# Books & Reports

## Hemispherical Field-of-View Above-Water Surface Imager for Submarines

A document discusses solutions to the problem of submarines having to rise above water to detect airplanes in the general vicinity. Two solutions are provided, in which a sensor is located just under the water surface, and at a few to tens of meter depth under the water surface.

The first option is a Fish Eye Lens (FEL) digital-camera combination, situated just under the water surface that will have near-full-hemisphere (360° azimuth and 90° elevation) field of view for detecting objects on the water surface. This sensor can provide a three-dimensional picture of the airspace both in the marine and in the land environment.

The FEL is coupled to a camera and can continuously look at the entire sky above it. The camera can have an Active Pixel Sensor (APS) focal plane array that allows logic circuitry to be built directly in the sensor. The logic circuitry allows data processing to occur on the sensor head without the need for any other external electronics.

In the second option, a single-photon sensitive (photon counting) detector-array is used at depth, without the need for any optics in front of it, since at this location, optical signals are scattered and arrive at a wide (tens of degrees) range of angles.

Beam scattering through clouds and seawater effectively negates optical imaging at depths below a few meters under cloudy or turbulent conditions. Under those conditions, maximum collection efficiency can be achieved by using a non-imaging photon-counting detector behind narrowband filters.

In either case, signals from these sensors may be fused and correlated or decorrelated with other sensor data to get an accurate picture of the object(s) above the submarine. These devices can complement traditional submarine periscopes that have a limited field of view in the elevation direction. Also, these techniques circumvent the need for exposing the entire submarine or its periscopes to the outside environment.

*This work was done by Hamid Hemmati, Joseph M. Kovalik, and William H. Farr of Caltech, and John D. Dannecker of QinetiQ NA Corp. for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47916*

## Quantum-Well Infrared Photodetector (QWIP) Focal Plane Assembly

A paper describes the Thermal Infrared Sensor (TIRS), a QWIP-based instrument intended to supplement the Operational Land Imager (OLI) for the Landsat Data Continuity Mission (LDCM). The TIRS instrument is a far-infrared imager operating in the push-broom mode with two IR channels: 10.8 and 12 μm. The focal plane will contain three 640×512 QWIP arrays mounted on a silicon substrate. The silicon substrate is a custom-fabricated carrier board with a single layer of aluminum interconnects. The general fabrication process starts with a 4-in. (≈10-cm) diameter silicon wafer. The wafer is oxidized, a single substrate contact is etched, and aluminum is deposited, patterned, and alloyed.

This technology development is aimed at incorporating three large-format infrared detecting arrays based on GaAs QWIP technology onto a common focal plane with precision alignment of all three arrays. This focal plane must survive the rigors of flight qualification and operate at a temperature of 43 K (–230 °C) for five years while orbiting the Earth. The challenges presented include ensuring thermal compatibility among all the components, designing and building a compact, somewhat modular system and ensuring alignment to very tight levels.

The multi-array focal plane integrated onto a single silicon substrate is a new application of both QWIP array development and silicon wafer scale integration. The Invar-based assembly has been tested to ensure thermal reliability.

*This work was done by Murzy Jhabvala, Christine A. Jhabvala, Audrey J. Ewin, Larry A. Hess, Thomas M. Hartmann, and Anh T. La of Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15849-1*