software. Once the software is running, the local PC is disconnected and the module is controlled by, and all output data from the module are collected by, a remote PC via an Ethernet bus. Several “smart” sensor modules like this one could be connected to the same Ethernet bus and controlled by the single remote PC.

The software running in the microprocessor includes driver programs for operation of the sensor, programs that implement self-assessment algorithms, programs that implement protocols for communication with the external computer(s), and programs that implement evolutionary methodologies to enable the module to improve its performance over time. The design of the module and of the health-monitoring system of which it is a part reflects the understanding that the main purpose of a health-monitoring system is to detect damage and, therefore, the health-monitoring system must be able to function effectively in the presence of damage and should be capable of distinguishing between damage to itself and damage to the system being monitored. A major benefit afforded by the self-assessment algorithms is that in the output of the module, the sensor data indicative of the health of the engineering system being monitored are coupled with a confidence factor that quantifies the degree of reliability of the data. Hence, the output includes information on the health of the sensor module itself in addition to information on the health of the engineering system being monitored.

This work was done by Ajay Mahajan of Southern Illinois University for Stennis Space Center.

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**Portable Apparatus for Electrochemical Sensing of Ethylene**

Concentrations between 5 and 5,000 ppb can be measured.

*John F. Kennedy Space Center, Florida*

A small, lightweight, portable apparatus based on an electrochemical sensing principle has been developed for monitoring low concentrations of ethylene in air. Ethylene has long been known to be produced by plants and to stimulate the growth and other aspects of the development of plants (including, notably, ripening of fruits and vegetables), even at concentrations as low as tens of parts per billion (ppb). The effects are magnified in plant-growth and -storage chambers wherein ethylene can accumulate. There is increasing recognition in agriculture and related industries that it is desirable to monitor and control ethylene concentrations in order to optimize the growth, storage, and ripening of plant products. Hence, there are numerous potential uses for the present apparatus in conjunction with equipment for controlling ethylene concentrations.

The ethylene sensor is of a thick-film type with a design optimized for a low detection limit. The sensor includes a noble metal sensing electrode on a chip and a hydrated solid-electrolyte membrane that is held in contact with the chip. Also located on the sensor chip are a counter electrode and a reference electrode. The sensing electrode is held at a fixed potential versus the reference electrode. Detection takes place at ac-
The sensor is fairly selective for ethylene. It is not subject to interference by O₂ or CO₂. It does respond to NO, NO₂, and H₂S, but these gases are generally not expected to be present at significant concentrations in controlled plant-growth environments. The sensor also responds to some volatile compounds present in some soil samples. Further research will be necessary to reduce these interferences.

This work was done by Mourad Mansoukian, Linda A. Tempelman, and John Forchione of Giner, Inc. and W. Michael Krebs and Edwin W. Schmitt of Giner Electrochemical Systems, LLC for Kennedy Space Center. For further information, contact:

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Increasing Linear Dynamic Range of a CMOS Image Sensor

Dual-gain pixels are automatically switched to the most appropriate gain level.

NASA’s Jet Propulsion Laboratory, Pasadena, California

A generic design and a corresponding operating sequence have been developed for increasing the linear-response dynamic range of a complementary metal oxide/semiconductor (CMOS) image sensor. The design provides for linear calibrated dual-gain pixels that operate at high gain at a low signal level and at low gain at a signal level above a preset threshold. Unlike most prior designs for increasing dynamic range of an image sensor, this design does not entail any increase in noise (including fixed-pattern noise), decrease in responsivity or linearity, or degradation of photometric calibration.

The figure is a simplified schematic diagram showing the circuit of one pixel and pertinent parts of its column readout circuitry. The conventional part of the pixel circuit includes a photodiode having a small capacitance, C_D. The unconventional part includes an additional larger capacitance, C_L, that can be connected to the photodiode via a transfer gate controlled in part by a latch.

In the high-gain mode, the signal labeled TSR in the figure is held low through the latch, which also helps to adapt the gain on a pixel-by-pixel basis.

The Pixel and Column Readout Circuitry enable operation in either of two gain modes and automatic choice of whichever mode is appropriate for the present illumination level.