Image enhancement based on selective-retinex fusion algorithm *

ISL Lab Seminar
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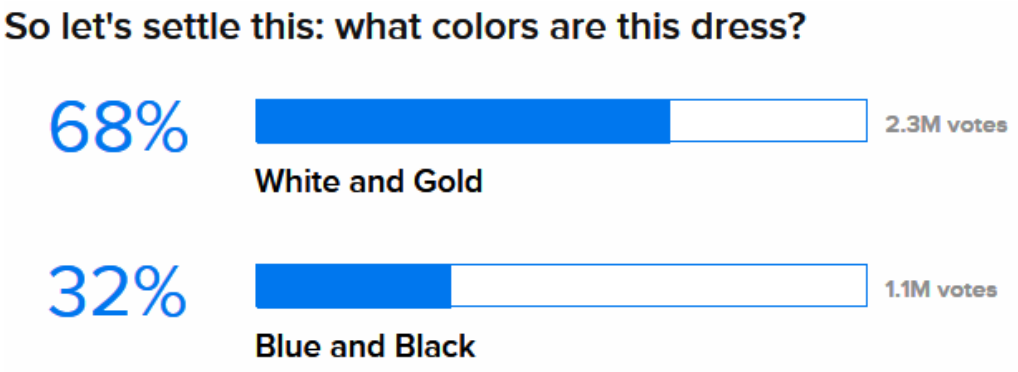
*Jin, Xuebo, Jia Bao, and Jingjing Du. "Image enhancement based on selective-retinex fusion algorithm." Journal of Software 7.6 (2012): 1187-1194.

INDEX

01 Retinex Theory*

☆ What colors are this dress?



➡ But actually the answer is **Blue and Black!!!**

We can explain this problem using **Retinex theory.**

** Land, Edwin H., and John McCann. "Lightness and retinex theory." JOSA 61.1 (1971): 1-11.*

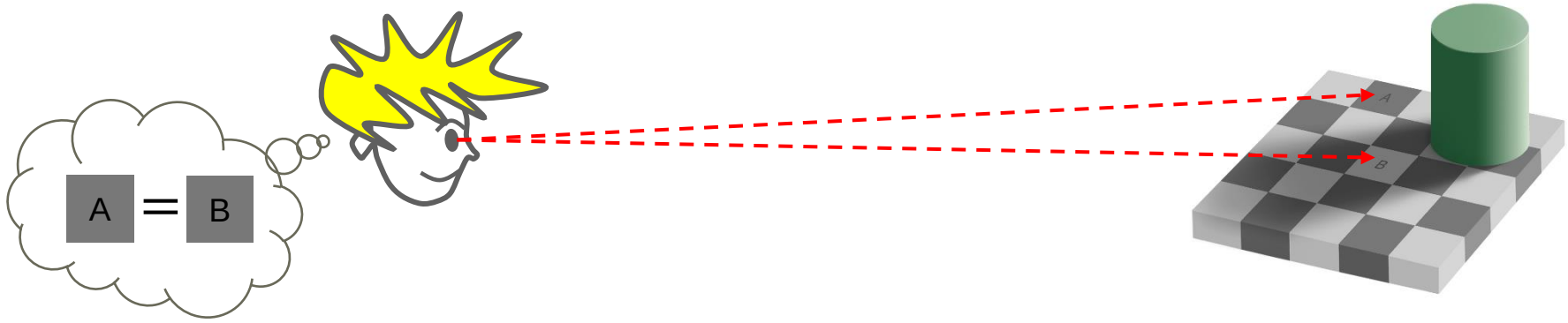
01 Retinex Theory*

☆ What's the meaning of Retinex Theory.

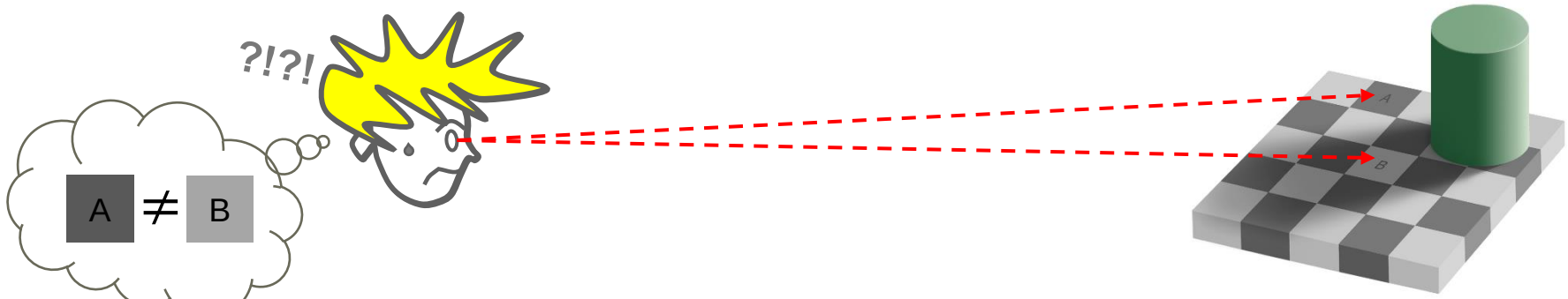
Retinex = Retina + Cortex

Both the eye and the brain are involved in the Image processing.

If we just use the eye,



But actually we use both the eye and the brain



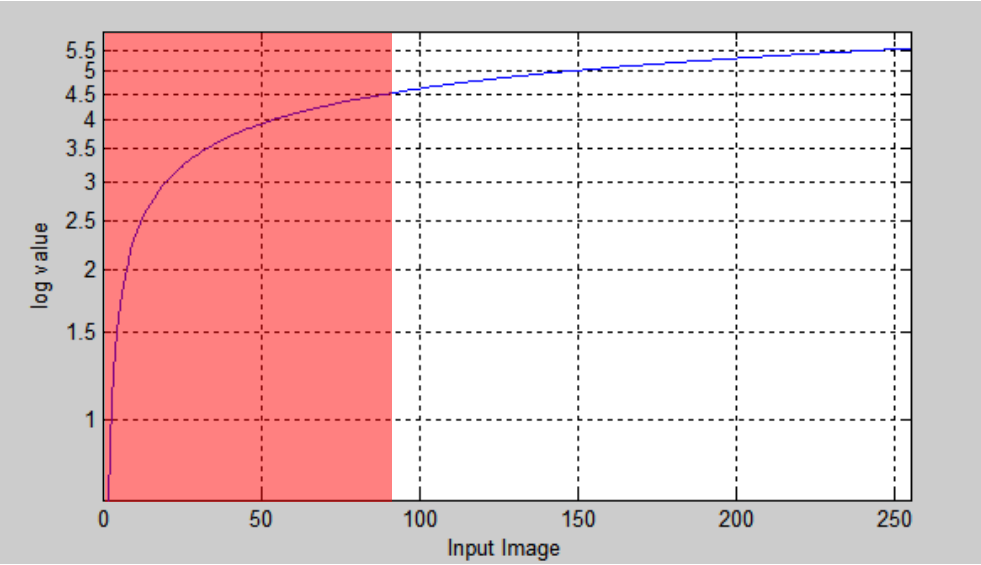
** Land, Edwin H., and John McCann. "Lightness and retinex theory." JOSA 61.1 (1971): 1-11.*

02 Single-Scale Retinex (SSR) & Multiple-Scale Retinex (MSR)

☆ SSR

$$I(x,y) = L(x,y)R(x,y)$$

We can use the log function.



$$\log(I(x,y)) = \log(L(x,y)R(x,y))$$

$$\log R(x,y) = \log I(x,y) - \log L(x,y)$$

$$\log R(x,y) = \log I(x,y) - \log(G(x,y) * I(x,y))$$

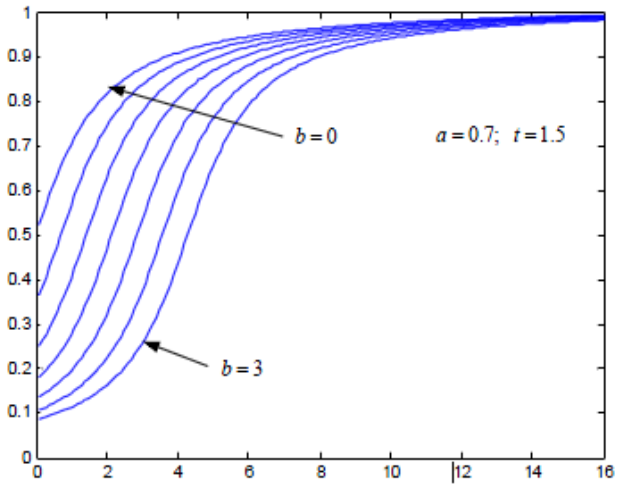
☆ MSR

$$R_{msr}(x,y) = \sum_{n=1}^{N} w_n R_{ssr}(x,y)$$

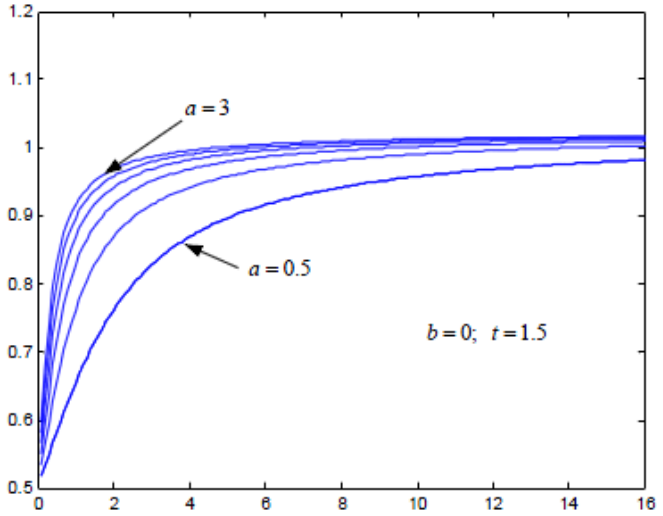
03 Selective-Retinex Fusion Algorithm

☆ S curve

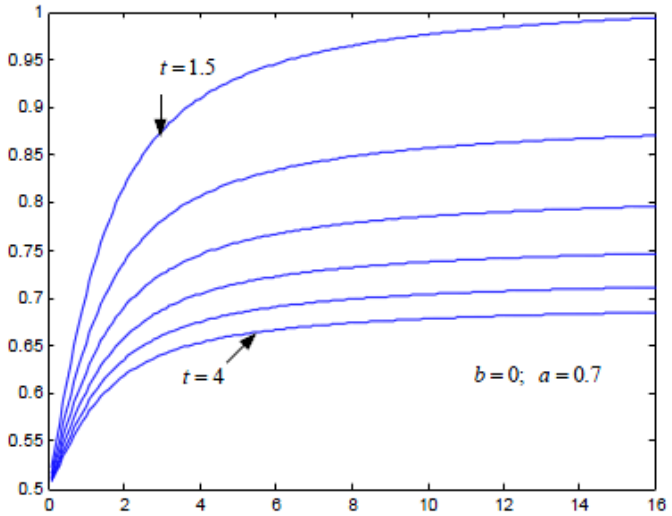
$$f = 0.5 + \frac{\arctan(a * x - b)}{2t}$$



[about b]



[about a]



[about t]

03 Selective-Retinex Fusion Algorithm

☆ The modified Retinex algorithm

$$P_R(i,j) = 0.5 + \frac{\arctan(a * R(i,j) - b)}{2t}$$

[Source]

[Modified Retinex]

➡ **BUT** we can also see the shade information is eliminated!!!

So we need to recognize **two different part.**

1) Light part need to reduce the brightness and its halo.

2) Dark part need to be enhanced according to the distance between the light source to keep distance information

03 Selective-Retinex Fusion Algorithm

☆ The selective and nonlinear gray mapping

[Four steps]

1) Find the light sources in the image.

erode first to eliminate speckles, then dilate to recover the area.

we can obtain the point light source $P_n,\ n = 1 \ldots N$.

2) Reduce the halo.

compute the **luminance-enhanced factor** related to **the distance**.

$$f_T(i,j) = \min \exp\left(-\frac{c\sqrt{(i-i_{0n})^2 + (j-j_{0n})^2}}{M_n} \right),\ n = 1 \ldots N$$

3) Deal with the two part differently.

compute the **luminance-enhanced factor** related to **the luminance**.

$$f_L(i,j) = \begin{cases} 1 & \text{in the area of each point light source} \\ d \cdot (p(i,j) - Light)^2 + 1 & \text{other parts in the image} \end{cases} \qquad d = \begin{cases} 6 & \text{image is very dark(the luminance average is less than 0.15)} \\ 3 & \text{otherwise} \end{cases}$$

4) Enhance the luminance component of the whole image by using $P_T(i,j)$.

compute the **luminance-enhanced factor** related to **the luminance**.

$$P_T(i,j) = p(i,j)\, f_L(i,j) \cdot f_T(i,j)$$

03 Selective-Retinex Fusion Algorithm

☆ The selective and nonlinear gray mapping

[luminance image of the source]

[luminance image by the method]

03 Selective-Retinex Fusion Algorithm

☆ Selective-Retinex Fusion Algorithm

$$P_Y(i,j) = g \cdot P_R(i,j) + (1-g) \cdot P_T(i,j) \qquad P_R(i,j) = 0.5 + \frac{\arctan(a * R(i,j) - b)}{2t}$$

$$P_T(i,j) = p(i,j)\, f_L(i,j) \cdot f_T(i,j)$$

$$g = \begin{cases} 0.1 \sim 0.3 & \text{good light condition and visual observation distance} \\ 0.3 \sim 0.6 & \text{otherwise} \end{cases}$$

[Source]

[Selective-Retinex Fusion Algorithm]

04 Experimental Results

[Source]

[Reference]

[S-Retinex Fusion]

[1] method

[2] method

[1] Songfeng Yin, Liangcai Cao, Yongshun Ling, Guofan Jin,"One color contrast enhanced infrared and visible image fusion method," *Infrared Physics & Technology*, vol. 53, pp. 146–150, 2010.
[2] Alexander Toet. "Natural color mapping for multi and night vision imagery," *Information Fusion*, vol. 4, pp. 155–166, August 2003.

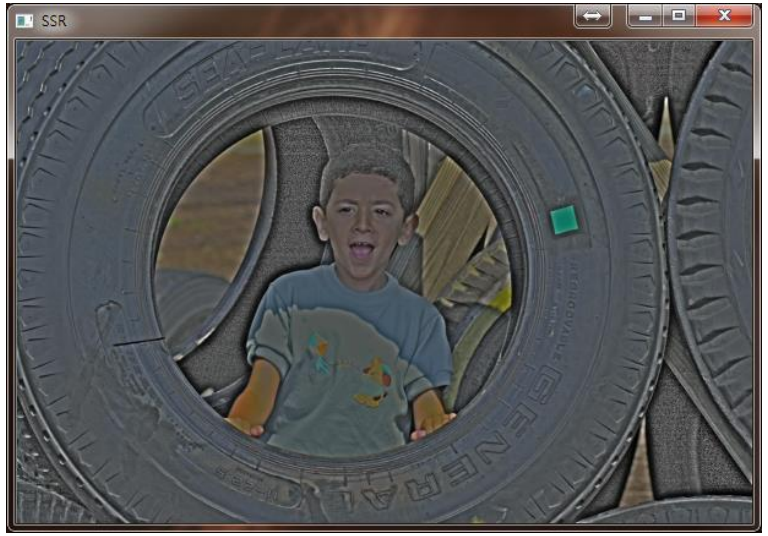
04 Experimental Results – modified retinex algorithm

[Source]

[HE]

[BBHE]

[Gamma Correction]
gamma= 2.2

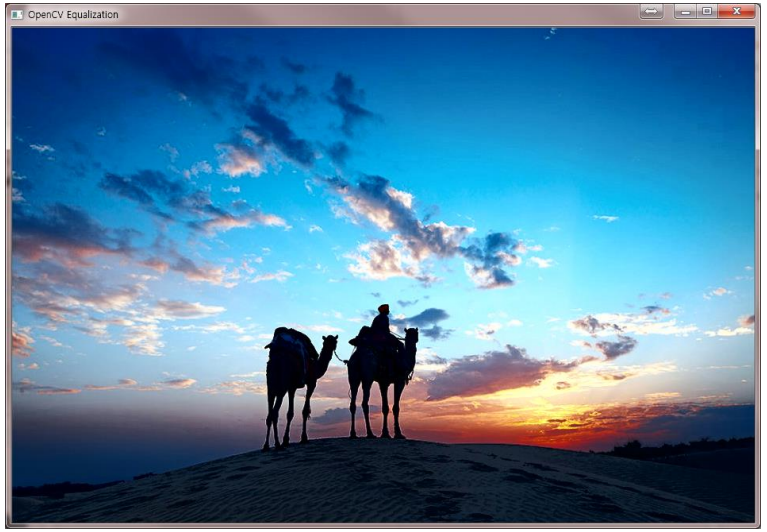


[SSR]

[Modified SSR]
a=0.7, b=0, t=1.5

04 Experimental Results – modified retinex algorithm

[Source]



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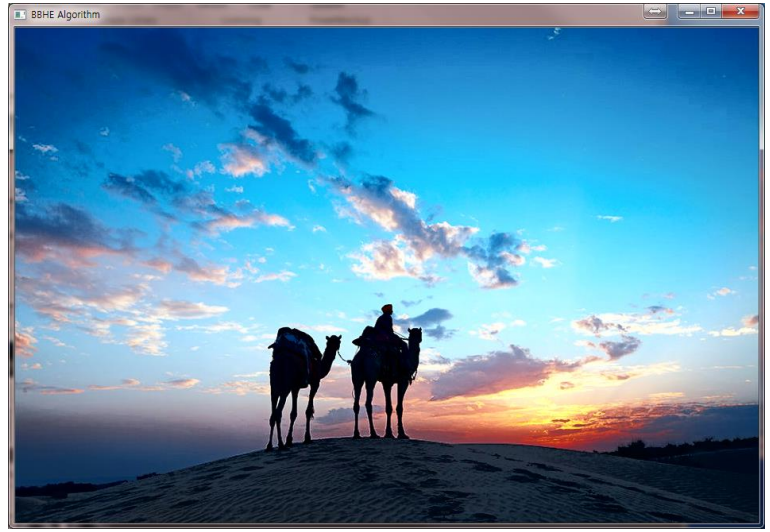
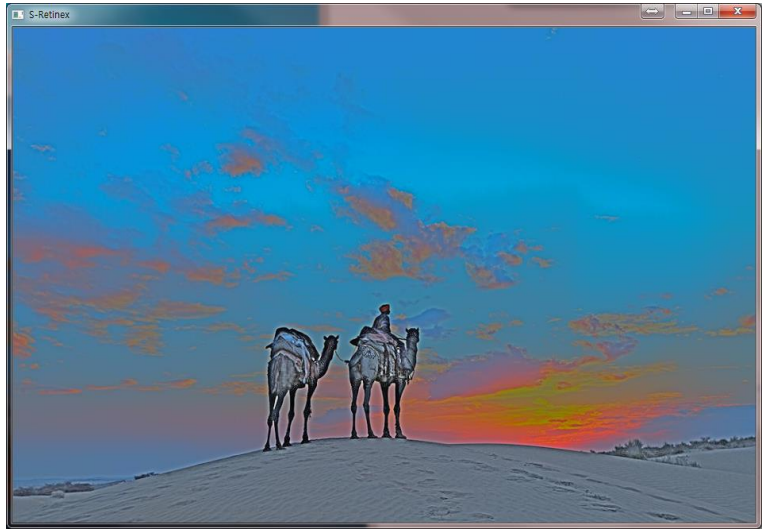


[BBHE]

[Gamma Correction]
gamma= 2.2

[SSR]



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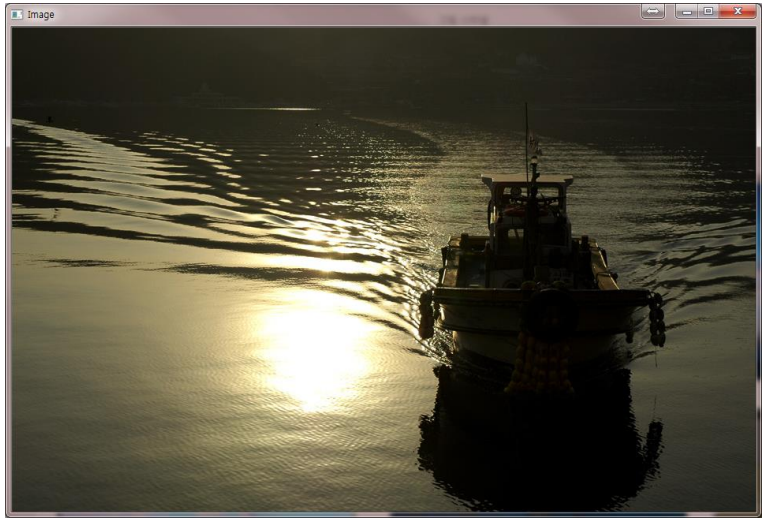
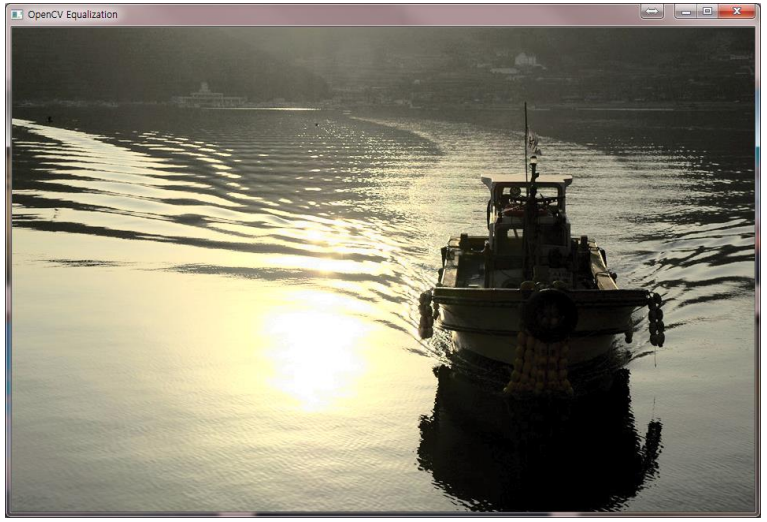
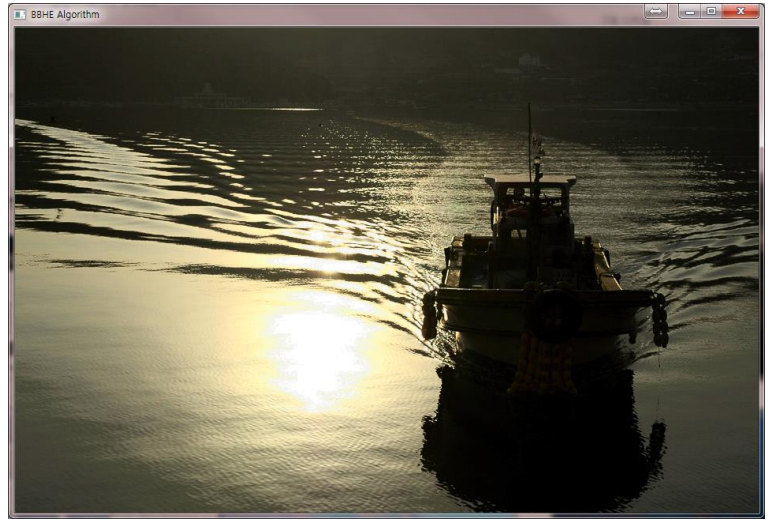
04 Experimental Results – modified retinex algorithm



[Source]



[HE]



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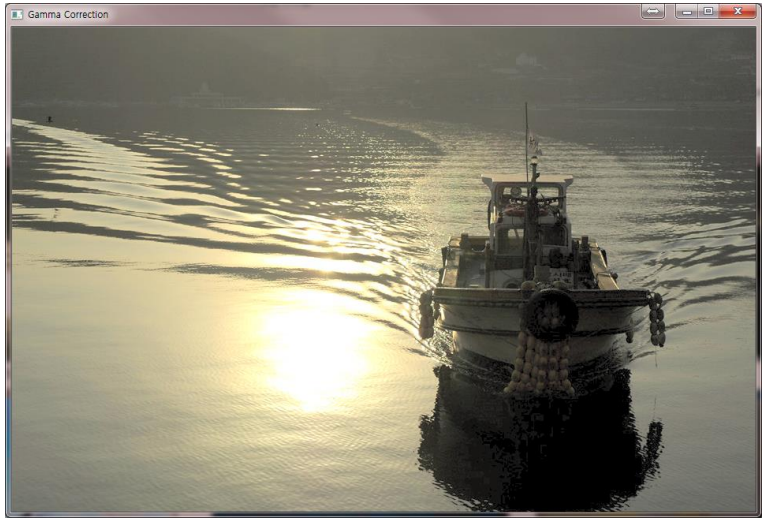

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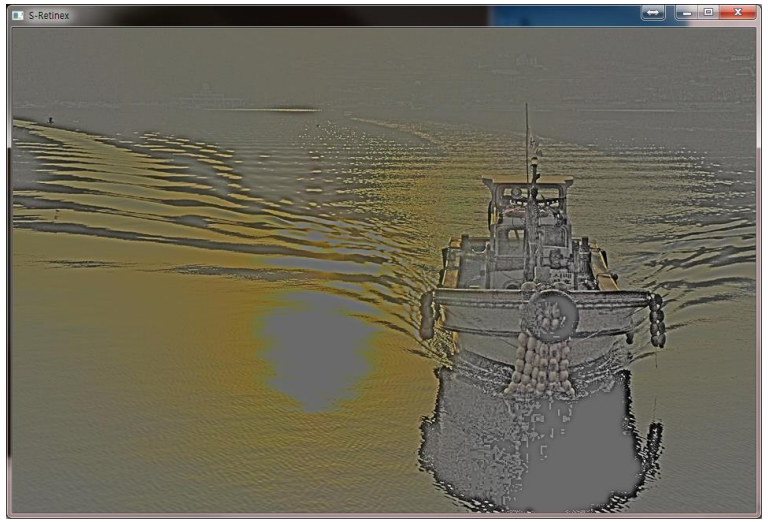

[Modified SSR]
a=0.7, b=0, t=1.5


Thank You