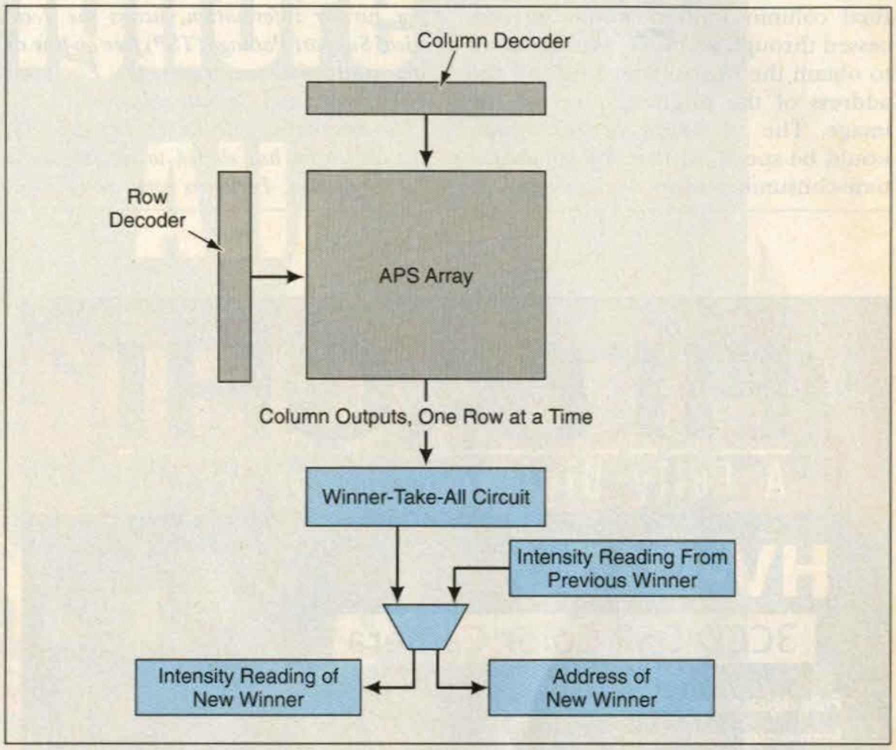
Active-Pixel Sensors With "Winner-Take-All" Mode

These sensors could function in either brightest-pixel or normal image-readout modes.

NASA's Jet Propulsion Laboratory, Pasadena, California

Circuits to generate the intensity reading and the coordinates of the brightest pixel in each image would be added to imaging photodetector arrays of the active-pixel-sensor (APS) type, according to a proposal. For a given APS, the additional circuitry for locating the brightest pixel would be installed at the periphery of the basic APS circuit. The additional circuitry would thus not degrade the original optical properties or interfere with the original electronic functions of the APS. The APS could be operated in its normal image-readout mode or, optionally, it could be operated with the additional circuitry in the brightest-pixel mode. Potential applications could include star tracking or fast tracking of a moving laser-beam spot in laser communication system.



A **Winner-Take-All Circuit** would identify the brightest pixel in each row in turn. This pixel would be compared with the brightest pixel found in the preceding rows.

The brightest-pixel mode would be a winner-take-all mode. The pixel intensities would be read out row by row as in ordinary imaging, but unlike in ordinary imaging, the column intensity values for each row would be processed through a winner-take-all circuit (see figure) that would select the brightest pixel in the row. The intensity reading of the brightest pixel in the row most recently read out would be compared with the previous winner; that is, with the stored intensity reading of the brightest pixel (if any) found in all previous rows. If the greatest intensity reading from the most recent row were greater than the stored intensity reading, then the pixel with this reading would become the new winner, and its intensity reading and coordinates would be stored. Once the intensity readings from all the rows in the APS had been processed in this way, the final winner would be the brightest pixel in the image.

There are several design options for the winner-take-all circuit and the overall mode of operation. In one option, the winner-take-all function would be implemented by a fast current- or voltage-mode analog circuit. In another option a hybrid analog/digital circuit would generate and compare an increasing voltage (ramp voltage waveform) with intensity-reading voltages for all the columns and would latch the address and intensity value for the column that most recently matched the ramp voltage.

In yet another option, each column pixel in the row read out most recently would be compared with the previous winning pixel in that column and would, if appropriate be declared the new winner. Once the last row had been thus read out and processed, the final column winners would be processed through a winner-take-all circuit to obtain the intensity reading and the address of the brightest pixel in the image. The advantage of this option would be speed, in that the somewhat time-consuming winner-take-all operation would be performed only once per frame period.

This work was done by Orly Yadid-Pecht, Eric Fossum, and Carver Mead of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category.*

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Active-Pixel-Sensor Digital Camera on a Single Chip

The entire camera, exclusive of the optics, is only 1 cm^3 (0.06 in.^{3}).

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The figure shows a complementary metal oxide/semiconductor (CMOS) integrated circuit that contains all of the electronic circuitry of a programmable active-pixel-sensor digital camera. Heretofore, digital cameras have been assembled from charge-coupled-device (CCD) chips, separate analog-to-digital converters, and separate units that perform timing, control, and interface functions; each unit adds to the size, cost, and power consumption of a camera. The present single-chip camera is a prototype developed for many applications within the space program. It also meets the demands of a large potential market for compact, low-power-consumption, and (eventually) inexpensive portable digital cameras. The chip has been packaged as a low-power camera occupying only 1 cm^3 (0.06 in.^{3}), exclusive of optics, with an all-digital 5-wire serial interface. The chip is also being incorporated, along with a wireless interface unit, into a battery-operated camera with a volume of less than 32 cm^3 (2 in.^{3}).

Included on the chip are analog-to-digital converters (ADCs) and full timing, control, and interface circuitry. All analog reference voltages for imaging and digitization are generated by programmable digital-to-analog converters (DACs) that are also included on the chip. Thus, the camera contains a complete digital interface. Through a single digital input pin, the chip can be programmed to perform a variety of imaging operations and/or to establish the required interface configuration; this capability facilitates integration with a variety of external digital systems.