



## Electronics/Computers

### Micro Sun Sensor for Spacecraft

NASA's Jet Propulsion Laboratory, Pasadena, California

A report describes the development of a compact micro Sun sensor for use as a part of the attitude determination subsystem aboard future miniature spacecraft and planetary robotic vehicles. The prototype unit has a mass of only 9 g, a volume of only 4.2 cm<sup>3</sup>, a power consumption of only 30 mW, and a 120° field of view. The unit has demonstrated an accuracy of 1 arc-minute. The unit consists of a multiple-pinhole camera: A micromachined

mask containing a rectangular array of microscopic pinholes, machined utilizing the microelectromechanical systems (MEMS), is mounted in front of an active-pixel sensor (APS) image detector. The APS consists of a 512×512-pixel array, on-chip 10-bit analog to digital converter (ADC), on-chip bias generation, and on-chip timing control for self-sequencing and easy programmability. The digitized output of the APS is processed to compute the centroids of

the pinhole Sun images on the APS. The Sun angle, relative to a coordinate system fixed to the sensor unit, is then computed from the positions of the centroids.

*This work was done by Sohrab Mobasser, Carl Liebe, Youngsam Bae, Jeffrey Schroeder, and Chris Wrigley of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1) NPO-30867*

### Passive IFF: Autonomous Nonintrusive Rapid Identification of Friendly Assets

Targeting decisions could be made with speed needed in urgent situations.

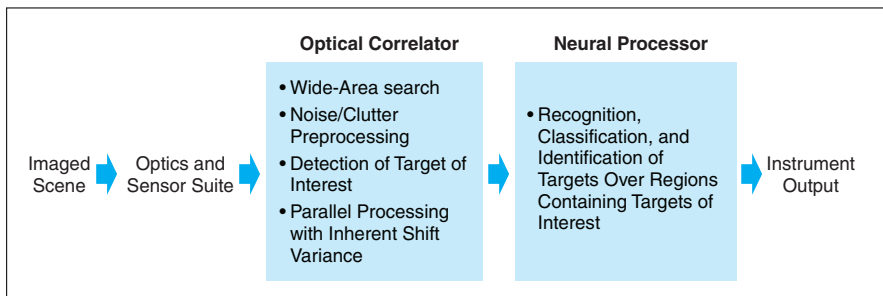
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A proposed optoelectronic instrument would identify targets rapidly, without need to radiate an interrogating signal, apply identifying marks to the targets, or equip the targets with transponders. The instrument was conceived as an identification, friend or foe (IFF) system in a battlefield setting, where it would be part of a targeting system for weapons, by providing rapid identification for aimed weapons to help in deciding whether and when to trigger them. The instrument could also be adapted to law-enforcement and industrial applications in which it is necessary to rapidly identify objects in view.

The instrument would comprise mainly an optical correlator and a neural processor (see figure). The inherent parallel-processing speed and

capability of the optical correlator would be exploited to obtain rapid identification of a set of probable targets within a scene of interest and to define regions within the scene for the neural processor to analyze. The neural processor would then concentrate on each region selected by the optical correlator in an effort to identify the target. Depending on whether or not a target was recognized by comparison of its image data with data in an internal database on which the neural processor was trained, the processor would generate an identifying signal (typically, "friend" or "foe"). The time taken for this identification process would be less than the time needed by a human or robotic gunner to acquire a view of, and aim at, a target.

An optical correlator that has been under development for several years and that has been demonstrated to be capable of tracking a cruise missile might be considered a prototype of the optical correlator in the proposed IFF instrument. This optical correlator features a 512-by-512-pixel input image frame and operates at an input frame rate of 60 Hz. It includes a spatial light modulator (SLM) for video-to-optical image conversion, a pair of precise lenses to effect Fourier transforms, a filter SLM for digital-to-optical correlation-filter data conversion, and a charge-coupled device (CCD) for detection of correlation peaks. In operation, the input scene grabbed by a video sensor is streamed into the input SLM. Pre-computed correlation-filter data files representative of known targets are then downloaded and sequenced into the filter SLM at a rate of 1,000 Hz. When there occurs a match between the input target data and one of the known-target data files, the CCD detects a correlation peak at the location of the target. Distortion-invariant correlation filters from a bank of such filters are then sequenced through the optical correlator for each input frame. The net result is the rapid preliminary recognition of one or a few targets.



An Optical Correlator and a Neural Processor, each performing a different portion of the overall target-identification task, would generate a signal indicative of the identity of a target (e.g., "friend" or "foe") in a fraction of a second.