Depth from Spectral Defocus Blur

TA.PC.7

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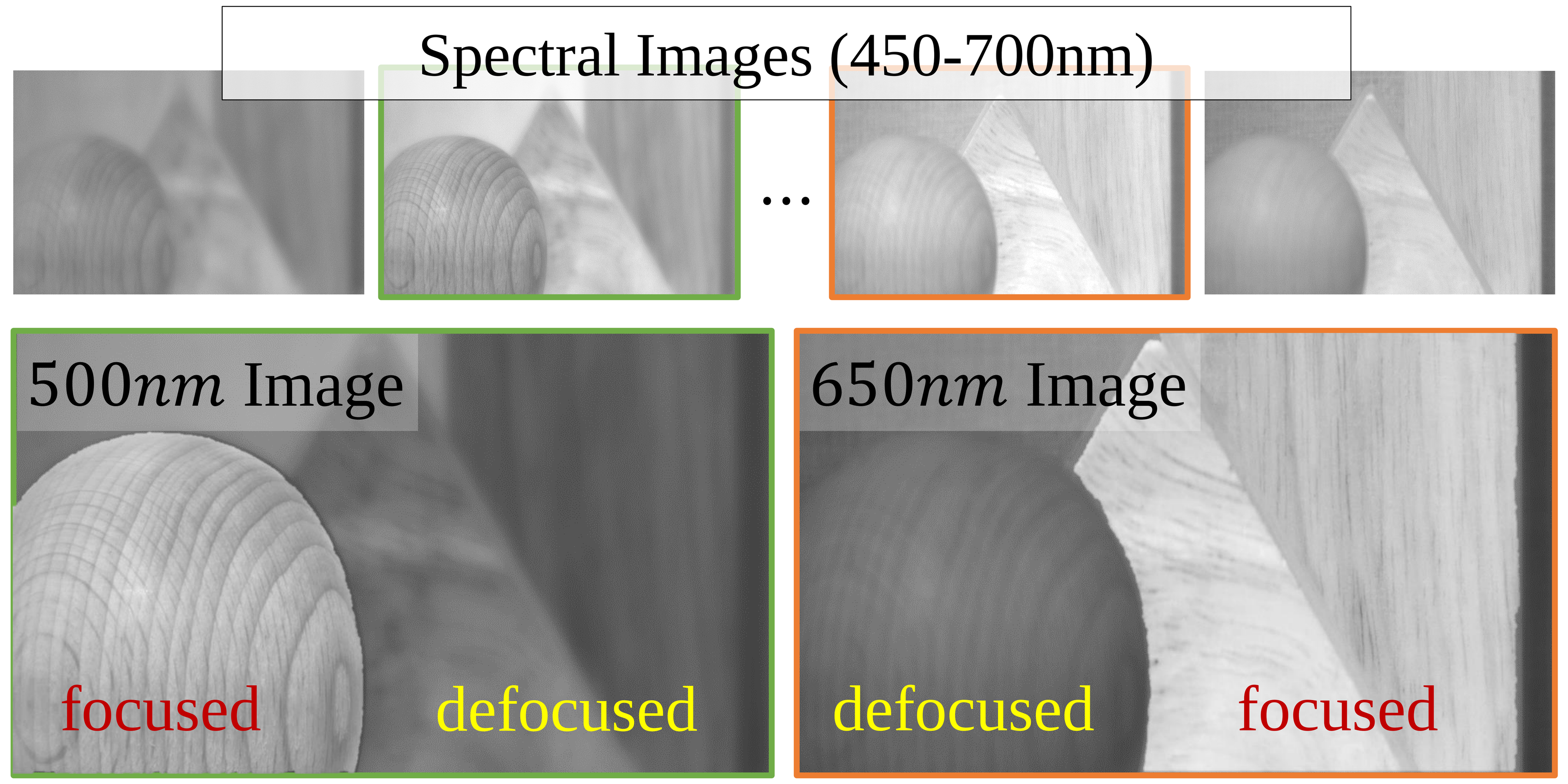
Goal

Our Goal: Simultaneous acquisition of clear multispectral image and scene depth from a blurred single multispectral image



– Different wavelength images have different focal positions

Depth Clues: Conventional depth-dependent blur and wavelength-dependent blur (known as chromatic aberration)

Imaging Model

Captured Image   Gaussian Blur   Texture (Pinhole)

$$I(x,y,\lambda) = k(x,y,\sigma(\lambda)) * P(x,y,\lambda)$$

– Both k and P are dependent on the wavelength λ

Depth

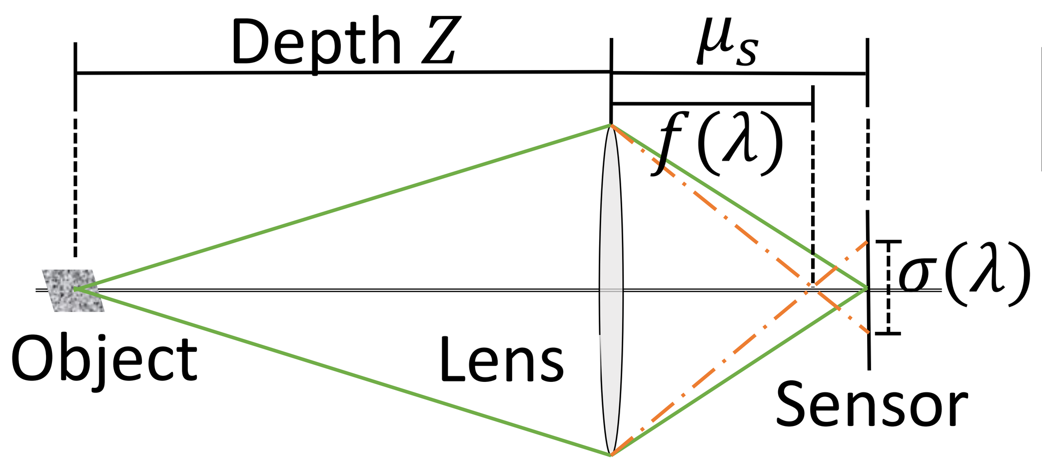
$$Z = \frac{\alpha(\lambda)\Delta I}{\beta(\lambda)\Delta I - \partial_\lambda I}$$

- x, y: spatial coordinates
- σ: variance of Gaussian
- α, β: lens parameters

– Depth Z can be derived by two types of derivative of captured image [1]; one is spatial (ΔI) and the other is spectral ($\partial_\lambda I$)

Method

Theory: Depth Z is actually derived as a closed form by the lens rule and the two types of derivatives of Gaussian blur



$\Delta k \propto \partial_\lambda k$

$$\Delta I = \frac{1}{\gamma^2 \sigma \partial_\lambda \sigma} \partial_\lambda I$$

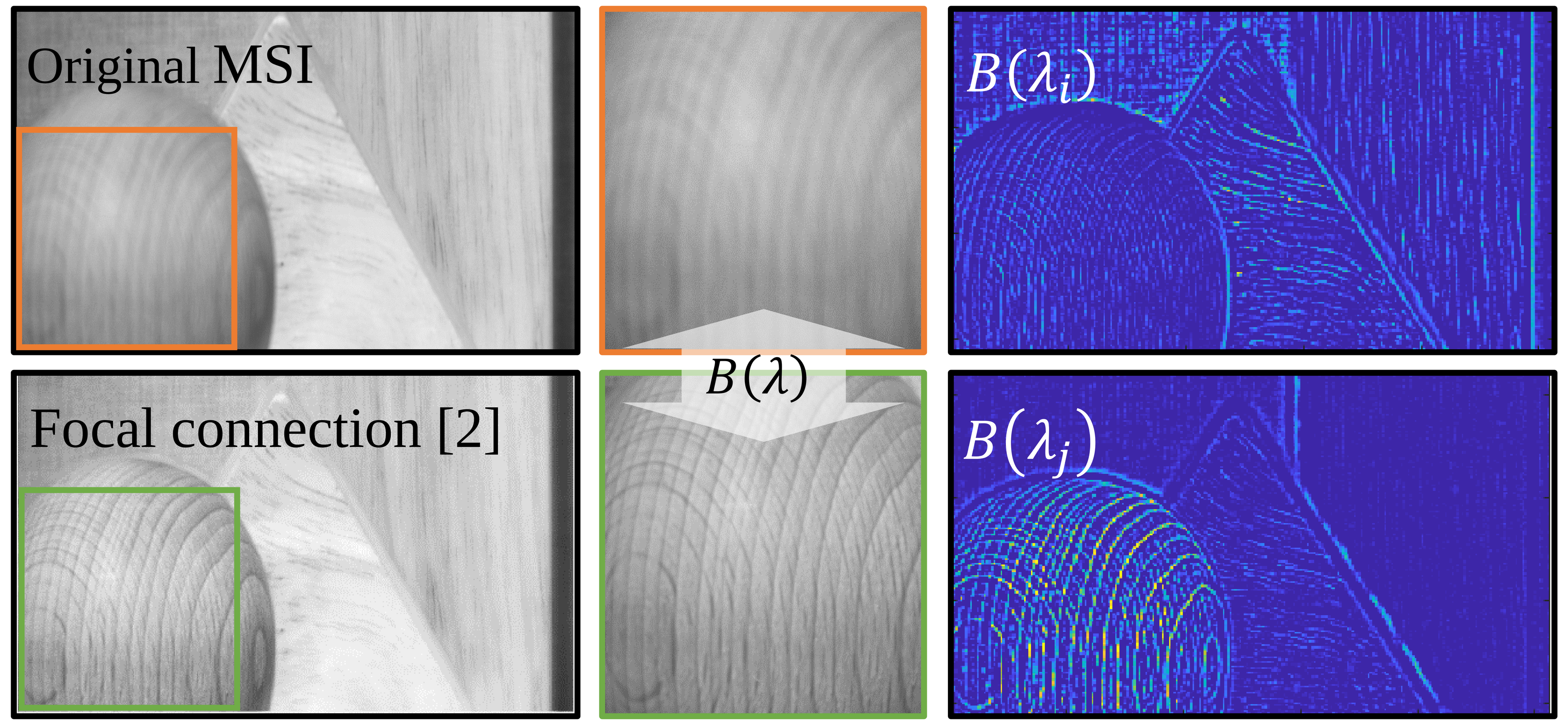
Lens rule

$$\sigma(\lambda) = \left(\frac{1}{Z} - \frac{1}{f(\lambda)}\right)\mu_s + 1$$

- γ: RMS width of Gaussian
- f: focal length of the lens
- μ_s: distance from the lens to the sensor

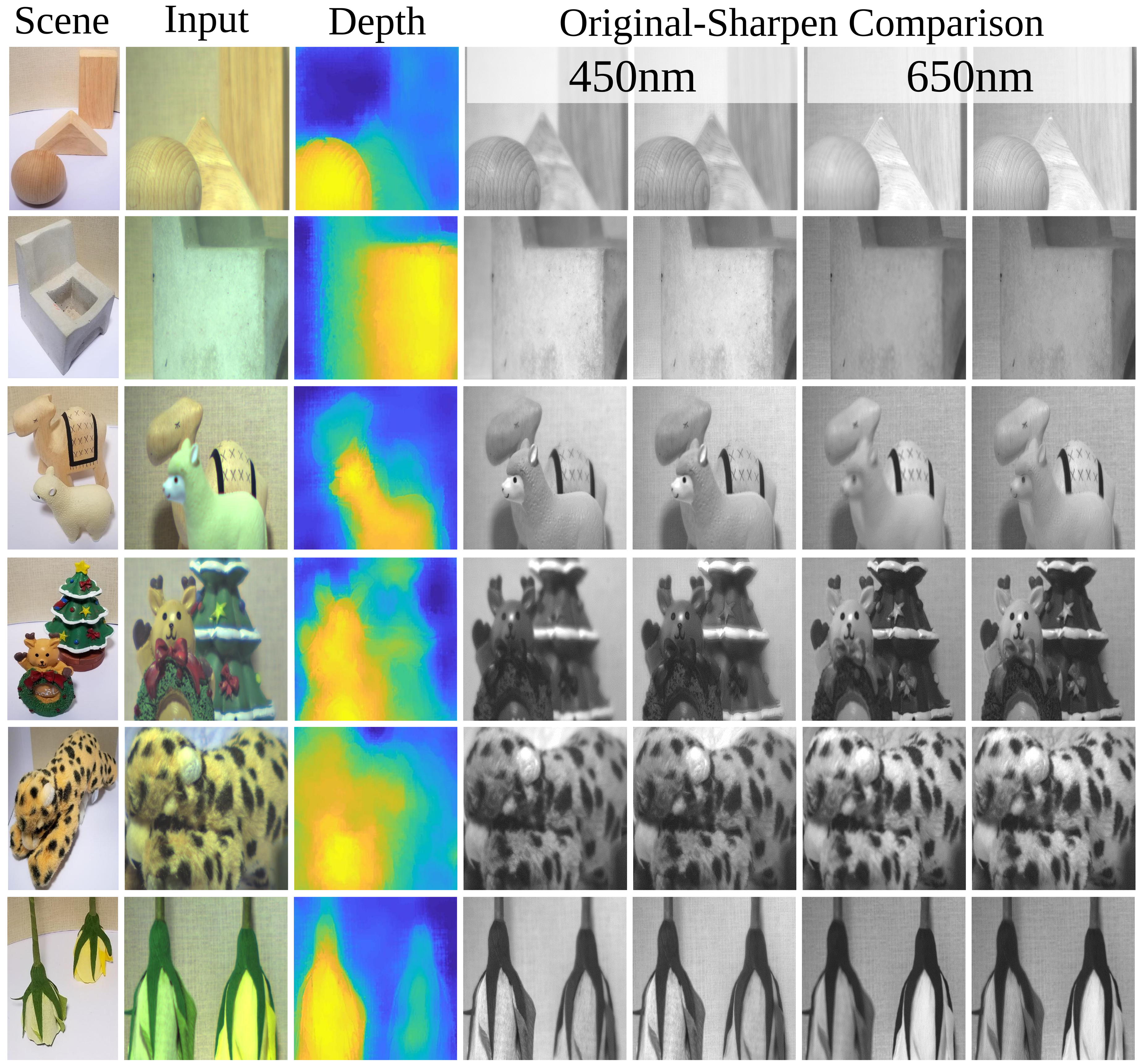
Computation: ΔI is obtained as laplacian filter. $\partial_\lambda I$ is approximated as the change of blurriness $B = I(\lambda) - I_{focused}(\lambda)$.

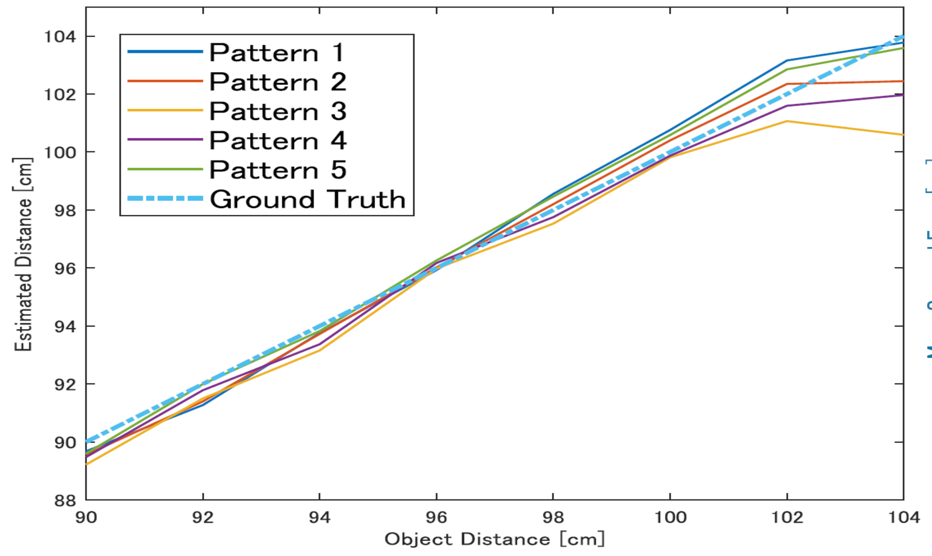
$$\partial_\lambda I = \partial_\lambda k * P = \left(k(\lambda_i) - k(\lambda_j)\right) * P \approx B(\lambda_i) - B(\lambda_j)$$

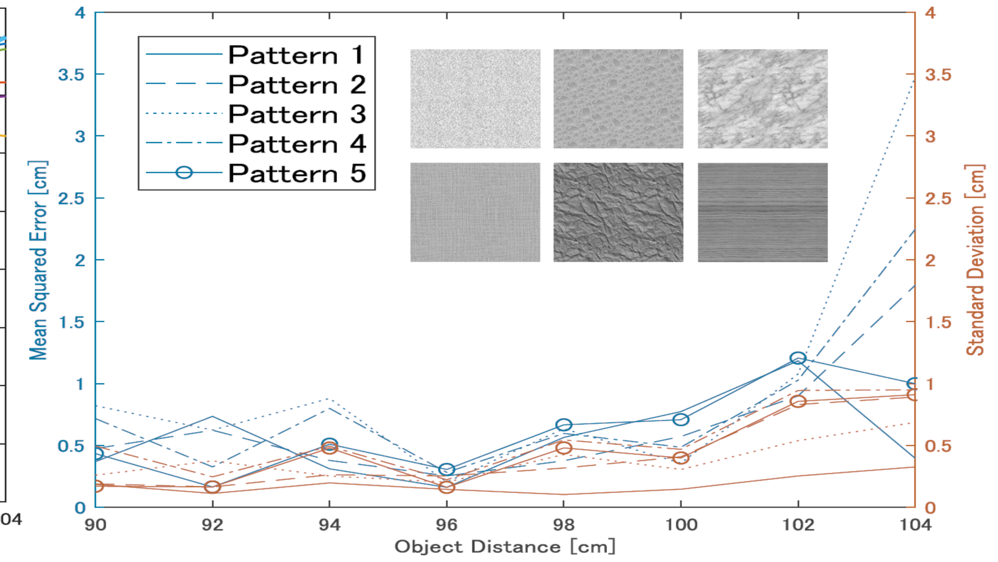


– Focal connected image are also utilized to generate clear multispectral image

Results







Website of our laboratory

[1]: Q.Guo, et al. ICCV'17, pp.966-974

[2]: H.Hariharan, et al. CVPR'07, pp.1-6