

Computational Photography with Novel Camera Sensors

Smart photography solutions for the future

Hang Zhao, Boxin Shi and Ramesh Raskar

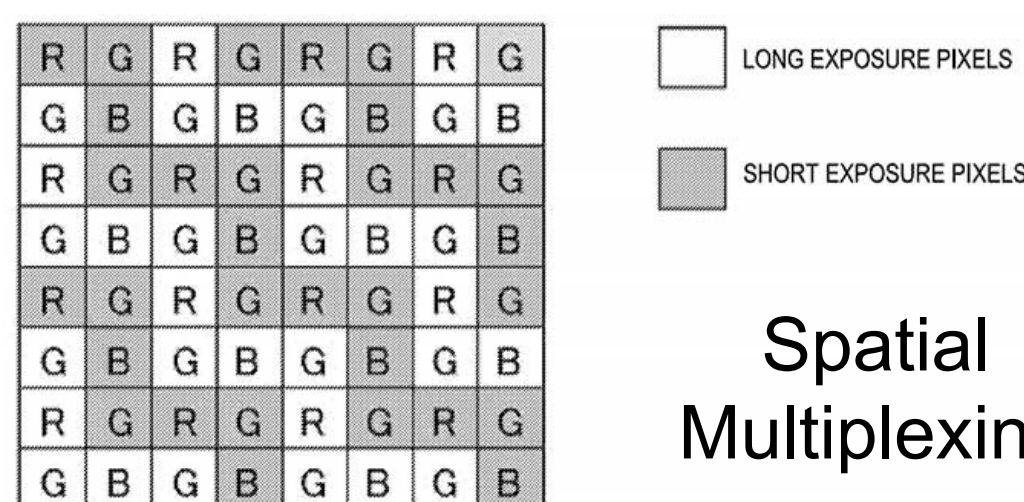


Unbounded High Dynamic Range (UHDR) Photography

ICCP 2015

Background

- High Dynamic Range (HDR) Photography is the technique that preserves both bright and dark details in a photo. Among traditional solutions, however, there is a **Trade-off** between **Resolution & Time!**

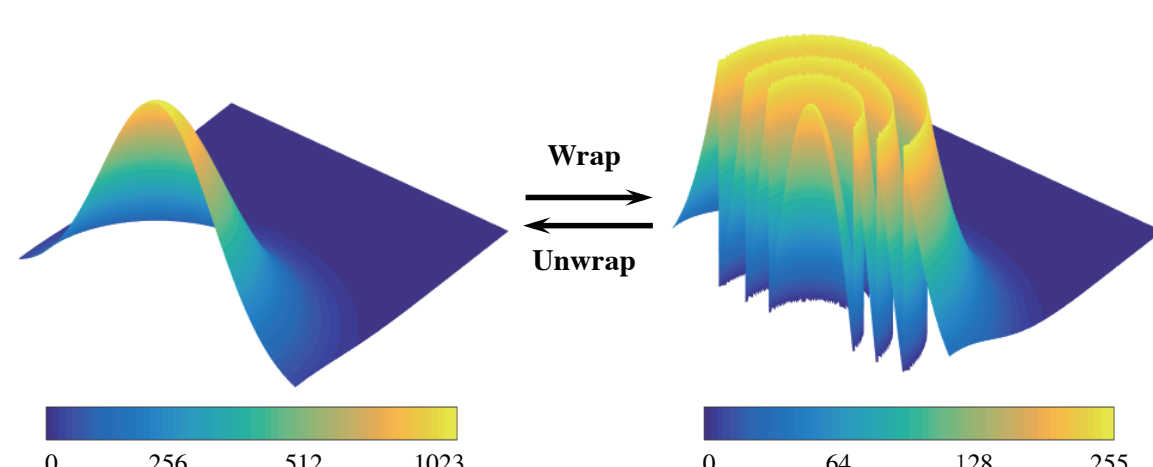


Our Solution

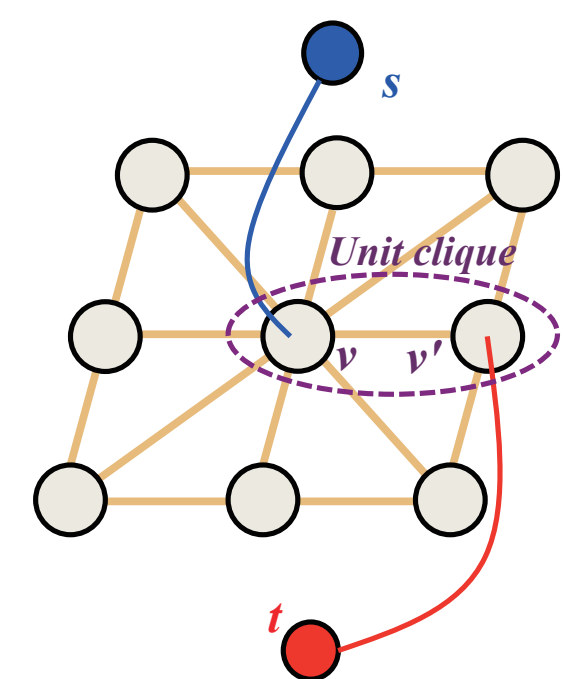
- We propose a modulo camera that takes the modulus image of scene radiance with co-design of hardware and software.

Modulo Camera

$$I_m(x, y) = \text{mod}(I(x, y), 2^N)$$



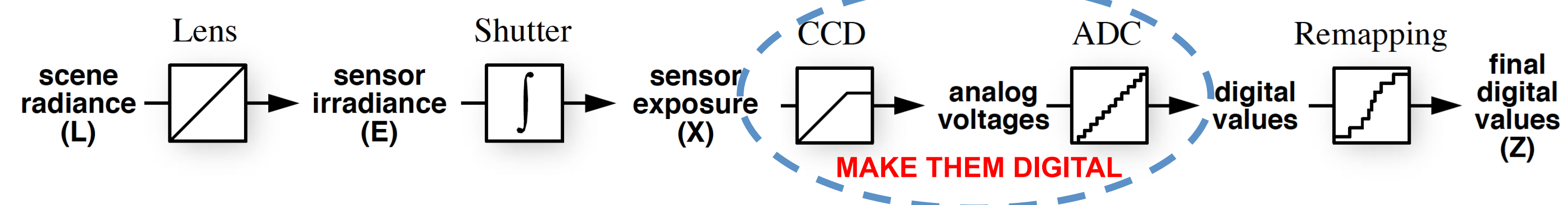
Software Algorithm



Markov Random Field
with 8 neighbors
Optimization with Graph Cuts

$$C(k|I_m) = \sum_{(i,j) \in \mathcal{G}} V(|\hat{I}_i - \hat{I}_j|)$$

Hardware Design



Results

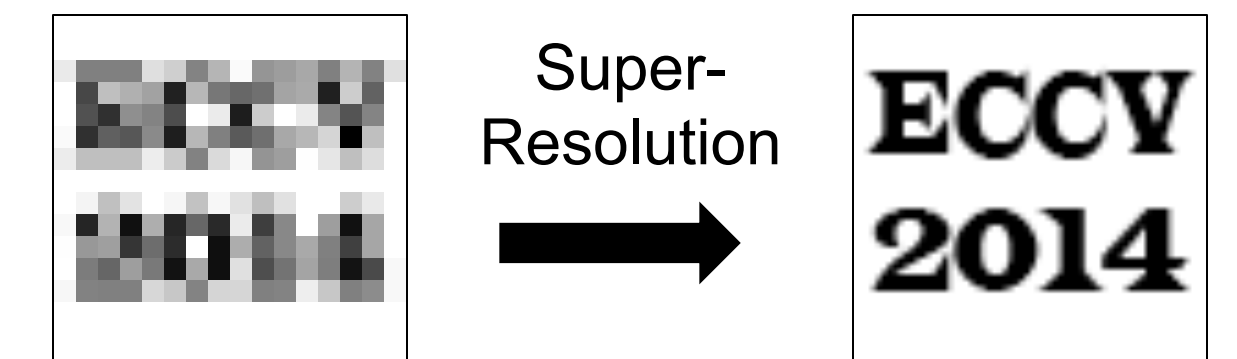


Sub-pixel Layout for Super-Resolution Photography

ECCV 2014

Background

- Multi-image super-resolution aims to recover a high-resolution image with multiple low-resolution counterparts.



Our Solution

- We show a sensor of asymmetric sub-pixel layout would increase the spatial sampling compared to a conventional sensor.

Comparison

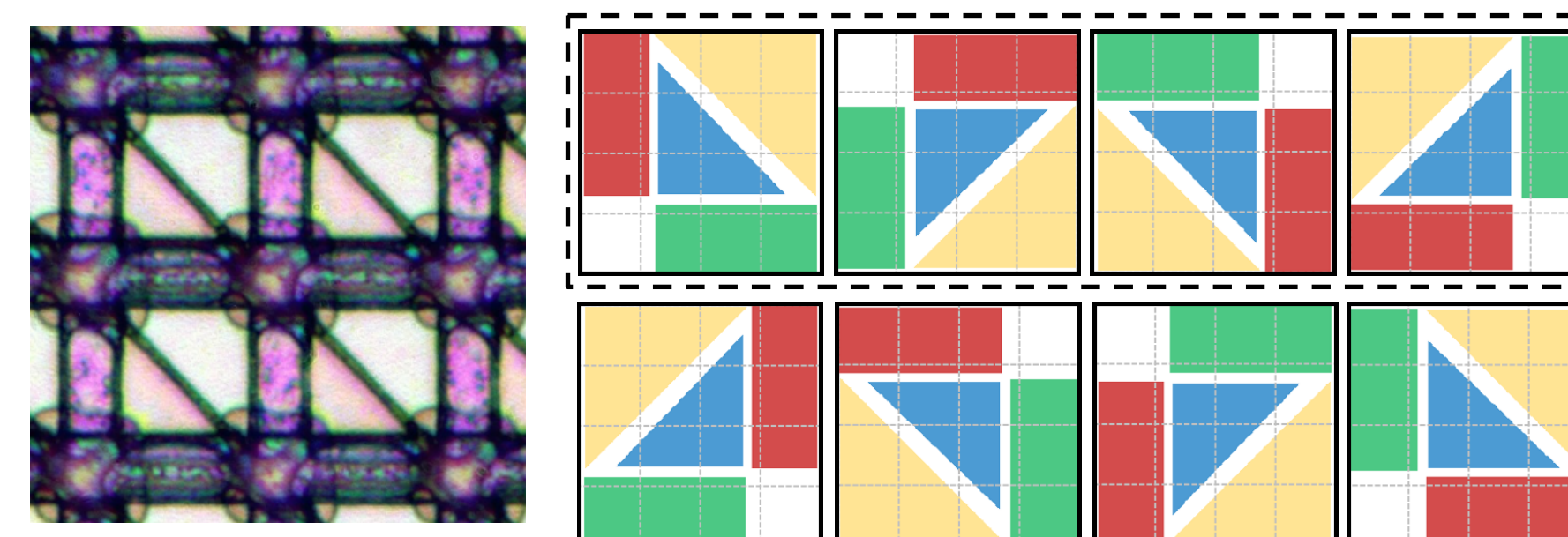


Super-resolution: 1.75

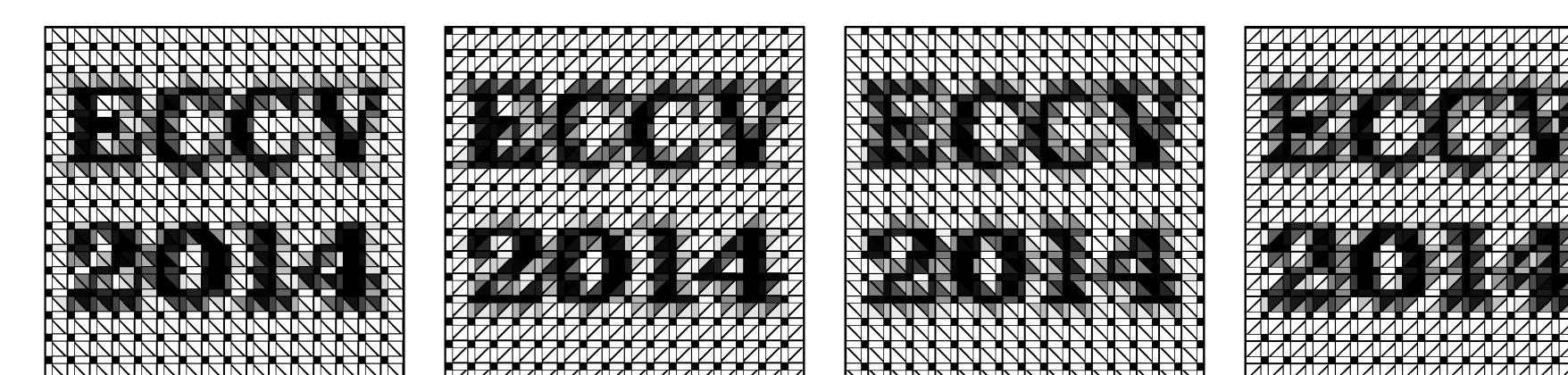


Pixel Geometry Design

OTCCD pixel (with 4 sub-pixels) in the octic group



OTCCD images rotated by 0, 90, 180, 270 degrees



Results

4x (left) and 8x (right) super-resolution

