wavelength bands as well.

So, it can be seen that the image sensors at the focal plane are measuring light intensities of alternately transmitted light from the two CMBFs. At the end of one complete illumination cycle, six images will have been collected. Then the images from R1, G1, and B1 become the primary colors for the left side of the stereo image, and R2, G2, and B2 become that of the right side of the stereo image. Two stereo images have been time-multiplexed on the same imaging chip. This intensity data is stored as an array from which the 3D stereoscopic color image is constructed by applying processing and reconstruction algorithms.

This work was done by Youngsam Bae, Harish Manohara, Victor E. White, and Kirill V. Shcheglov of Caltech and Hray Shahinian of Skull Base Institute 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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**Parallel Wavefront Analysis for a 4D Interferometer**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

This software provides a programming interface for automating data collection with a PhaseCam interferometer from 4D Technology, and distributing the image-processing algorithm across a cluster of general-purpose computers.

Multiple instances of 4Sight (4D Technology's proprietary software) run on a networked cluster of computers. Each connects to a single server (the controller) and waits for instructions. The controller directs the interferometer to several images, then assigns each image to a different computer for processing. When the image processing is finished, the server directs one of the computers to collate and combine the processed images, saving the resulting measurement in a file on a disk.

The available software captures approximately 100 images and analyzes them immediately. This software separates the capture and analysis processes, so that analysis can be done