



Thermal light valve helps capture IR images

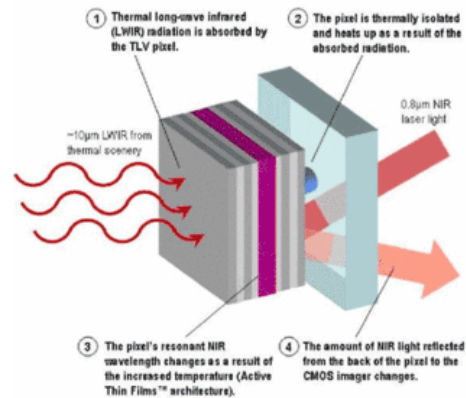
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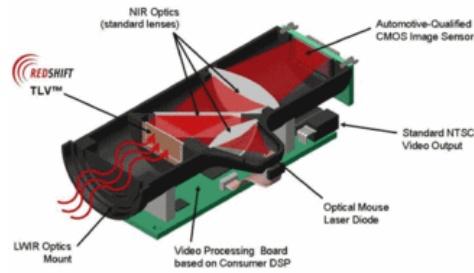
June 1, 2006

Three types of infrared (IR) cameras have dominated the detection of long-wavelength IR (LWIR) radiation. These include low-cost and less-sensitive microbolometer-based units that use vanadium oxide or amorphous silicon and sensitive, yet more-expensive, cameras based on mercury cadmium telluride (HgCdTe or MCT) and gallium arsenide (GaAs) quantum-well IR photodetector (QWIP) detectors.

“Cameras based on these technologies have remained expensive because of numerous factors that include the exotic materials used, the number of mask steps required to produce them, and the custom ASICs and electronics required to develop readout ICs. This is true even of the low-cost microbolometers,” says Daniel Ostrower, senior director of product management at RedShift Systems (Waltham, MA, USA; www.redshiftsystems.com).

Intent on lowering the cost of LWIR cameras, RedShift has developed a low-cost optical thermal camera that uses an optical wavelength converter, the Thermal Light Valve (TLV), based on amorphous-silicon and silicon nitride thin films originally developed by Aegis Semiconductor (Woburn, MA, USA; www.aegis-semi.com) for fabrication of tunable filters for the telecommunications industry. RedShift is now releasing TLV-based camera modules for use by OEMs. The first evaluation modules are scheduled for shipment to qualified OEMs later this year.





In the design of its optical LWIR camera module for OEMs, RedShift Systems uses its Thermal Light Valve (top). As the resonant wavelength of each pixel is changed by incident radiation, it is scanned by a low-cost laser and reflected onto an off-the-shelf CMOS imager and read out in NTSC format (bottom).

To build the tunable telecom filters, a transparent substrate, integrated resistive heating layer, and dielectric mirrors are sandwiched around a thermo-optic tunable semiconductor layer. The wavelength of light that is transmitted through the filter is then a function of the temperature of the semiconductor layer. To change the transmitted wavelength, the current in the resistive heating layer is changed, resulting in a tunable filter. RedShift has used this tunable semiconductor technology to build a 160×120 thermal imager in which the wavelength of the tunable layer is shifted not by resistive heating but by incident LWIR radiation.

Because the filter's resonant wavelength changes are due to this incident LWIR radiation, probing the device with a fixed-wavelength laser and measuring the reflected laser light provides a method of measurement of the LWIR frequency (see figure). RedShift has developed a small thermal-imaging camera that uses the technology to image reflected laser light onto a standard CMOS imager. The TLV is mounted into a vacuum-packaged housing with a LWIR lens. Incident LWIR radiation incident on the TLV then changes the filter resonant wavelength of each pixel in the array. By flooding the array with an 850-nm vertical-cavity surface emitting laser, reflected laser light is then focused onto a CMOS imager from Micron Technology (Boise, ID, USA; www.micron.com).

Because the near-IR probe signal reflected from the TLV depends on the incident LWIR radiation, the intensity of light received by the CMOS imager is effectively modulated by the LWIR signature of the observed scene. Images from the CMOS imager are then processed and encoded into NTSC format, which allows the camera to display images on low-cost broadcast-compatible systems. The camera incorporates a DSP to perform image filtering and automatic gain correction of the captured image. According to RedShift's Ostrower, the spectral sensitivity of the TLV-based camera in the 8-12- μm LWIR region is 150 mK, a figure comparable, for example, with that of uncooled microbolometers but still far less than the 25 mK for MCT-based devices.

"OEM cameras based on this technology can be built for about \$1000, making them more cost-effective than microbolometer-based devices," adds Ostrower. At the recent SPIE Defense & Security Symposium (April 2006; Orlando, FL, USA), RedShift demonstrated a prototype of the camera and an OEM imaging module the company plans to offer to camera manufacturers targeting LWIR firefighting, security, and thermography applications.

Vision Systems Design June, 2006

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