Application Note: Cheetah 640 CL for high speed imaging in SWIR

Cheetah 640 CL: Key performance indicators:

- *Fastest InGaAs 2D camera in the world*
- *InGaAs sensor 640x512 format with 20µm pixel pitch; 16 outputs and 40MHz pixel clock*
- *Quantum efficiency of 80% in the 900 to 1700nm range*
- *Excellent response to 1060, 1300 and 1550nm lasers*
- *Dual CameraLink Medium interface for 1730 full frames per second at 12 bit per pixel*

Adaptive optics

Free-space satellite communication
The laser beams used for free-space satellite communication emit typically at 1060 nm or 1550 nm (eye-safe and low atmospheric attenuation). In reduced region of interest mode of, e.g., 100x100 pixels, the Cheetah camera can achieve well over 10.000 fps. This feature of the camera is being used in adaptive optics systems to correct imaging systems for atmosphere turbulence. The high speed Cheetah camera, mounted behind a Shack-Hartmann sensor to measure the wave distortion, provides active feedback to the deformable telescope mirror in order to have a corrected wavefront on the high-speed demodulator.

Astronomy
Since astronomical observations are also prone to atmospheric turbulence, adaptive optics techniques are also being used. Observations in the NIR and SWIR are specifically interesting because of the absorption bands of CO_2, H_2O and a number of trace gases. Moreover, airglow emission in SWIR can be detected from several planets. The combination of adaptive optics and a high-speed Cheetah camera is key to achieving diffraction limited observations.

Tracking free-space optical lasers

Free-space optical communications using narrow laser beams create difficult constraints for the pointing and tracking abilities of the terminals. For example, in ground-to-ground transmissions where objects such as trees or buildings can frequently block the line of sight, fast re-acquisition is necessary to reduce link outages.
InGaAs-based cameras image the eye-safe laser wavelengths typically used for free-space communications. High-frame rate cameras, used for locating the laser source, permit the control electronics to quickly center the beam in the image despite rapid movements of transmitter/receiver platforms

Situational awareness – flash detection

Acoustic sensors that “listen” to the shockwave of a bullet are not the only solution for gunshot detection. Gunshot signature can be identified, located and processed even faster using high-speed short-wave infrared cameras such as the Cheetah 640 CL.

Medical – optical coherence tomography

Optical coherence tomography (OCT) is a promising biomedical application that permits cross-sectional imaging of biological tissues with good spatial resolution and to depths of a few millimeters. It is mainly used for non-invasive diagnostics of pre-cancerous growths. Typically, an illumination beam centered around 1300nm is being used for optimum penetration into biological tissues. Rapid image acquisition is limited by the necessity for mechanical scanning when using time domain (TD) or spectral domain (SD) OCT. However, when using a high-speed 2D camera, full-field OCT can be achieved without mechanical scanning. High-speed InGaAs cameras such as the Cheetah 640 CL are ideally suited for this application.

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Fig. 1: Cheetah 640 CL; front and back

Fig. 2: ESA's optical ground station on the Canary Islands; used for adaptive optics experiments