Contribution ID: **34**   Type: **Oral presentation (20 minute)**

Spatial Frequency domain probes of the brighter-fatter effect

Wednesday 13 March 2024 10:25 (25 minutes)

The brighter-fatter effect is an important systematic arising in CCD sensors, and its characterisation and mitigation have become quite routine in recent years, generally by means either of measuring the correlations in flat fields, or by directly measuring the signal dependent width of the point spread function in projected spots.

In this contribution we describe an investigation into measuring the brighter-fatter effect (specifically the "a" matrix by which flat fields are often described in the literature) using laser speckle projection. Laser speckle is a powerful tool to measure the modulation transfer function (MTF) of a sensor because it does not rely on refractive optics and has known spatial frequency domain characteristics. This makes it uniquely suitable for use in sensors with very small pixels, where projection using refractive optics may not probe the sensor characteristics well. However, other properties of laser speckle also make it helpful in probing the brighter-fatter effect as well: The known spatial frequency power spectrum density enables measurement of the MTF with very high statistics, and furthermore the laser speckle samples over many different regimes of contrast ratio in the spatial domain, as compared to a flat field (which has minimal spatial contrast), or a point source projection (with the maximum possible contrast).

We present theoretical and experimental considerations about probing the brighter-fatter effect in the spatial frequency domain using laser speckle, including comparisons of experiment agains conventional correlation measurement using flat fields.

contribution subject matter

point spread function fidelity

Keywords for your contribution subject matter (this will assist SOC in accurately characterizing your contribution)

MTF, Laser Speckle, Brighter-Fatter Effect

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Session Classification: Detector Models

Track Classification: Major ISPA Workshop Tracks: Sensor and Systematics Characterization