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Image Distortion Model

$\mathbf{I} = \mathbf{J} \circ \mathbf{t} + \mathbf{A} \circ (1 - \mathbf{t})$.
$I^c(\mathbf{x}) = J^c(\mathbf{x})t(\mathbf{x}) + A^c(\mathbf{x})(1 - t(\mathbf{x}))$.

Sharpening

$\mathbf{A} = \text{blur}(\mathbf{I})$. (A is an image)
$\mathbf{t} \in [0, 1]$ (scalar or grayscale image)

$$\mathbf{J} = \frac{\mathbf{I} - \mathbf{A} \circ (1 - \mathbf{t})}{\mathbf{t}}$$
$$= \frac{1}{\mathbf{t}} \circ \mathbf{I} + \mathbf{A} \circ (1 - \frac{1}{\mathbf{t}}).$$

Dark Channel Prior

$\mathbf{A} = (r, g, b)$. (estimate atmospheric light)

$$I^{\text{dark}}(\mathbf{x}) = \min_c \min_{\mathbf{y} \in \Omega_I(\mathbf{x})} I^c(\mathbf{y}).$$

$\hat{\mathbf{t}} = 1 - \mathbf{I}^{\text{dark}}$.
$\mathbf{t} = \text{guidedFilter}(\hat{\mathbf{t}}, \mathbf{I})$.

$$\mathbf{J}(\mathbf{x}) = \frac{\mathbf{I}(\mathbf{x}) - \mathbf{A}}{\max(t(\mathbf{x}), \epsilon)} + \mathbf{A}.$$

$\implies \mathbf{J} = \text{DCP}(\mathbf{I})$

Illumination Correction

$\mathbf{A} = (1, 1, 1)$. (whitebalanced light source)

$$I^{\text{dark}}_{\text{inv}}(\mathbf{x}) = \min_{c} \min_{\mathbf{y} \in \Omega_I(\mathbf{x})} 1 - I^c(\mathbf{y}).$$

$$\hat{t}_{\text{inv}}(\mathbf{x}) = 1 - I^{\text{dark}}_{\text{inv}}(\mathbf{x}).$$

$$\mathbf{t}_{\text{inv}} = \text{guidedFilter}(\hat{\mathbf{t}}_{\text{inv}}, \mathbf{I}).$$

$$\mathbf{J}(\mathbf{x}) = 1 - \left[\frac{1 - \mathbf{I}(\mathbf{x}) - \mathbf{A}}{\max(t(\mathbf{x}), \epsilon)} + \mathbf{A} \right].$$

$$\implies \mathbf{J} = 1 - \text{DCP}(1 - \mathbf{I})$$