Haze removal

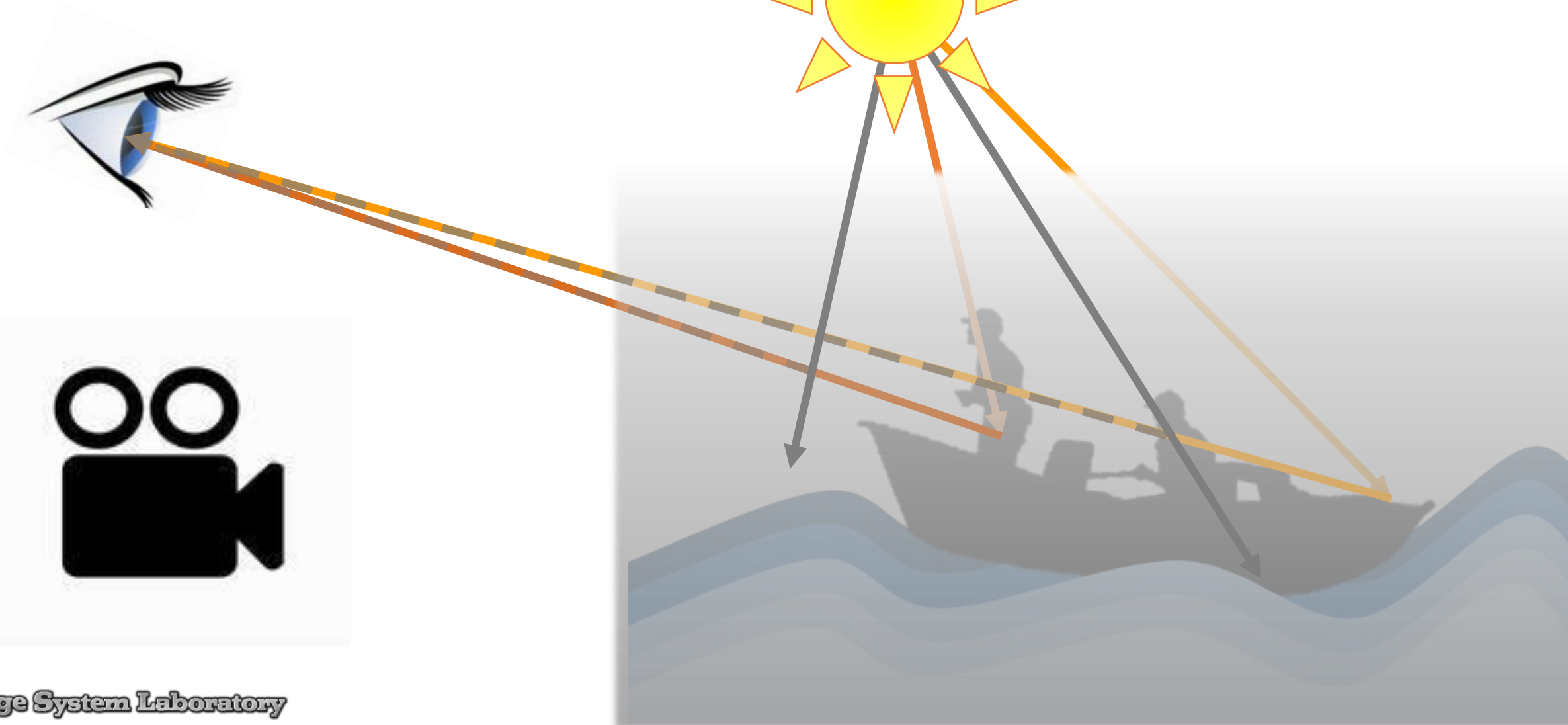
※ He, Kaiming, Jian Sun, and Xiaoou Tang. "Single image haze removal using dark channel prior." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 33.12 (2011): 2341-2353.

안재원

목차

01 Haze

- *Intro*



01 Haze

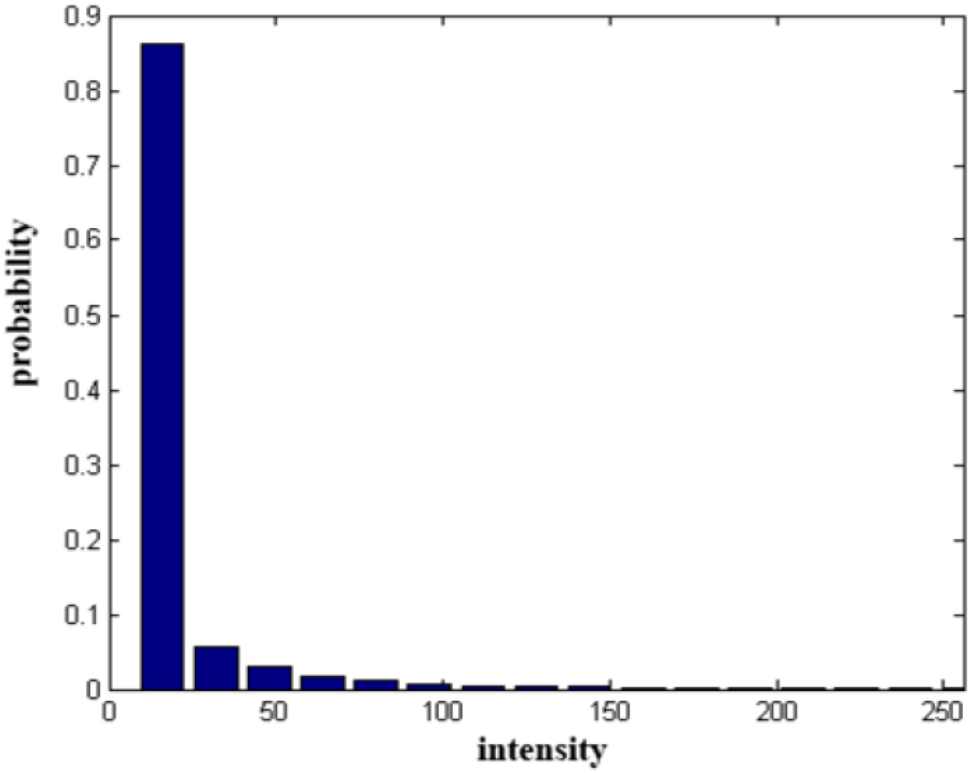
- *Modeling*

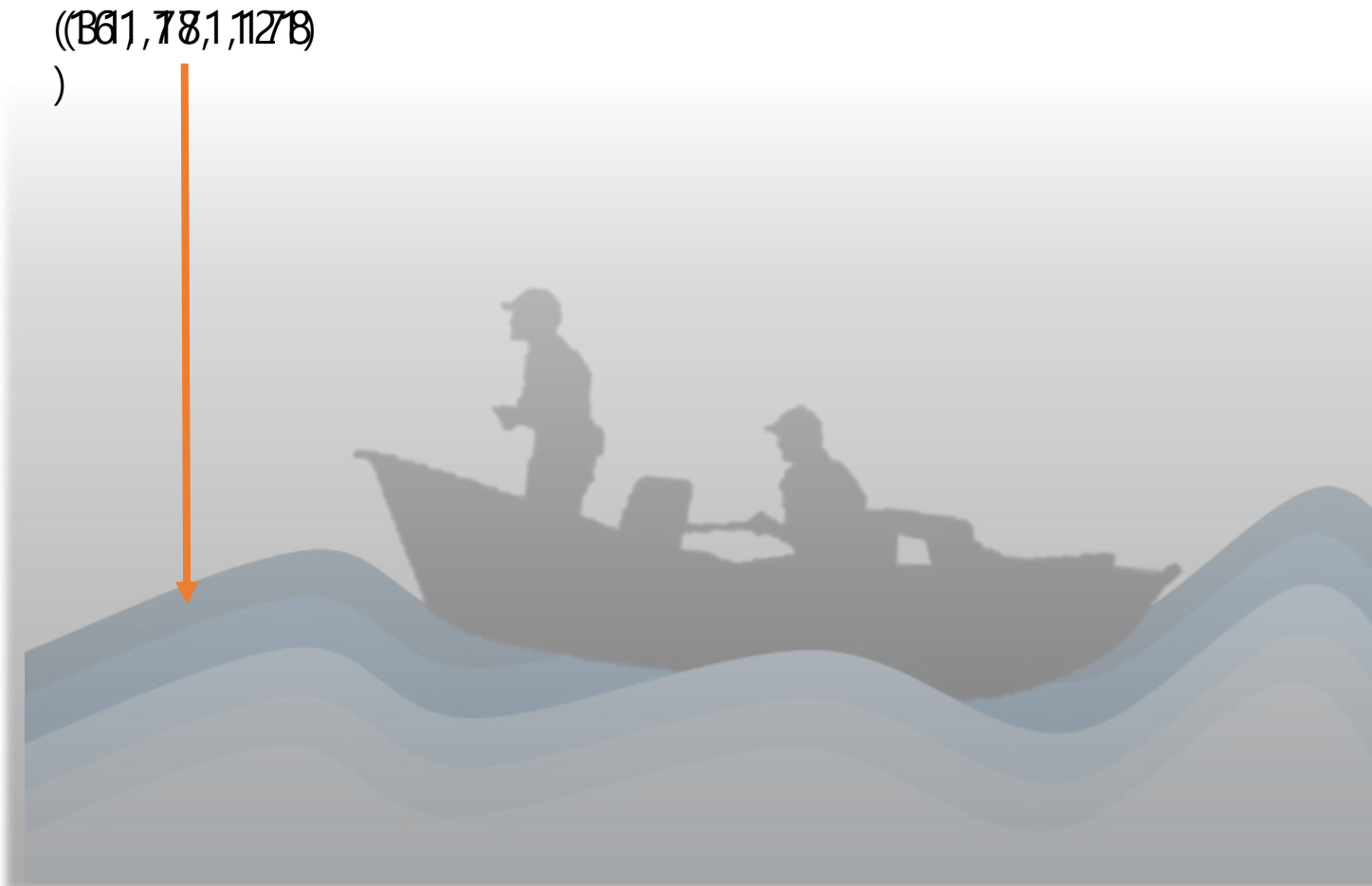
$$I(x) = J(x)t(x) + A(1 - t(x))$$

$$J(x) = \frac{I(x) - A}{t(x)} + A$$

02 Dark channel prior Haze removal

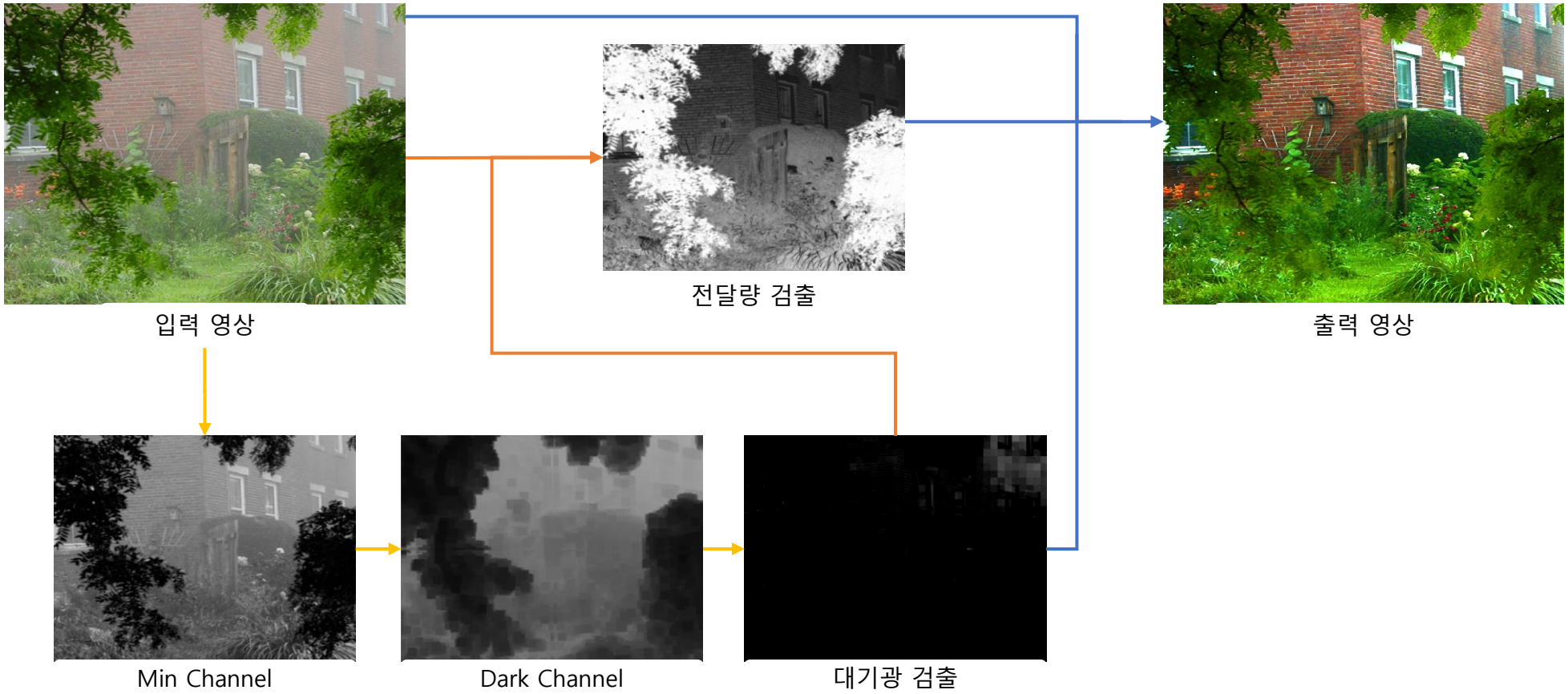
- Intro





02 Dark channel prior Haze removal

- *Flow*



02 Dark channel prior Haze removal

- *Estimate t(x)*

- $I(x) = J(x)t(x) + A(1-t(x))$

$$\min_{y\in\Omega(x)}(I^C(y)) = \hat{t}(x)\min_{y\in\Omega(x)}(J^C(y)) + A^C(1-\hat{t}(x))$$

※ C = RGB Channel
Ω(x) = 일정 영역

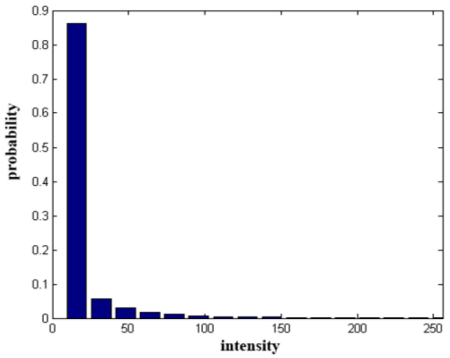
$$\min_C(\min_{y\in\Omega(x)}(\frac{I^C(y)}{A^C})) = \hat{t}(x)\min_C(\min_{y\in\Omega(x)}(\frac{J^C(y)}{A^C})) + (1-\hat{t}(x))$$

$$\min_C(\min_{y\in\Omega(x)}(\frac{I^C(y)}{A^C})) = (1-\hat{t}(x))$$

$$\hat{t}(x) = 1 - \min_C(\min_{y\in\Omega(x)}(\frac{I^C(y)}{A^C}))$$

$$\min_C(\min_{y\in\Omega(x)}(\frac{J^C(y)}{A^C})) \approx 0$$

※ Dark channel prior



- $J(x) = \frac{I(x) - A}{t(x)} + A$

03 Min channel prior Haze removal

- *Intro*

입력 영상

출력 영상

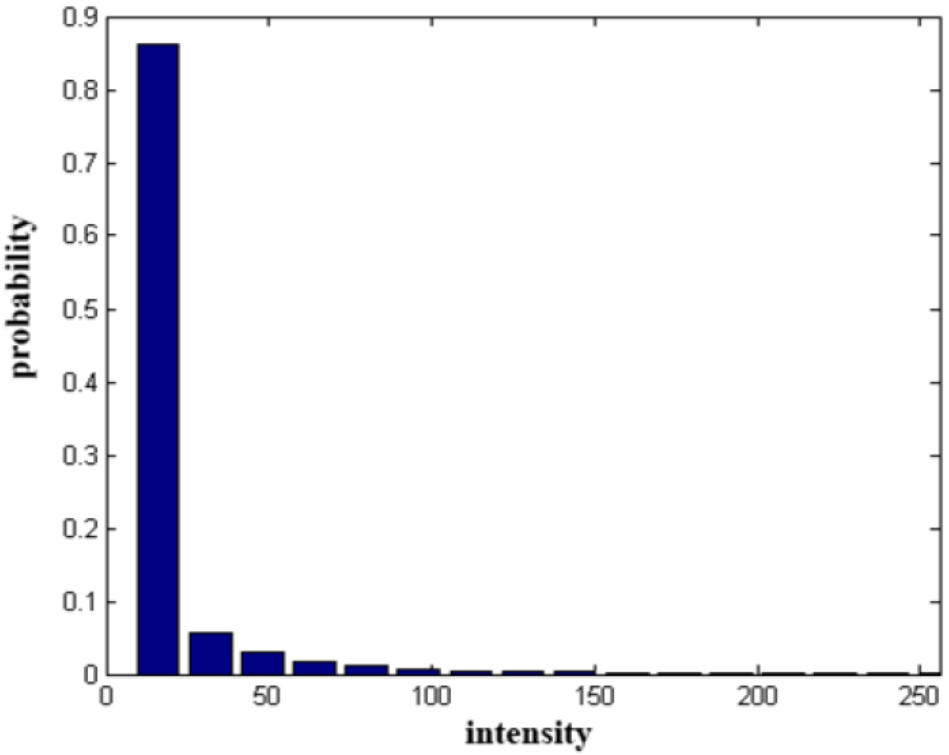
```
//////////Result//////////
Ready                : 0.000000
min channel          : 0.002000
padding              : 0.002000
dark channel         : 0.092000
local entropy        : 0.006000
atmospheric light    : 0.002000
transmission         : 0.013000
recovering           : 0.005000

total                : 0.126000
////////////////////////////
```

프로파일링 결과

$$All\ pixels \times Mask\ size$$

※ Image = 640x480 / Mask size = 17x17 일 때 루프문 88,780,800회 반복



03 Min channel prior Haze removal

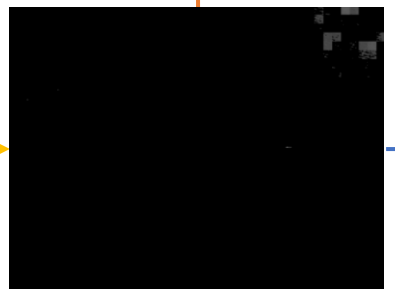
- *Flow*

입력 영상

전달량 검출

출력 영상

Min Channel



대기광 검출

```
//////////Result//////////
Ready                : 0.001000
min channel          : 0.002000
local entropy        : 0.001000
atmospheric light    : 0.002000
transmission         : 0.009000
recovering           : 0.004000


total                : 0.026000
////////////////////////////////
```

프로파일링 결과

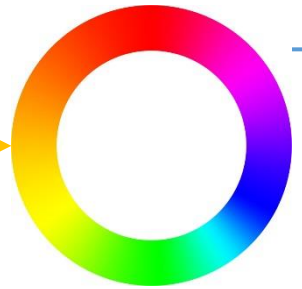
04 HLS color space Haze removal

- Intro

04 HLS color space Haze removal

- *Flow*

입력 영상



Hue

Saturation

전달량 검출

Luminance

Dark Channel

대기광 검출

출력 영상

전달량 검출

04 HLS color space Haze removal

- Calculation

- $S = 1 - \frac{3}{R+G+B} \times \min(R,G,B)$ $\quad R+G+B = X$ $\quad \min(R,G,B) = C$

  ➡ $S = 1 - \frac{3C}{X}$ $\quad (S_J = 1 - \frac{3C_J}{X_J},\ S_I = 1 - \frac{3C_I}{X_I})$

  ※ I = 입력 영상(오염된 영상)
  J = 원본 영상(오염되지 않은 영상)

- $I = Jt + A(1-t)$

  ➡ $R_I = R_J t + A_R(1-t) \quad G_I = G_J t + A_G(1-t) \quad B_I = B_J t + A_B(1-t) \quad C_I = C_J t + A_C(1-t)$

- $A_R = A_G = A_B$

  ➡ $R_I + G_I + B_I = (R_J + G_J + B_J)t + (A_R + A_G + A_B)(1-t)$

  $X_I = X_J t + 3A(1-t)$

04 HLS color space Haze removal

- Calculation

- $S_I = 1 - \frac{3}{X_I} C_I$

$$S_I = 1 - \frac{3C_I}{X_J t + 3A(1-t)}$$

$$X_I = X_J t + 3A(1-t)$$

$$X_J = \frac{3C_J}{1-S_J}$$

$$S_I = 1 - \frac{3C_I}{\frac{3C_J}{1-S_J} t + 3A(1-t)}$$

$$1 - S_I = \frac{C_I(1-S_J)}{C_J t + A(1-t)(1-S_J)}$$

$$C_J t = C_I - A(1-t)$$

$$1 - S_I = \frac{C_I(1-S_J)}{C_I - A(1-t) + A(1-t)(1-S_J)}$$

$$1 - S_I = \frac{C_I(1-S_J)}{C_I - A(1-t)S_J}$$

$$\Rightarrow S_J = \frac{S_I C_I}{C_I + A(1-t)(S_I - 1)}$$

04 HLS color space Haze removal

- *Estimate t(x)*

- $C_I = C_J t + A(1-t)$

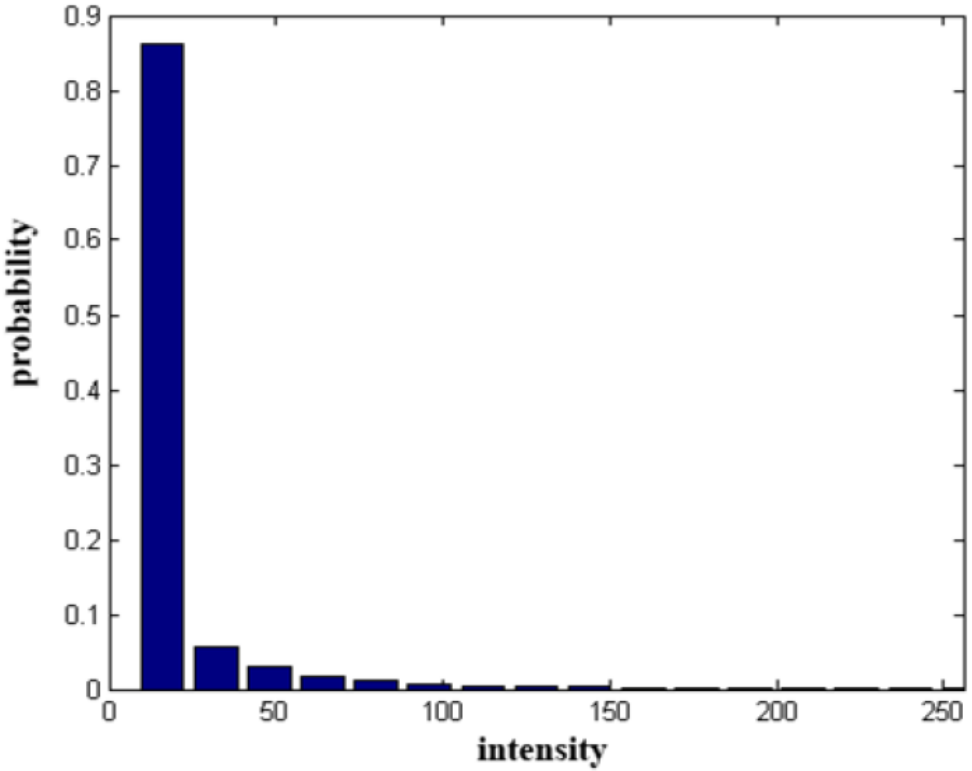
  $\Rightarrow \quad C_I = A(1-t)$ ← $C_J \approx 0$

- $S_I = 1 - \frac{3}{X_I} C_I$

  $\Rightarrow \quad X_I S_I - X_I = -3C_I$

  $X_I S_I - X_I = -3A(1-t)$

- $t = 1 - \frac{X_I (1-S_I)}{3A}$



05 Results


input image
Dark result
fast result
HLS result
input image
Dark result
fast result
HLS result

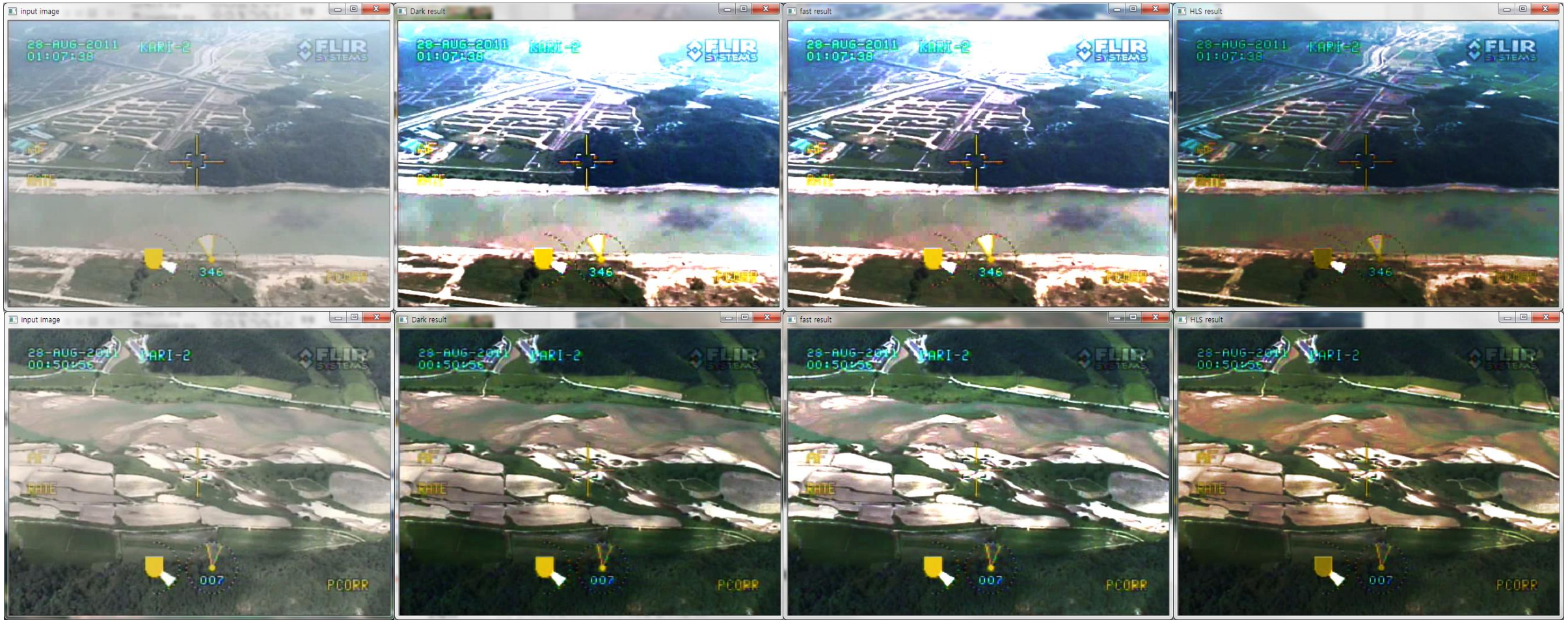
05 Results


input image
Dark result
fast result
HLS result
input image
Dark result
fast result
HLS result

05 Results


input image
Dark result
fast result
HLS result
FLIR SYSTEMS
AF
RATE
345
356
PCORR
RCORR
28-AUG-2011
01:29:00
KARI-2

05 Results


input image
Dark result
fast result
HLS result
28-AUG-2011
01:07:38
KARI-2
FLIR SYSTEMS
346
28-AUG-2011
00:50:56
007
PCORR

감사합니다

Q & A