Optical imaging and image processing (X)

4.4 Color image processing 4.4 カラー画像処理

4.4.1 Properties of color images カラー

es **カラー画像の性質**

- Monochromatic image, B/W image = 1-dimensional
- \Rightarrow Color image = 3-dimensional
- larger bandwidth in the luminance signal, and smaller bandwidth in the chrominance signal
 - TV signal, Color image compression
- Resemblance in RGB primary component
 - The spectral reflectance of most objects are smooth
- The characteristics of human visual system (HVS)
 - HVS is not sensitive to the blur in the chrominance component
 - but is sensitive to the spatial color variation
 - It is difficult to memorize the color accurately (The memorized color shifts)



Color





2

R

Original

Smoothing only chrominance component



4.4.2 Wiener filtering in color images (Color estimation)

カラー画像におけるウイナーフィルタ(色推定)

Image signal $y = S E f + n = S f_p + n$

Color (tristimulus values) $\mathbf{g} = \mathbf{C} \mathbf{E} \mathbf{f} = \mathbf{C} \mathbf{f}_{\mathbf{a}}$

Estimated Color $\hat{\mathbf{g}} = \mathbf{M} \mathbf{y}$

$$e = E\{ \| \mathbf{g} - \hat{\mathbf{g}} \|^2 \} = E\{ \| \mathbf{g} - \mathbf{M}\mathbf{y} \|^2 \} \longrightarrow \min$$

$$e = E\{tr[(\mathbf{g} - \mathbf{M}\mathbf{y})(\mathbf{g} - \mathbf{M}\mathbf{y})^{t}]\}$$

$$\frac{\partial e}{\partial \mathbf{M}} = 0$$
$$\frac{\partial}{\partial \mathbf{M}} (\mathbf{g} - \mathbf{M}\mathbf{y}) = \frac{\partial}{\partial \mathbf{M}} [\mathbf{CEf} - \mathbf{M}(\mathbf{SEf} + \mathbf{n})] = -(\mathbf{SEf} + \mathbf{n})$$

4.4.3 Color image restoration

カラー画像の復元

- Restoration of R, G, B channels independently
- Restoration of luminance component only
 - Human vision is less sensitive to the high-frequency component of chrominance.
- Image restoration considering inter-channel correlation
 - Chromatic aberration => Different blur in each channel => It is effective to make use of the difference of the transfer functions in the R, G, B components.
- Color image captured by color filter array (demosaicing)
 - Color artifact sometimes appears at the edge of monochromatic object
 - Restoration using the inter-channel correlation