Algorithm for LWIR Thermal Imaging Camera with Minimal Mechanical Shutter Utilization

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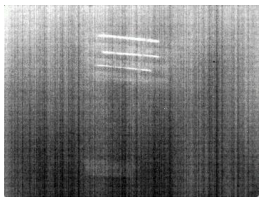
Motivation

- Uncooled LWIR (Long-Wave InfraRed) thermal imaging cameras are characterized by non-uniformity. Because infrared detectors exhibit non-linear characteristics depending on the environmental temperature. In this paper, we propose a method to smoothly transition between a method of correcting non-uniformity using a shutter one time when the thermal imaging camera is not stable at the start-up, and a method of correcting non-uniformity by performing conventional NUC (Non-Uniformity Correction) when thermal image camera is stabilized.
- The conventional method closes the shutter multiple times to correct non-uniformity, which obscures information necessary for driving. In contrast, the proposed method closes the shutter only one time during initial start-up to correct non-uniformity, which does not obscure information necessary for driving.

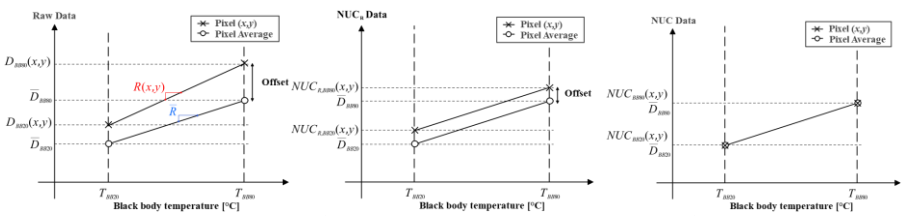


(a) without NUC

(b) with NUC

Proposed Method

- **Correction Method B for Steady-State** [1]



$$NUC_R(x,y) = G(x,y) \times D(x,y)$$

$$G(x,y) = \frac{\overline{R}}{R(x,y)}$$

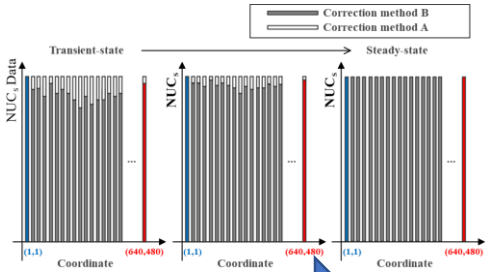
- $\overline{R}$: responsivity of pixel average
- $R(x,y)$: responsivity of pixel at the (x,y)

$$NUC(x,y) = G(x,y) \times D(x,y) + O(x,y)$$

$$O(x,y) = \overline{D_{BB20}} - G(x,y) \times D_{BB20}(x,y)$$

- $\overline{D_{BB20}}$: average raw data of all pixels
- $D_{BB20}(x,y)$: raw data of pixel at the (x,y)

- **Correction Method A for Transient-State**



$$NUC_S(x,y) = NUC(x,y) + f(t) \times O_S(x,y)$$

$$O_S(x,y) = \overline{D_S} - G(x,y) \times D_S(x,y) - O(x,y)$$

- $f(t)$: time-varying function
- $\overline{D_S}$: average raw data of all pixels collected from shutter
- $D_S(x,y)$: average raw data of pixel at the (x,y) collected from shutter

Experimental Results

(a) t = 0 minute

(b) t = 5 minute

Uncooled LWIR thermal imaging camera test images with correction method A and B

(a) t = 0 minute

(b) t = 5 minute

Uncooled LWIR thermal imaging camera test images with only correction method B

References

[1] Jing Hu, Zhenzhen Xu and Qinqin Wan, "Non-uniformity correction of infrared focal plane array in point target surveillance systems," *Infrared Physics & Technology*, vol. 66, 2014, pp. 56-69