4D Light Field Imaging System Using Programmable Aperture

This system would be useful for inspections and surgeries, as well as in any stereo imaging system using two cameras.

NASA's Jet Propulsion Laboratory, Pasadena, California

Complete depth information can be extracted from analyzing all angles of light rays emanated from a source. However, this angular information is lost in a typical 2D imaging system. In order to record this information, a standard stereo imaging system uses two cameras to obtain information from two view angles. Sometimes, more cameras are used to obtain information from more angles. However, a 4D light field imaging technique can achieve this multiple-camera effect through a single-lens camera.

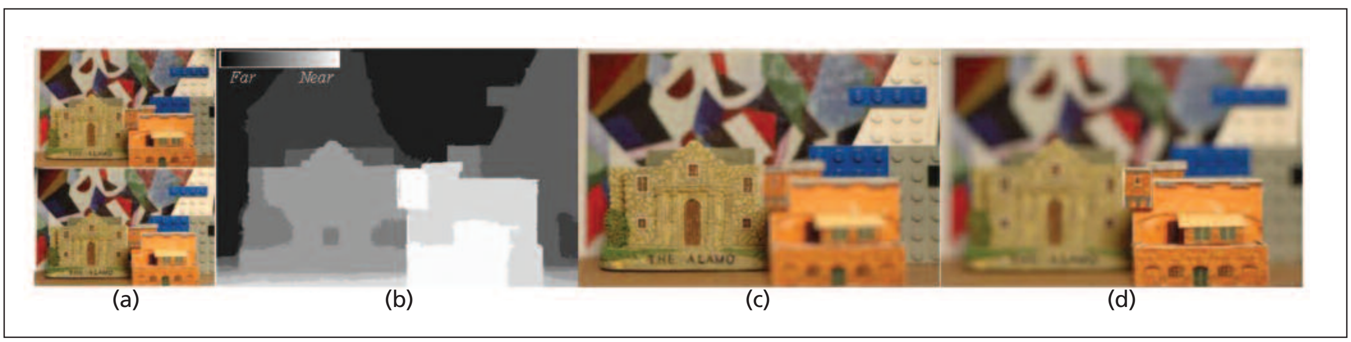
Two methods are available for this: one using a microlens array, and the other using a moving aperture. The moving-aperture method can obtain more complete stereo information. The existing literature suggests a modified liquid crystal panel [LC (liquid crystal) panel, similar to ones commonly used in the display industry] to achieve a moving aperture. However, LC panels cannot withstand harsh environments and are not qualified for spaceflight. In this regard, different hardware is proposed for the moving aperture.

A digital micromirror device (DMD) will replace the liquid crystal. This will be qualified for harsh environments for the 4D light field imaging. This will enable an imager to record near-complete stereo information.

The approach to building a proof-of-concept is using existing, or slightly modified, off-the-shelf components. An SLR (single-lens reflex) lens system, which typically has a large aperture for fast imaging, will be modified. The lens system will be arranged so that DMD can be integrated. The shape of aperture will be programmed for single-viewpoint imaging, multiple-viewpoint imaging, and coded aperture imaging.

The novelty lies in using a DMD instead of a LC panel to move the apertures for 4D light field imaging. The DMD uses reflecting mirrors, so any light transmission lost (which would be expected from the LC panel) will be minimal. Also, the MEMS-based DMD can withstand higher temperature and pressure fluctuation than a LC panel can. Robotics need near complete stereo images for their autonomous navigation, manipulation, and depth approximation. The imaging system can provide visual feedback.

This work was done by Youngsam Bae of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48604



(a) Two demultiplexed light field images generated by the **4D Light Field Imaging System**. The full 4D resolution is 4×4×3039×2014. (b) The estimated depth map of the top image of (a). (c, d) Post-exposure refocused images generated from the light field and the depth maps.

Device and Container for Reheating and Sterilization

This device can be used for packaged products that require heating prior to use.

Lyndon B. Johnson Space Center, Houston, Texas

Long-duration space missions require the development of improved foods and novel packages that do not represent a significant disposal issue. In addition, it would also be desirable if rapid heating technologies could be used on Earth as well, to improve food quality during a sterilization process. For this purpose, a package equipped with electrodes was developed that will enable rapid reheating of contents via ohmic heating to serving temperature during space vehicle transit. Further, the package is designed with a resealing feature, which enables the package, once used, to contain and sterilize waste, including human waste for storage prior to jettison during a long-duration mission.

Ohmic heating is a technology that has been investigated on and off for over a century. Literature indicates that foods processed by ohmic heating are of superior quality to their conventionally processed counterparts. This is due to