

by inertial sensors. The downlink beam would then be reflected out through the telescope by use of a mirror that would be partially (<1 percent) transmissive. The small part of the beacon beam transmitted through the mirror would impinge on a retroreflector and thereby be sent back to the focal-plane array to provide information on the pointing direction of the downlink beam.

The uplink from each lower terminal would be validated by means of the downlink beacon. To make this possible, the fast-steering mirror would also be made to rapidly scan the downlink beam across the locations of the lower termi-

nals as indicated by the locations of their beam spots on the focal-plane array.

In the data channel, the uplink signals would impinge on a diffraction grating, then each beam would be focused on data-detector-and-beam-stabilization unit (denoted in the figure as  $d_i$  for the  $i$ th beam). Each  $d_i$  would include a quadrant detector and a fine-steering mirror acting together as parts of a servo loop to maintain strength of the uplink signal on a data detector.

*This work was done by Keith Wilson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

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## Variable Shadow Screens for Imaging Optical Devices

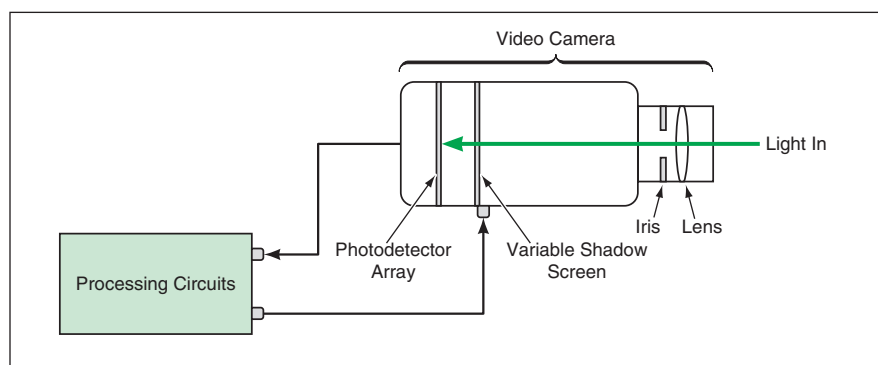
Effective dynamic ranges would be increased.

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Variable shadow screens have been proposed for reducing the apparent brightnesses of very bright light sources relative to other sources within the fields of view of diverse imaging optical devices, including video and film cameras and optical devices for imaging directly into the human eye. In other words, variable shadow screens would increase the effective dynamic ranges of such devices.

Traditionally, imaging sensors are protected against excessive brightness by use of dark filters and/or reduction of iris diameters. These traditional means do not increase dynamic range; they reduce the ability to view or image dimmer features of an image because they reduce the brightness of all parts of an image by the same factor. On the other hand, a variable shadow screen would darken only the excessively bright parts of an image. For example, dim objects in a field of view that included the setting Sun or bright headlights could be seen more readily in a picture taken through a variable shadow screen than in a picture of the same scene taken through a dark filter or a narrowed iris.

The figure depicts one of many potential variations of the basic concept of the variable shadow screen. The shadow screen would be a normally transparent liquid-crystal matrix placed in front of a focal-plane array of photodetectors in a charge-coupled-device



**Image Feedback From the Focal Plane** would be processed to generate a thresholded negative image on the shadow plane.

video camera. The shadow screen would be placed far enough from the focal plane so as not to disrupt the focal-plane image to an unacceptable degree, yet close enough so that the out-of-focus shadows cast by the screen would still be effective in darkening the brightest parts of the image.

The image detected by the photodetector array itself would be used as feedback to drive the variable shadow screen: The video output of the camera would be processed by suitable analog and/or digital electronic circuitry to generate a negative partial version of the image to be impressed on the shadow screen. The parts of the shadow screen in front of those parts of the image with brightness below a specified threshold would be left

transparent; the parts of the shadow screen in front of those parts of the image where the brightness exceeded the threshold would be darkened by an amount that would increase with the excess above the threshold.

*This work was done by Ed Lu of Johnson Space Center and Jean L. Chretien (an independent contributor). For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.*

*This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23037.*