Image Processing Homework 2 Report

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Low-luminosity Enhancement

1. Algorithm

1.1 RGB to YC_bC_r

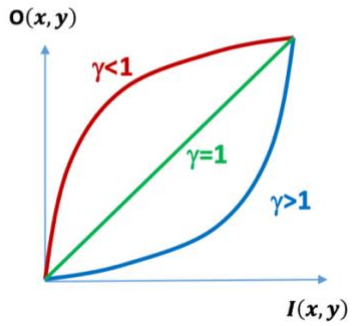
To do the intensity domain operation, convert RGB to YC_bC_r and operate the Y channel only. Use Rec. 601 standard; the range of Y is 16 to 235, and the range of C_bC_r is 16 to 240.

$$\begin{bmatrix} Y'_{601} \\ C_B \\ C_R \end{bmatrix} = \begin{bmatrix} 0.257 & 0.504 & 0.098 \\ -0.148 & -0.291 & 0.439 \\ 0.439 & -0.368 & -0.071 \end{bmatrix} \cdot \begin{bmatrix} R' \\ G' \\ B' \end{bmatrix} + \begin{bmatrix} 16 \\ 128 \\ 128 \end{bmatrix}$$

1.2 Power-Law transformation

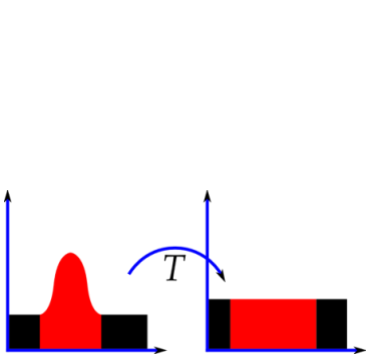
Choose gamma<1 to enhance the low luminosity area. The smaller gamma can improve the input stronger.

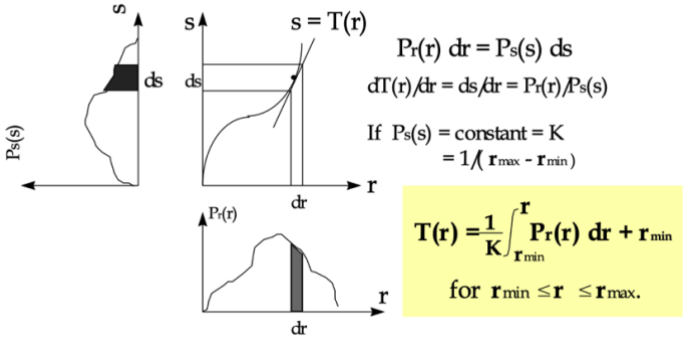
$$O(x,y) = I_{max}(\frac{I(x,y)}{I_{max}})^{\gamma}$$



1.3 Histogram equalization

The intensities can be better distributed on the histogram through histogram equalization. This can increase the global contract.





1.4 Discussion

I tried two methods to d Low-luminosity Enhancement. In this case, the intensity values are mostly small but large in some areas. Histogram equalization may enhance low luminosity area, but it is too strong for high luminosity area.

(left)original image (right)histogram equalization

2. Different degrees of modification

Use Power-Law transformation and choose gamma for 1.5 and 2.

(left) gamma=1.5 (right) gamma=2

Sharpness Enhancement

1. Algorithm

    1.1 Unsharp Masking & High-Boosting Filtering

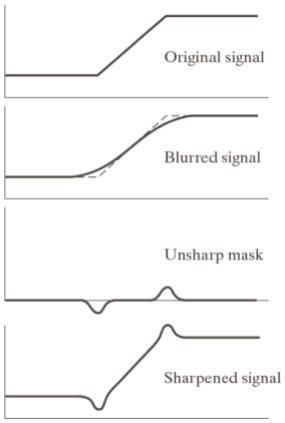
Convert the image to YC_bC_r and operate the Y domain. First, use a mean filter to blur the input image. Subtract the input image and the blurred image to get the unsharp mask. Multiply the unsharp mask by a coefficient k and add it to the input image.

$$g_{mask}(x,y) = f(x,y) - \overline{f}(x,y)$$

$\overline{f}(x,y)$: a blurred version of f(x,y)

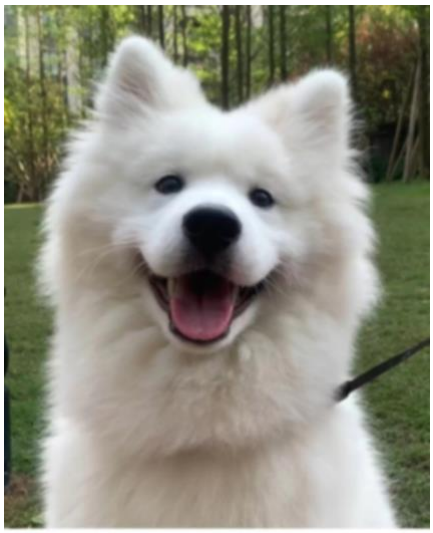
$$g(x,y) = f(x,y) + k \cdot g_{mask}(x,y)$$

k = 1 : Unsharp Masking
k > 1: High-Boost Filtering

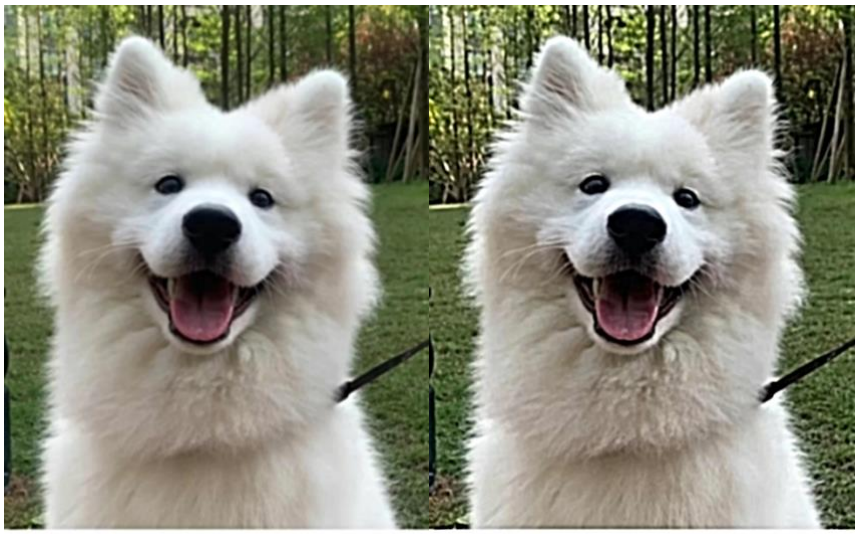


2. Different degrees of modification

Choose k for 1 and 3.



(input image)



(left) k=1 (right) k=3

Denoise

1. Algorithm

   1.1 Mean filter

$$\frac{1}{9}\times\begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix}$$

Use a mean filter as a low-pass filter to smooth the high-frequency noise. Difference sizes of the mean filter can blur the input difference degrees. The bigger size is more powerful.

2. Different degrees of modification

Choose sizes of the filter for 3 and 9.

(input image)

(left) size=3 (right) size=9