

Rain removal using Kalman Filter in video

※ Park, Wan-Joo, and Kwae-Hi Lee. "Rain removal using Kalman filter in video." *Smart Manufacturing Application, 2008. ICSMA 2008. International Conference on*. IEEE, 2008.

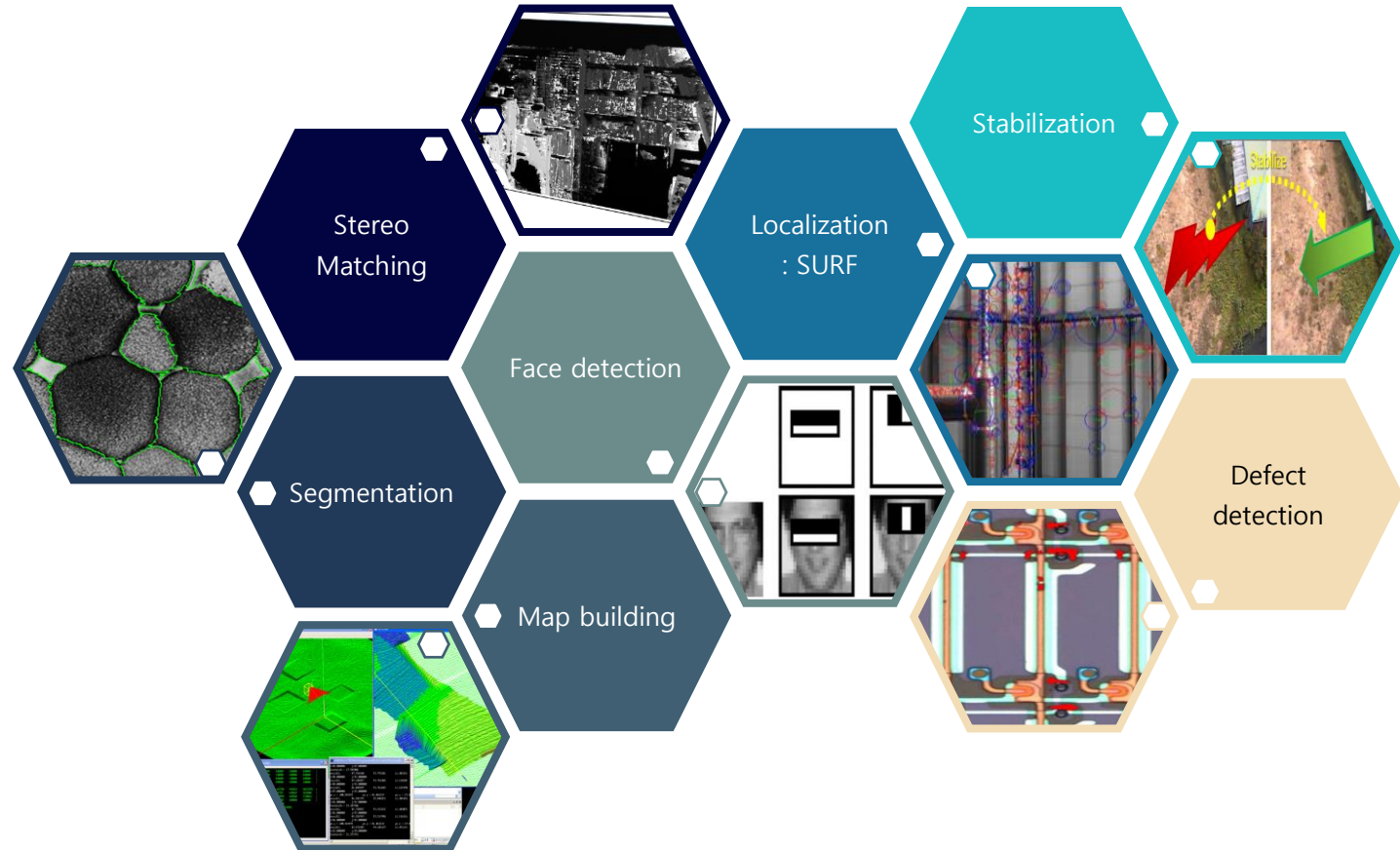
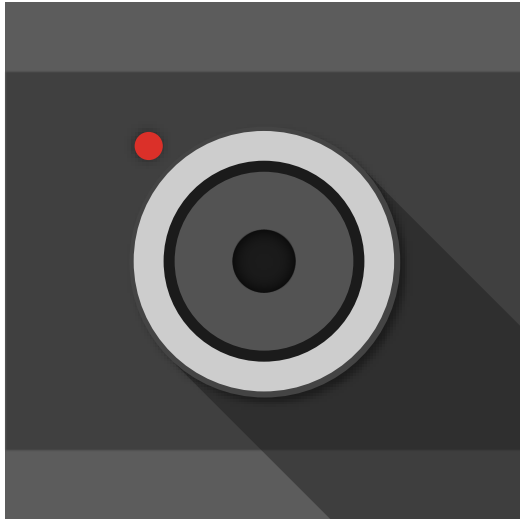
ISL

안재원

- Vision system & Outdoor environment
- Properties of rain
- Kalman filter
- Intensity estimation using Kalman Filter
- Experimental result
- Further work

Vision system & Outdoor environment

- Vision system



Vision system & Outdoor environment

- Indoor

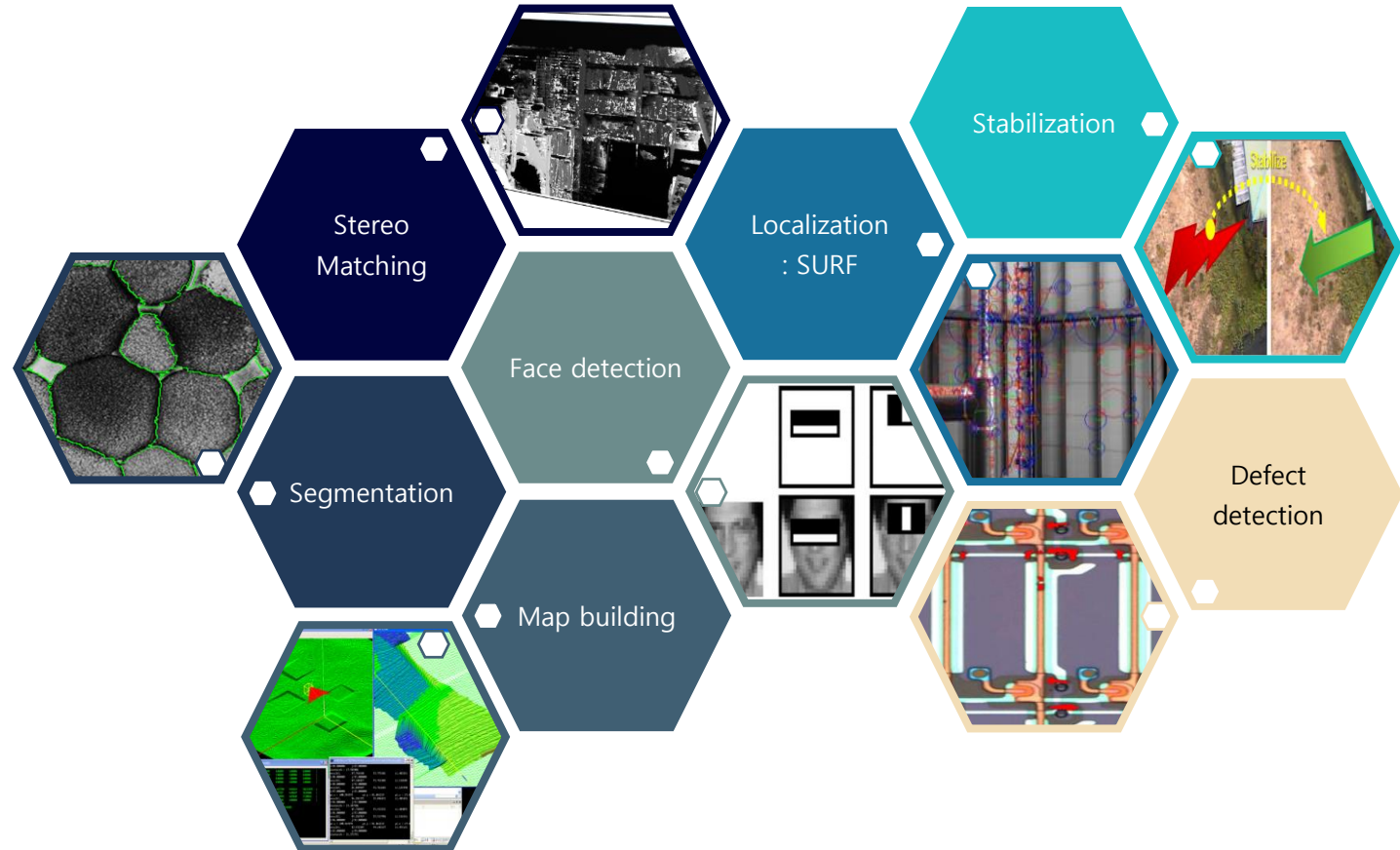
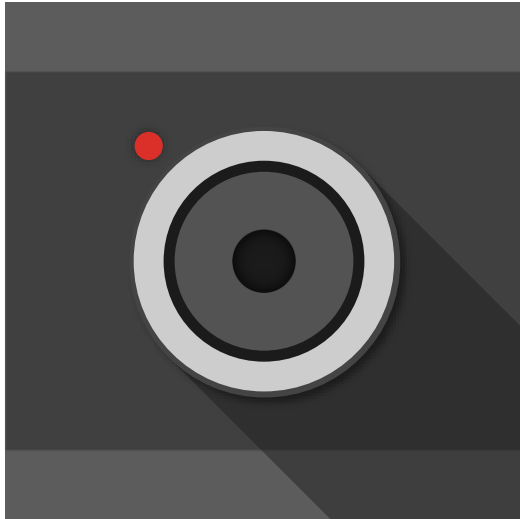


<Artificial Illumination>

<Ideal Environment>

Vision system & Outdoor environment

- Outdoor



01

Vision system & Outdoor environment

- Outdoor



Bad Information



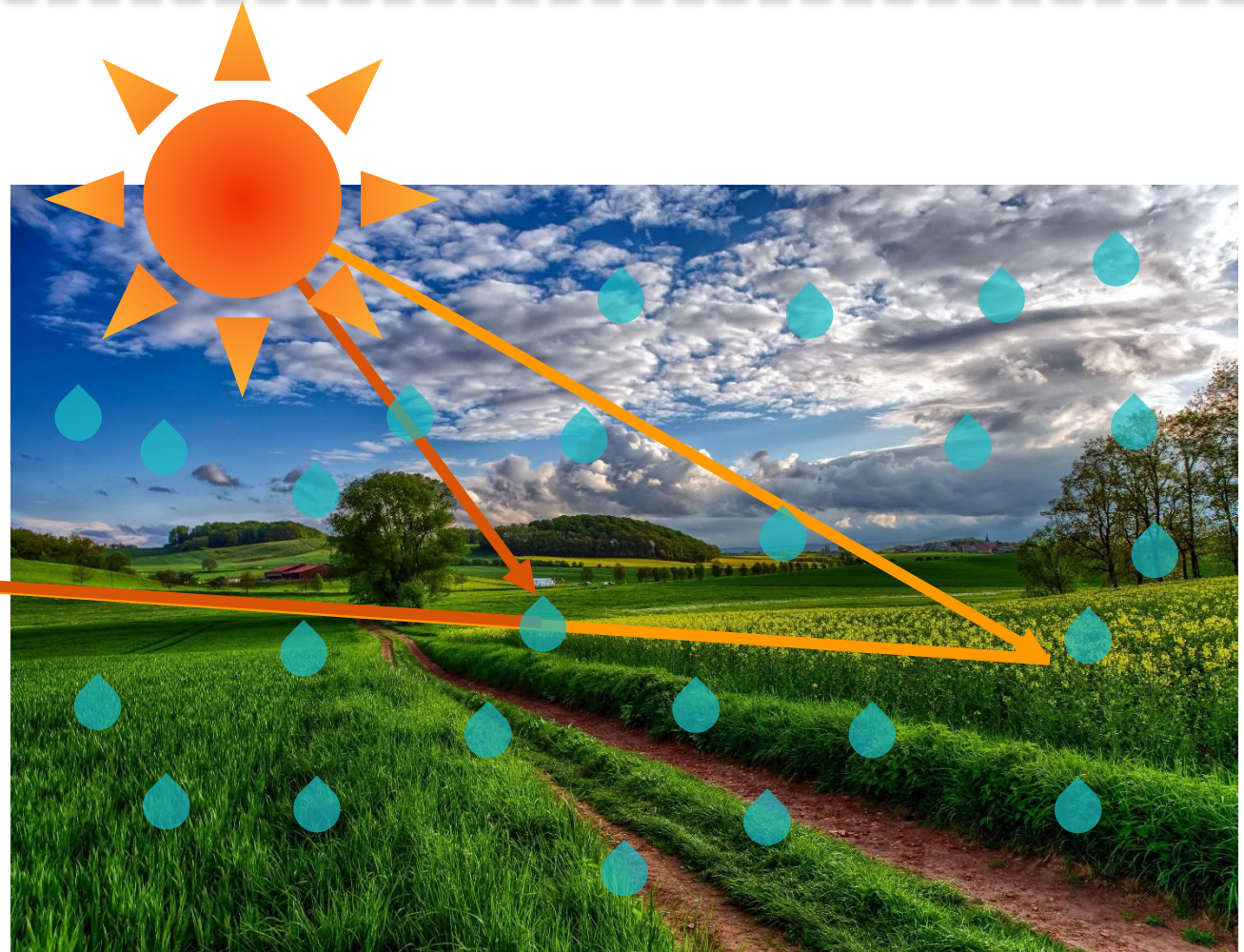
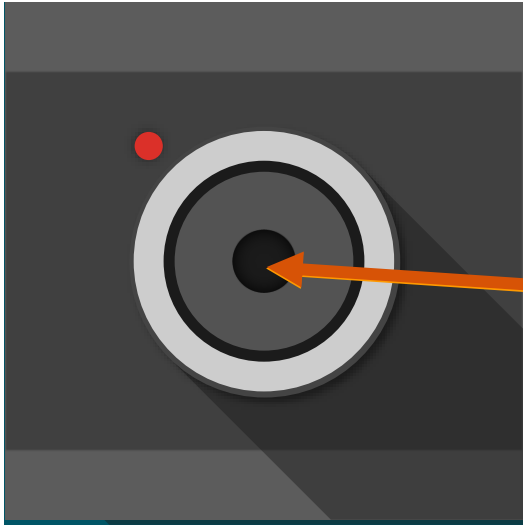
<Heavy noise>



<Real world environment>

Properties of rain

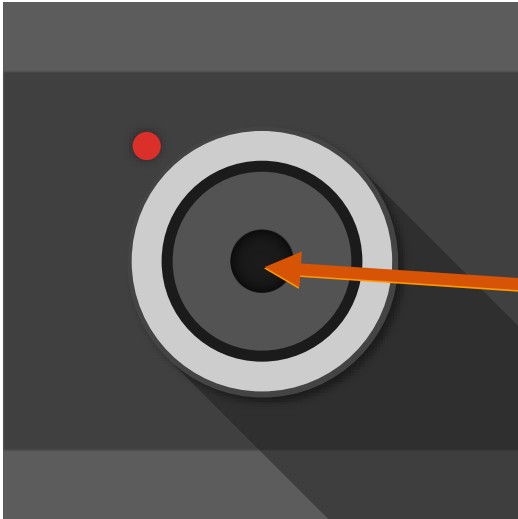
- *Temporal property of rain*



Properties of rain

02

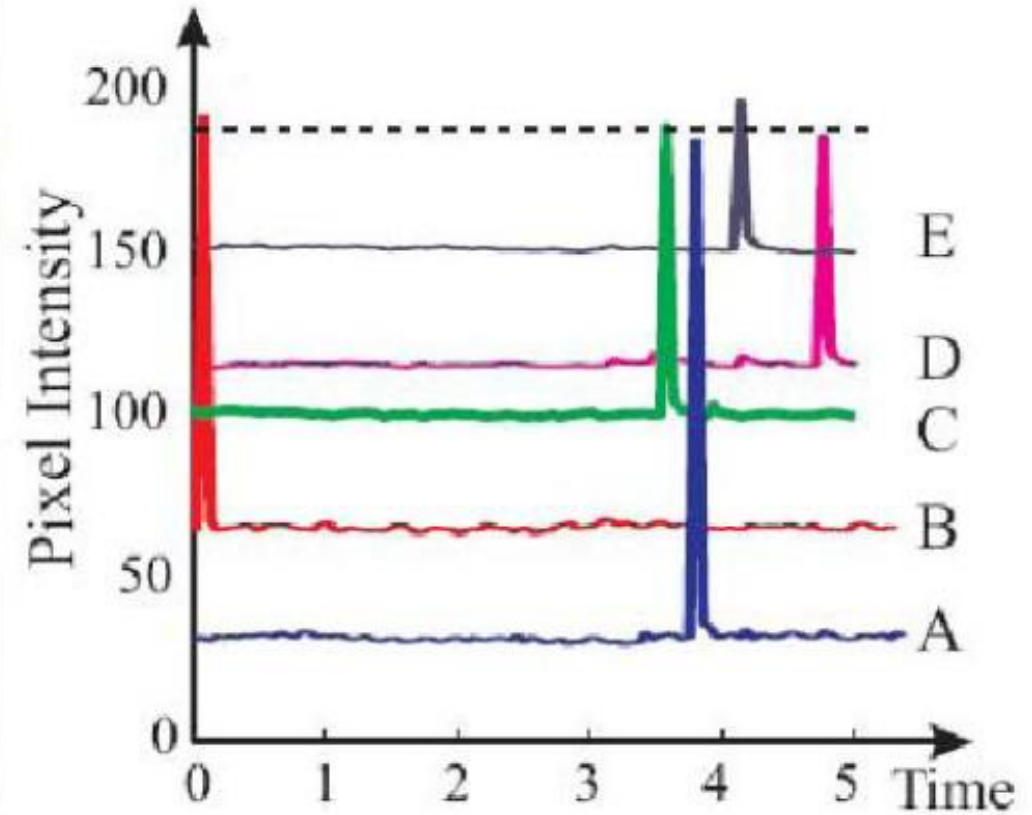
- Temporal property of rain



<Video>

Properties of rain

- Temporal property of rain



Kalman Filter

- Intro

※ Kalman, Rudolph Emil. "A new approach to linear filtering and prediction problems." *Journal of Fluids Engineering* 82.1 (1960): 35-45.

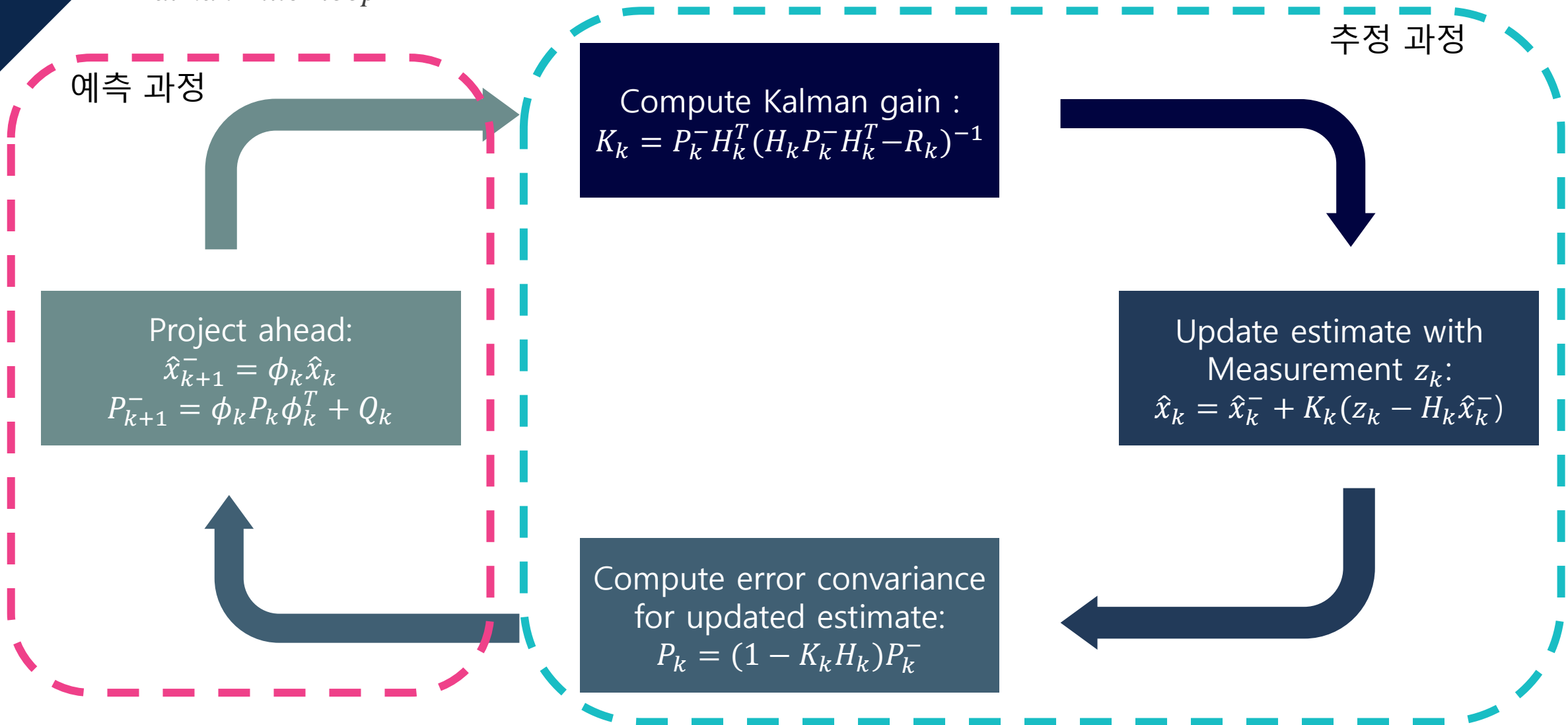
- 예측과정
 - 시스템 모델을 이용해 다음 상태와 공분산을 예측
- 추정과정
 - 측정값과 예측값의 차이를 이용해서 새로운 추정값을 계산.
- 1차 저주파 통과 필터 : $\bar{x}_k = (1 - K)\bar{x}_{k-1} + Kx_k$
- 칼만 필터 : $\hat{x}_k = (I - K)\hat{x}_k^- + K_k z_k$



03

Kalman Filter

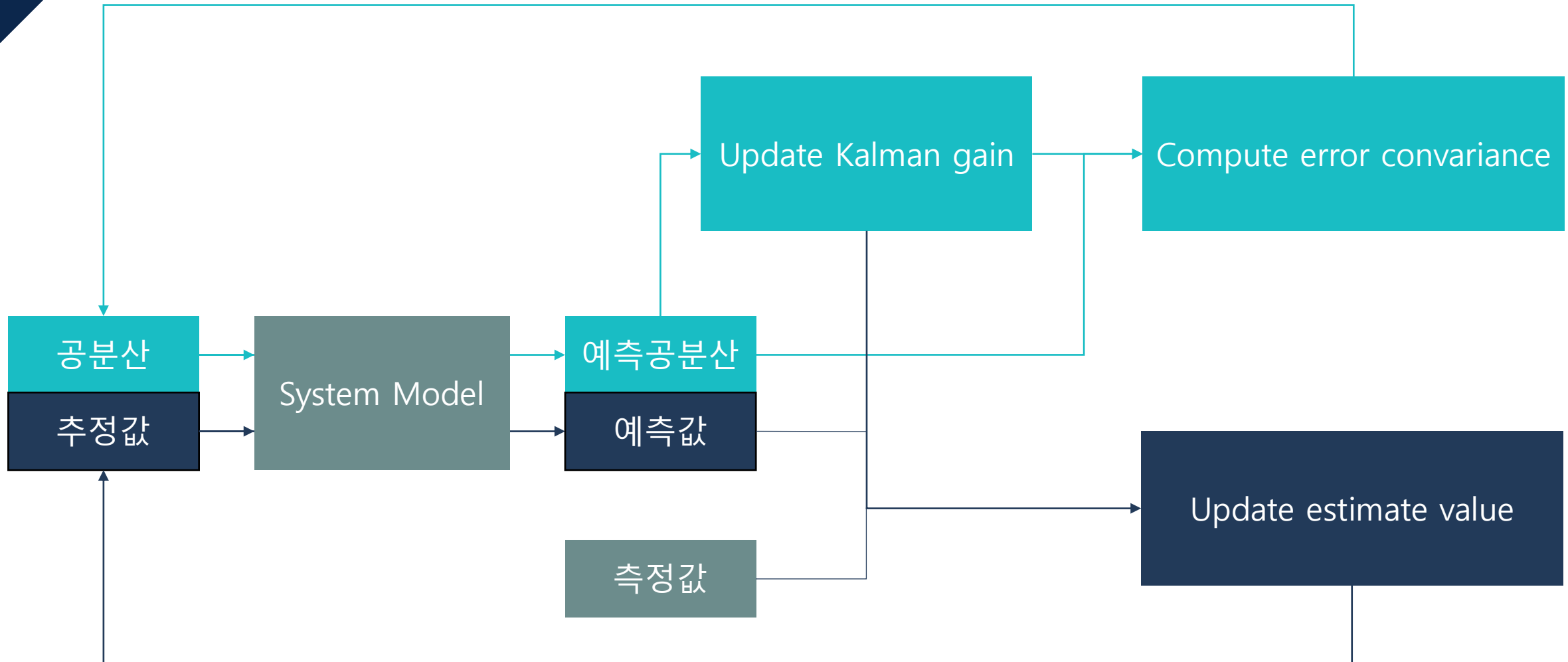
- Kalman Filter loop



03

Kalman Filter

- Kalman Filter diagram



Intensity estimation using Kalman Filter

- Discrete time Kalman Filter equations

- *Intensity model*

$$x_{k+1} = \Phi_k x_k + w_k$$

$$\Phi_k = 1$$

- *Measurement model*

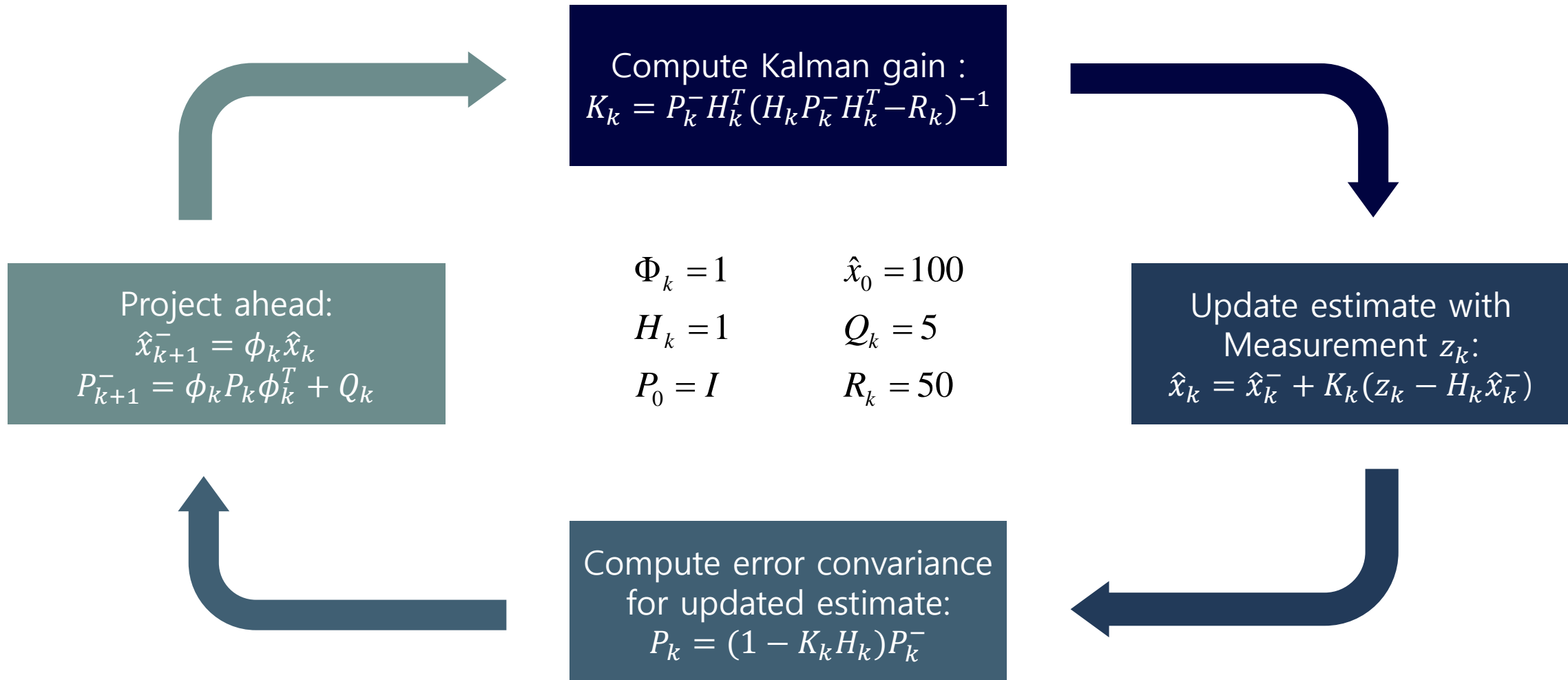
$$z_k = H_k x_k + v_k$$

$$H_k = 1$$



Intensity estimation using Kalman Filter

- Discrete time Kalman Filter equations



Experimental Result

- Result 2



(a) Original scene



(b) Proposed method



(a) Original scene



(b) Proposed method



(c) Zhang's method



(d) Nayar's method



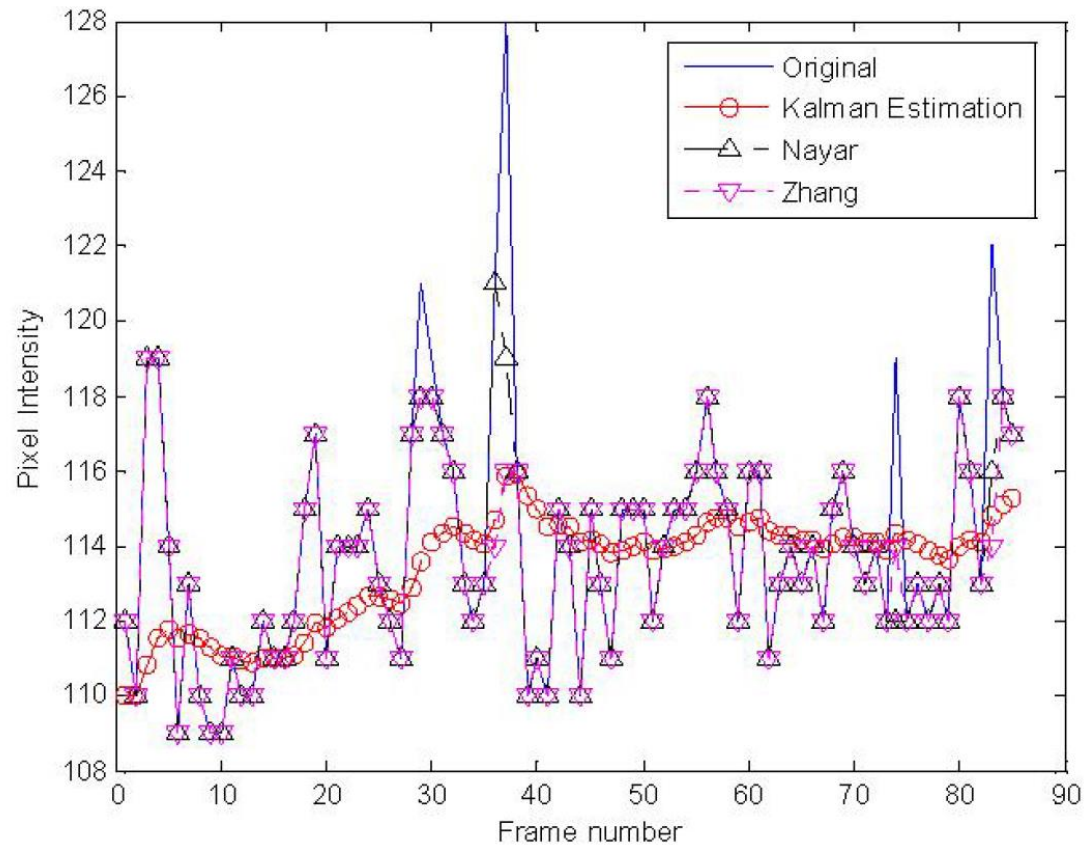
(c) Zhang's method



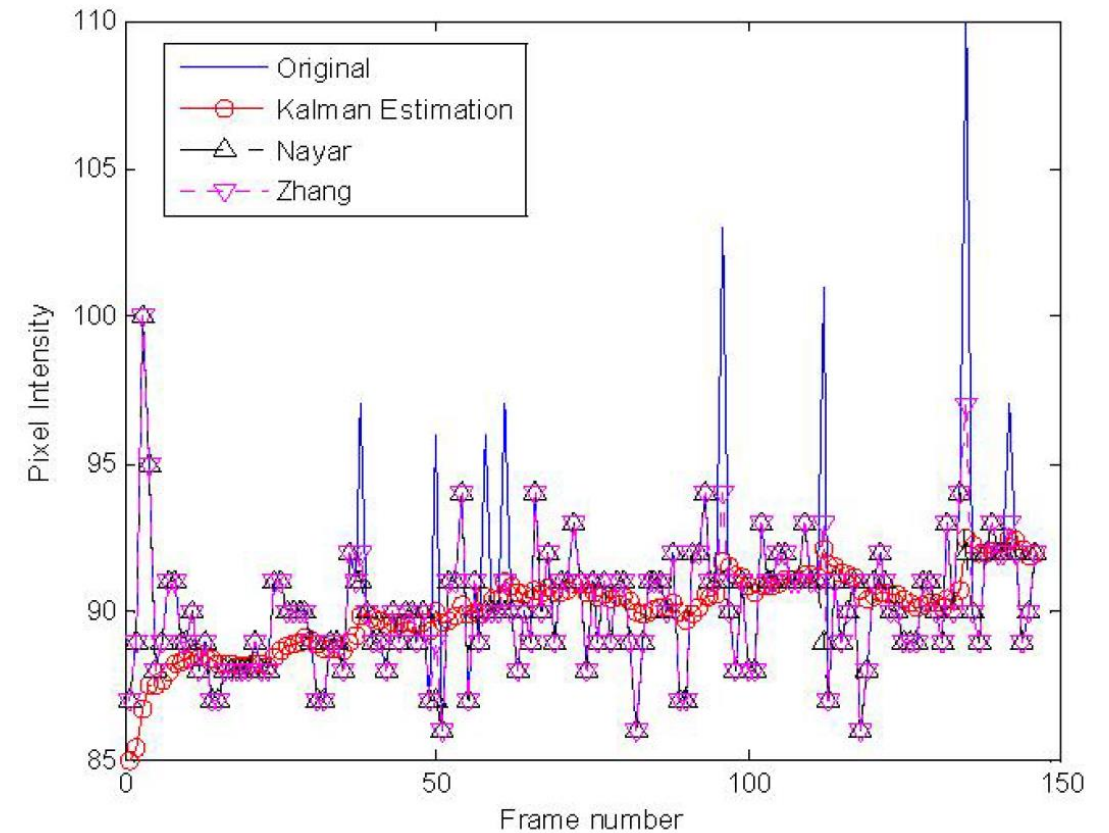
(d) Nayar's method

Experimental Result

- Result 1



<n Frame's random point>



<Other experiment>

Further work

- Apply the scenes taken by a moving camera.
 - With Motion estimation & Video stabilization.
- For various environments, We expect that Extended Kalman Filter is more robust and will develop suitable algorithm.

Q & A
