What More Can You Do With Color Image Sensors?
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Research at ISSL is aimed at understanding the increasingly large role that signal systems play in the real-world. We connect the applied design efforts with the first principle ideas of mathematics and statistics to enable new capabilities in image processing, computer vision, and sensor exploitation.
Signal System Models

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Data lost here!

Human Vision

Data lost here!

Natural Scene Statistics

Acquisition Hardware

Signal & Image Processing

Display Hardware

Impose limits on DSP

Impose limits on vision
Color image sensor has color filter array. Demosaicking recovers full color image.
Binning Pixels

Example sensor data processing. Binning reduces noise but introduces aliasing artifacts.
Example camera processing. Same sensor observation but increased robustness to noise.

- Denoising and interpolation in tandem has limitations.
- Inaccurate noise model (Gaussian distribution).
- Use statistical modeling of images.
- Photon/electron noise model (Poisson distribution).

Joint denoising and interpolation has limitations in conventional processing with noise compared to ISSL reconstruction.
Example single shot HDR using conventional hardware. Captures moving subjects or video.
Example image sensor design. Same number of pixels, but increased spatial resolution.
Example image sensor design. Same number of pixels, but increased spatial resolution.
Example display design. Same number of pixels, but increased spatial and color resolution.
Color Image Processing

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color scientists have long ignored spatial information

not robust to dominant colors

conventional white balance

manual color balance by photographer

statistical modeling of color images

spatio-color modeling

quential white balance

elegantically pleasing but inaccurate

epleased with color science.
Motion Blur Detection

Example of blur detection. Has many computer vision and surveillance applications.

Motion blur kernel has a parametric form.

Blurred wavelet coefficients behave differently than sharp wavelet coefficients.

Robust statistical model for image features using wavelets.

Exploit sparsity of wavelet coefficients to estimate blur parameter.

Robust to noise and assumptions.

Input image with motion blur.

ISSL motion blur detection.
Image Quality Assessment

Example of image quality assessment with corrupted reference data.

full-reference quality assessment

I like this!
reference
algorithm1
algorithm2
image quality with respect to Ideal image

only used with training data

corrupted-reference quality assessment

I like this!
corrupted
algorithm1
algorithm2
benchmark algorithms and parameters

corrupted reference in real applications

image quality with respect to ideal image
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