between the thermocouple and the object, the temperature of which one seeks to measure.

The software running in the processor includes components that implement statistical algorithms to evaluate the state of the thermocouple and the instrumentation system. When power is first turned on, the user can elect to start a diagnosis/monitoring sequence, in which the PWM is used to estimate the characteristic times corresponding to the correct configuration. The user also has the option of using previous diagnostic values, which are stored in an electrically erasable, programmable read-only memory so that they are available every time the power is turned on.

This work was done by Jose Perotti and Josephine Santiago of Kennedy Space Center and Carlos Mata, Peter Vokrot, Carlos Zavala, and Bradley Burns of ASRC Aerospace Corp.

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 Kennedy Innovative Partnerships Office at (321) 861-7158. Refer to KSC-12875.

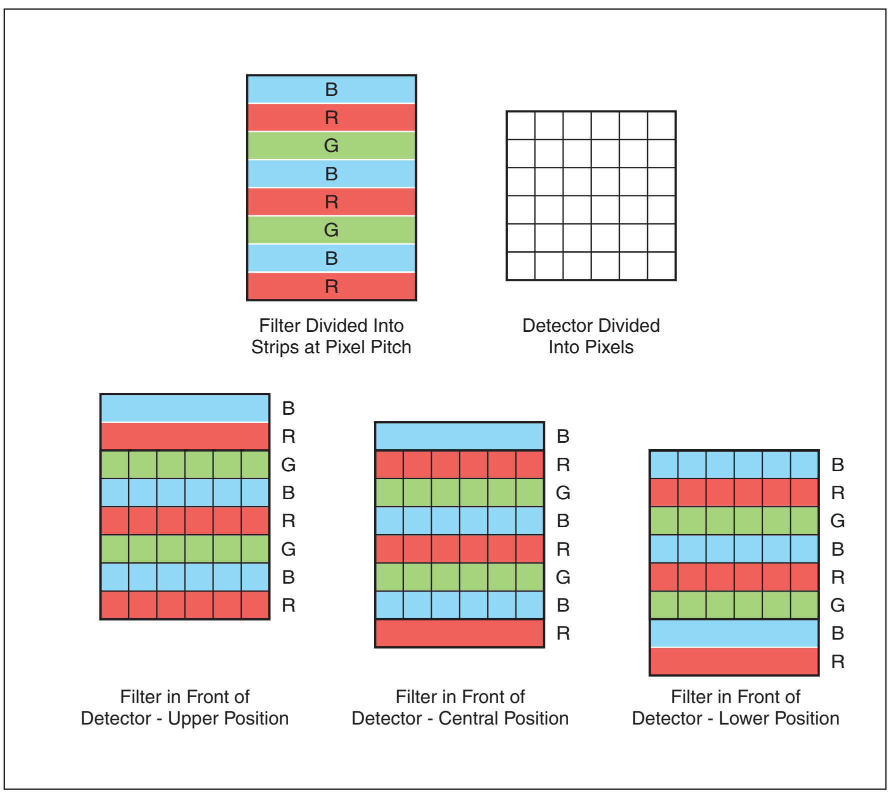
Chromatic Modulator for a High-Resolution CCD or APS

Color images would be detected without loss of spatial resolution.

NASA's Jet Propulsion Laboratory, Pasadena, California

A chromatic modulator has been proposed to enable the separate detection of the red, green, and blue (RGB) color components of the same scene by a single charge-coupled device (CCD), active-pixel sensor (APS), or similar electronic image detector. Traditionally, the RGB color-separation problem in an electronic camera has been solved by use of either (1) fixed color filters over three separate image detectors; (2) a filter wheel that repeatedly imposes a red, then a green, then a blue filter over a single image detector; or (3) different fixed color filters over adjacent pixels. The use of separate image detectors necessitates precise registration of the detectors and the use of complicated optics; filter wheels are expensive and add considerably to the bulk of the camera; and fixed pixelated color filters reduce spatial resolution and introduce color-aliasing effects. The proposed chromatic modulator would not exhibit any of these shortcomings.

The proposed chromatic modulator would be an electromechanical device fabricated by micromachining. It would include a filter having a spatially periodic pattern of RGB strips at a pitch equal to that of the pixels of the image detector (see figure). The filter would be placed in front of the image detector, supported at its periphery by a spring suspension and electrostatic comb drive. The spring suspension would bias the filter toward a middle position in which each filter strip would be registered with a row of pixels of the image detector. Hard stops would limit the excursion of the spring suspension to precisely one pixel row above and one pixel row below the middle position.



Red, Green, and Blue Filter Strips would be registered with pixel rows in a repeating pattern. The filter would be repeatedly placed in the upper, middle, and lower positions to repeatedly expose each pixel to each color.

In operation, the electrostatic comb drive would be actuated to repeatedly snap the filter to the upper extreme, middle, and lower extreme positions. This action would repeatedly place a succession of the differently colored filter strips in front of each pixel of the image detector. At each filter position, each detector pixel would thus acquire information on the local brightness in the momentarily selected color. The frequency of actuation of the comb drive would be three times the frame rate of the camera, so that over one frame period, each pixel would acquire full color information. Hence, the camera would acquire full color information at full pixel resolution.

Of course, it would be necessary to time-multiplex the outputs of the pixels for processing in a manner consistent with the spatial and temporal periodicity of the color information acquired by each detector pixel. To simplify the processing, it would be desirable to encode information on the color of the filter strip over each row (or at least over some representative rows) of pixels at a given instant of time in synchronism with the pixel output at that instant. This could be accomplished by means of an alternating pattern of opaque patches over the last two pixel-column positions of each filter strip: for example, nonzero illumination at both of these column positions could signify the presence of the red filter strip, zero illumination at one of these column positions could signify the presence of the green filter strip, and zero illumination at both of these column positions could signify the presence of the blue filter strip.

This work was done by Frank Hartley and Anthony Hull of Caltech for NASA's Jet Propulsion Laboratory.

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, NASA Management Office–JPL. Refer to NPO-20896.

Commercial Product Activation Using RFID

Products would be tracked to points of sale and there activated automatically.

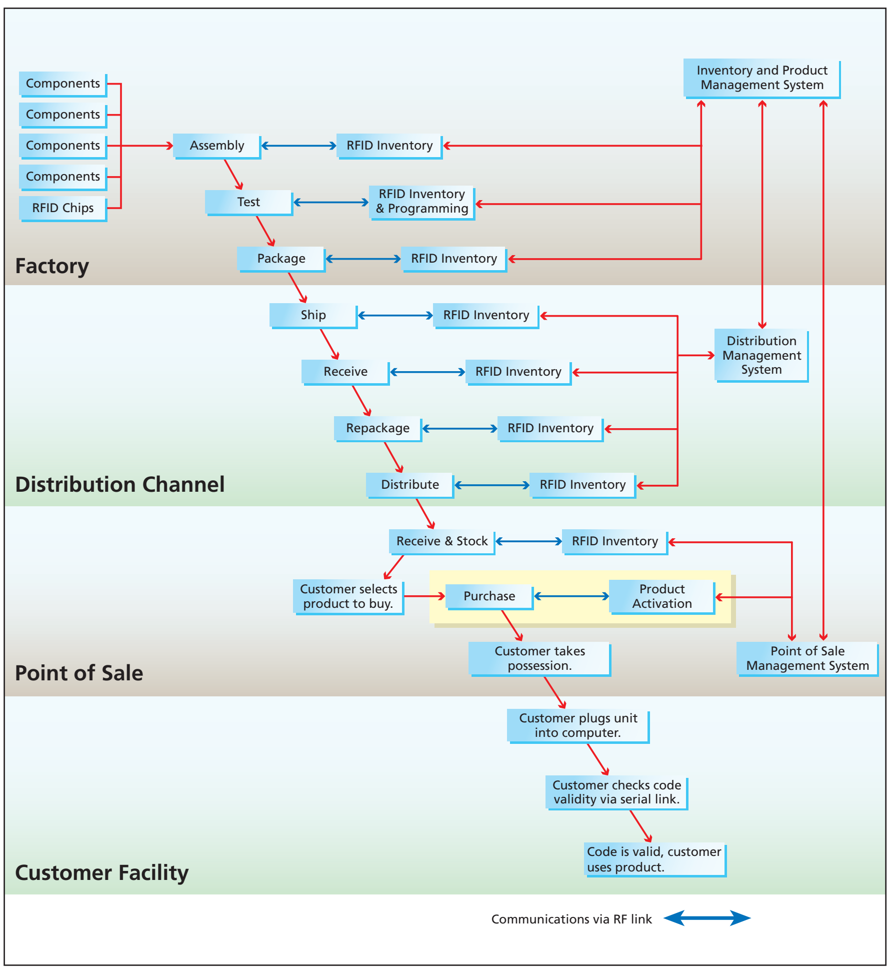
NASA's Jet Propulsion Laboratory, Pasadena, California

Radio-frequency identification (RFID) would be used for commercial product activation, according to a proposal. The concept of RFID is not new: RFID systems are widely used in commerce for tracking such diverse assets as animals, credit cards, and retail products. Also not new is the concept of manufacturing commercial products to be nonfunctional or unusable until activated at points of sale or in response to electronic submission of proof of purchase. What is new here is the concept of combining RFID with activation — more specifically, using RFID for activating commercial products (principally, electronic ones) and for performing such ancillary functions as tracking individual product units on production lines, tracking shipments, and updating inventories (see figure).

According to the proposal, an RFID chip would be embedded in each product. The information encoded in the chip would include a unique number for identifying the product. An RFID reader at the point of sale would record the number of the product and would write digital information to the RFID chip for either immediate activation of the product or for later interrogation and processing.

To be practical, an RFID product-activation system should satisfy a number of key requirements:

- The system should be designed to be integrable into the inventory-tracking and the data-processing and -communication infrastructures of businesses along the entire supply chain from manufacture to retail.
- The system should be resistant to sophisticated hacking.
- Activation codes should be made sufficiently complex to minimize the probability of activating stolen products.
- RFID activation equipment at points of sale must be capable of two-way RF communication for the purposes of reading information from, and writing information to, embedded RFID chips.
- The equipment at points of sale should be easily operable by sales clerks with little or no training.
- The point-of-sale equipment should verify activation and provide visible and/or audible signals indicating verification or the lack thereof.
- The system should be able to handle millions of products per year with minimal human intervention.
- The system should support non-simultaneous dual data-communication interfaces: (1) the RF link between the product-activation infrastructure and the RFID chip in each product and (2) a serial link, within each product, between the RFID chip and a control circuit.
- To the extent possible, the system should be constructed using relatively inexpensive off-the-shelf RFID equipment and methods that conform to in-



An **RFID Chip** embedded in each product at manufacture would be used to track the product through the entire supply chain and would be used to activate the product at the point of sale.