ORIGINATING TECHNOLOGY/

NASA CONTRIBUTION

When it comes to real-time image processing, everyone is an expert. People begin processing images at birth and rapidly learn to control their responses through the real-time processing of the human visual system. The human eye captures an enormous amount of information in the form of light images. In order to keep the brain from becoming overloaded with all the data, portions of an image are processed at a higher resolution than others, such as a traffic light changing colors.

In the same manner, image processing products strive to extract the information stored in light in the most efficient way possible. Digital cameras available today capture millions of pixels worth of information from incident light. However, at frame rates more than a few per second, existing digital interfaces are overwhelmed. All the user can do is store several frames to memory until that memory is full and then subsequent information is lost. New technology pairs existing digital interface technology with an off-the-shelf complementary metal oxide semiconductor (CMOS) imager to provide more than 500 frames per second of specialty image processing. The result is a cost-effective detection system unlike any other.

"Smart camera" technology has evolved as a way to process images inside a camera and reduce the amount of information passed through the data bus to the processor by several orders of magnitude. This increases the bandwidth of a control system while preserving resolution with specialized image-processing algorithms inside the camera. Robotic guidance, product inspection, quality assurance, and packaging are fields that benefit from smart camera systems.

NASA's Marshall Space Flight Center uses smart cameras for its Advanced Video Guidance Sensor (AVGS) on the Demonstration of Autonomous Rendezvous Technology (DART) mission. NASA's goal is to launch an unmanned spacecraft that autonomously docks with an on-orbit satellite without human intervention. The AVGS is an optical transceiver mounted on the spacecraft that fires near-infrared lasers in a predetermined sequence. A target on the satellite returns some of this light to the AVGS which then performs a pattern-recognition routine to determine its position and attitude relative to the satellite. Marshall's Engineering Directorate (ED)-19 developed the image-processing algorithms for the original Video Guidance Sensor flown on two previous Shuttle missions. Orbital Sciences Corporation, in Beltsville, Maryland, teamed with Advanced Optical Systems (AOS), in Huntsville, Alabama, and Marshall's ED-19 and ED-14 groups to increase the range and the update rate for the AVGS unit.

PARTNERSHIP

Southern Vision Systems, Inc. (SVSi), also of Huntsville, Alabama, developed its commercial SpecterView™ sensor based upon the work done in support of NASA's DART mission. SVSi President Andy Whitehead was the AOS program manager for Marshall's AVGS and recognized the potential applications of the technology. SVSi started prototype development on the SpecterView sensor in April 2003 at AOS and began volume manufacturing in its own facility by April 2004. AOS received one of the first beta

SpecterView™ contains smart camera technology to benefit applications in quality assurance, product inspection, and automated manufacturing.

INDUSTRIAL PRODUCTIVITY/MANUFACTURING TECHNOLOGY

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SpecterView™ performs as a rapid prototyping and diagnostic tool for scientists and engineers developing optical systems.

displays and logs the light signals captured. Its primary application is as a rapid prototyping and diagnostic tool for scientists and engineers developing optical systems. This application provided immediate benefits to NASA.

Following fabrication of the first flight unit of Marshall's AVGS, performance testing showed that one or more lasers inside the box were either firing out of sequence or at reduced output power. Since range information for the DART mission is very dependent on having a stable transceiver, the cause of the misfire needed to be quickly identified. As a flight box, the cover to the AVGS could only be removed for diagnostics under controlled environments. However, AOS used an imaging lens to image the output fiber bundle onto the SpecterView and record each individual laser's firing sequence. The high resolution of the imager array and large sampling bandwidth (up to 500 kilohertz) quickly identified which laser was firing at reduced output power. This enabled rapid repair once the decision was made to go inside the box.

The smart camera technology developed for AVGS and implemented in SpecterView has applications in quality assurance, product inspection, and even automated manufacturing of everyday products. The technology's implementation into these areas is driven by the manufacturer's desire to produce reliable quality products as efficiently as possible to satisfy customers' competing demands for quality inexpensive goods.

SpecterView™ is a trademark of Southern Vision Systems, Inc.

units and immediately used it to diagnose the flight version of the AVGS when problems arose during testing.

PRODUCT OUTCOME

The SpecterView is built around a CMOS imager that captures images of 1,280 by 1,024 pixels at 500 frames per second. An adjacent, large-area field programmable gate array controls the imager, downloads frames, and processes the image to reduce the throughput to manageable streams. After frame processing, digital data are sent to the host computer through a universal serial bus interface without the need for a frame-grabber. The largest commercial advantage of the sensor is its ability to emulate a suite of analog detectors with one two-dimensional digital imager. Similar to the way in which digital electronics displaced analog electronics for many applications, digital photo-detectors are replacing analog photo-detectors as digital speeds increase. The user-friendly nature of digital signals eases data manipulation and display.

Designed to be the equivalent to an optical engineer as the oscilloscope is to an electrical engineer, the SpecterView sensor looks at light in many different ways and graphically