

Computational Photography

Assignment 1 Report

106061704

Yun-Sheng Chang

Outline

- Global tone mapping
- Local tone mapping
- Timing analysis
- Creating HDR images

Global Tone Mapping

- In this part, we perform global tone mapping using the following formula

$$\log \hat{X} = s * (\log X - \log X_0) + \log X_0$$

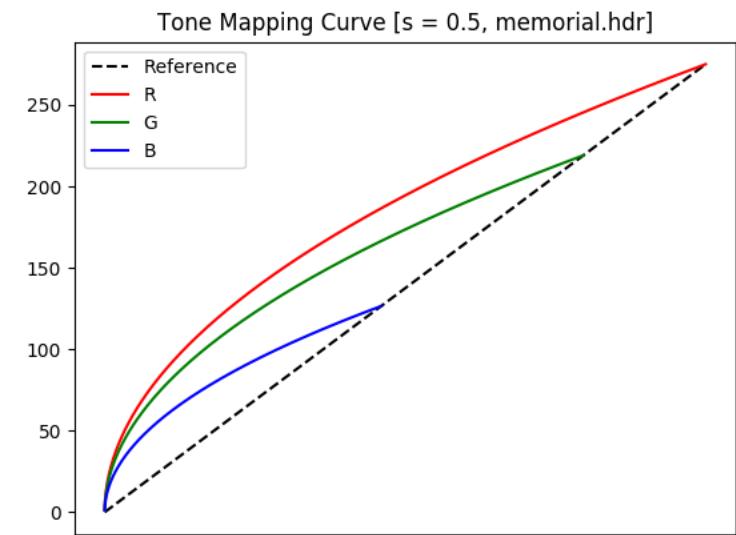
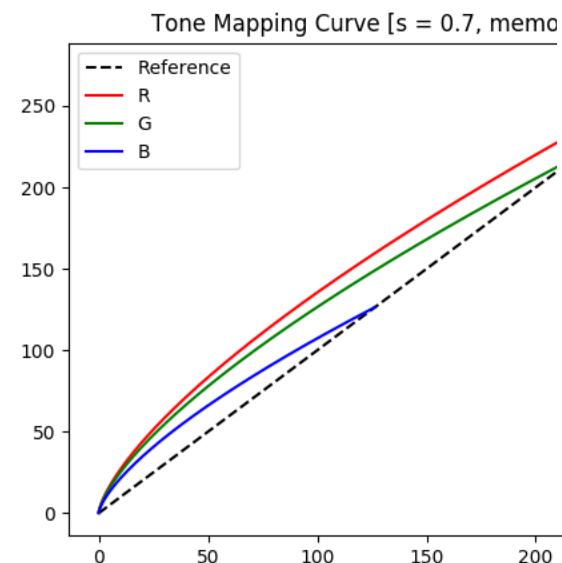
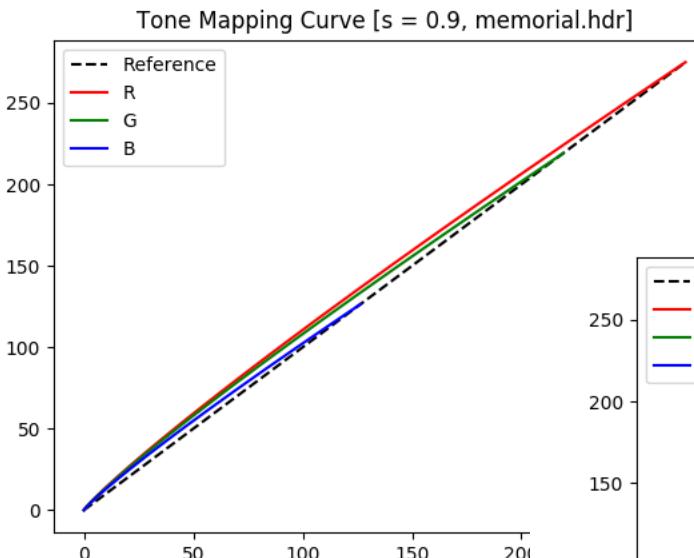
or

$$\hat{X} = X^s * X_0^{1-s}$$

- The first term is essentially *gamma compression*

Tone Mapping Curves

- As S decreases, the intensity of image increases
- As S decreases, the contrast of dark regions increases and the contrast of light regions decreases



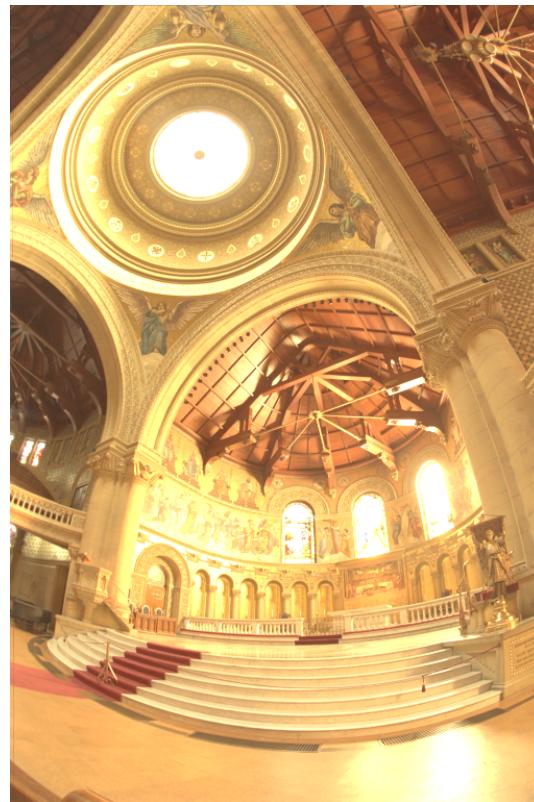
Analysis

- Global tone mapping performs universal operation to every pixel, and therefore may bring positive impact on most parts of the image while having side effects on some specific parts
- For the following analysis, I will focus on the *global* and *local* changes in contrast after performing global tone mapping
- To measure contrast, I evaluate the *gradient* of each pixel and plot the distribution of gradient

Result



$S = 0.9$



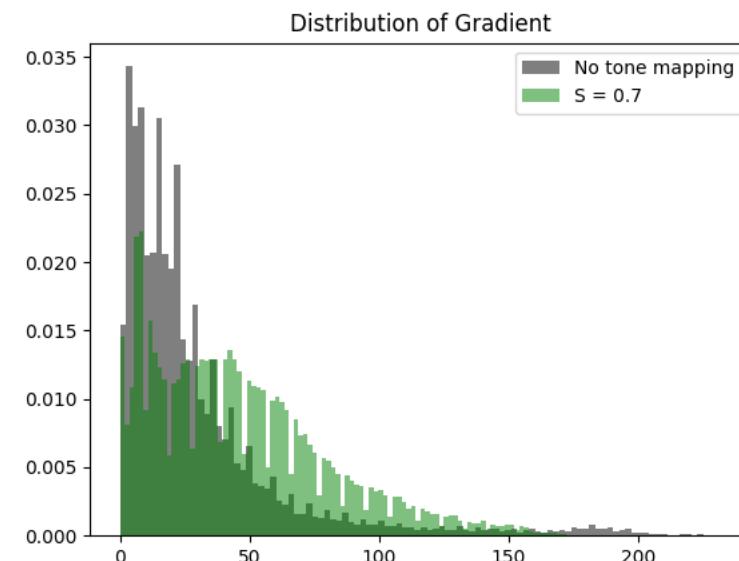
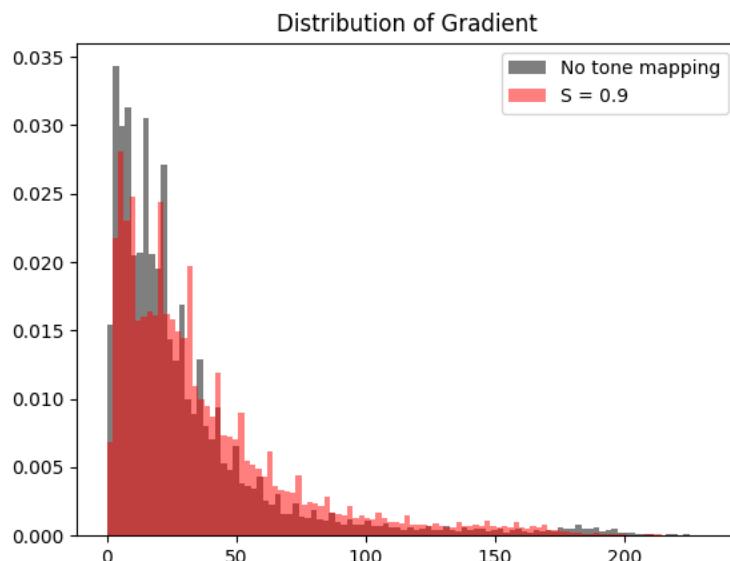
$S = 0.7$



$S = 0.5$

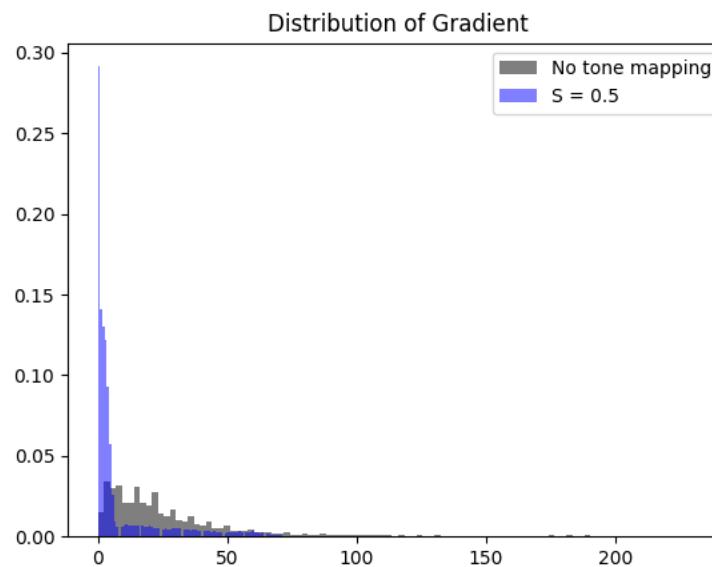
Analysis: Global Change

- With $S = 0.9, 0.7$, the distribution of gradient shifts to the right, meaning that the overall contrast increases
- I think it's because the original image (*memorial.hdr*) has low intensity for the most part and the global tone mapping formula we use tends to increase the contrast of dark regions

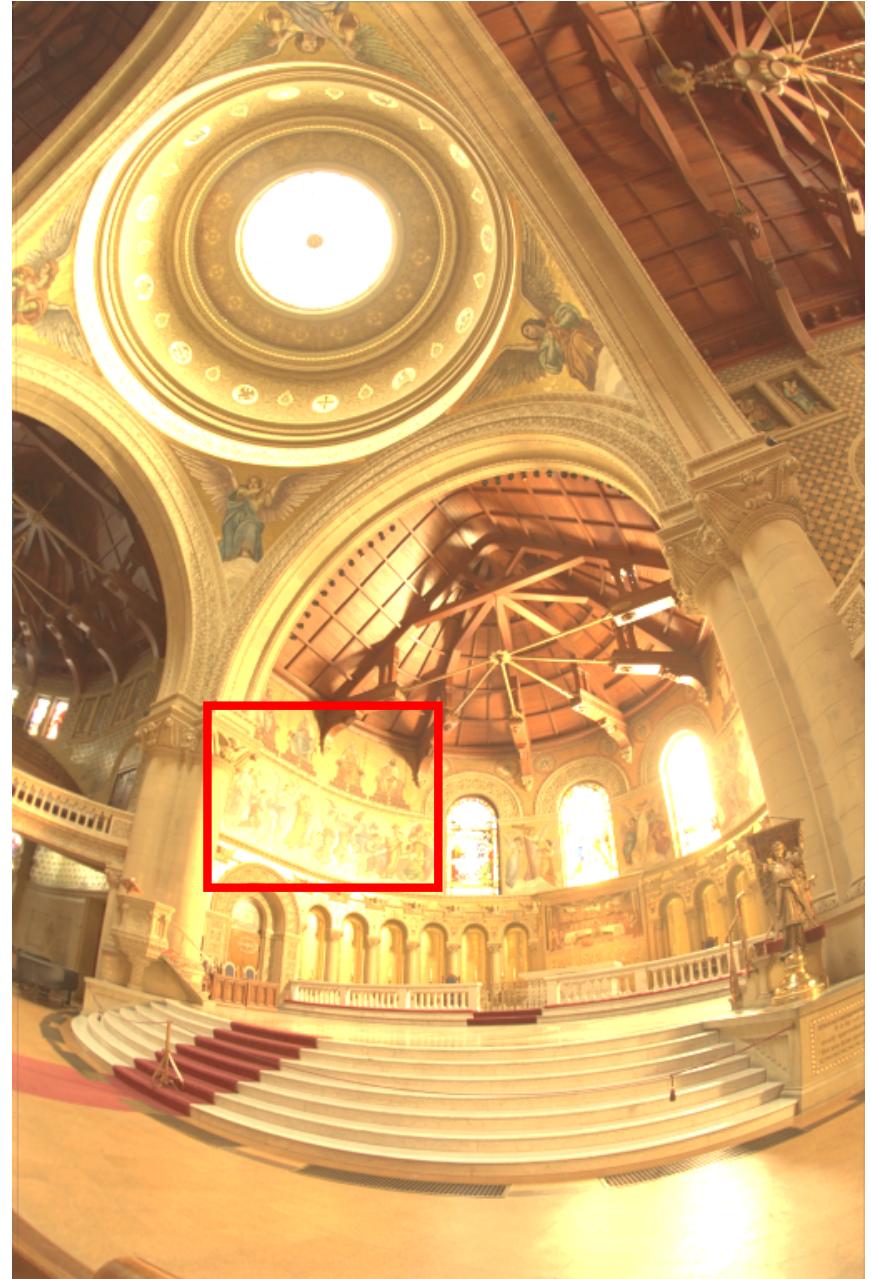
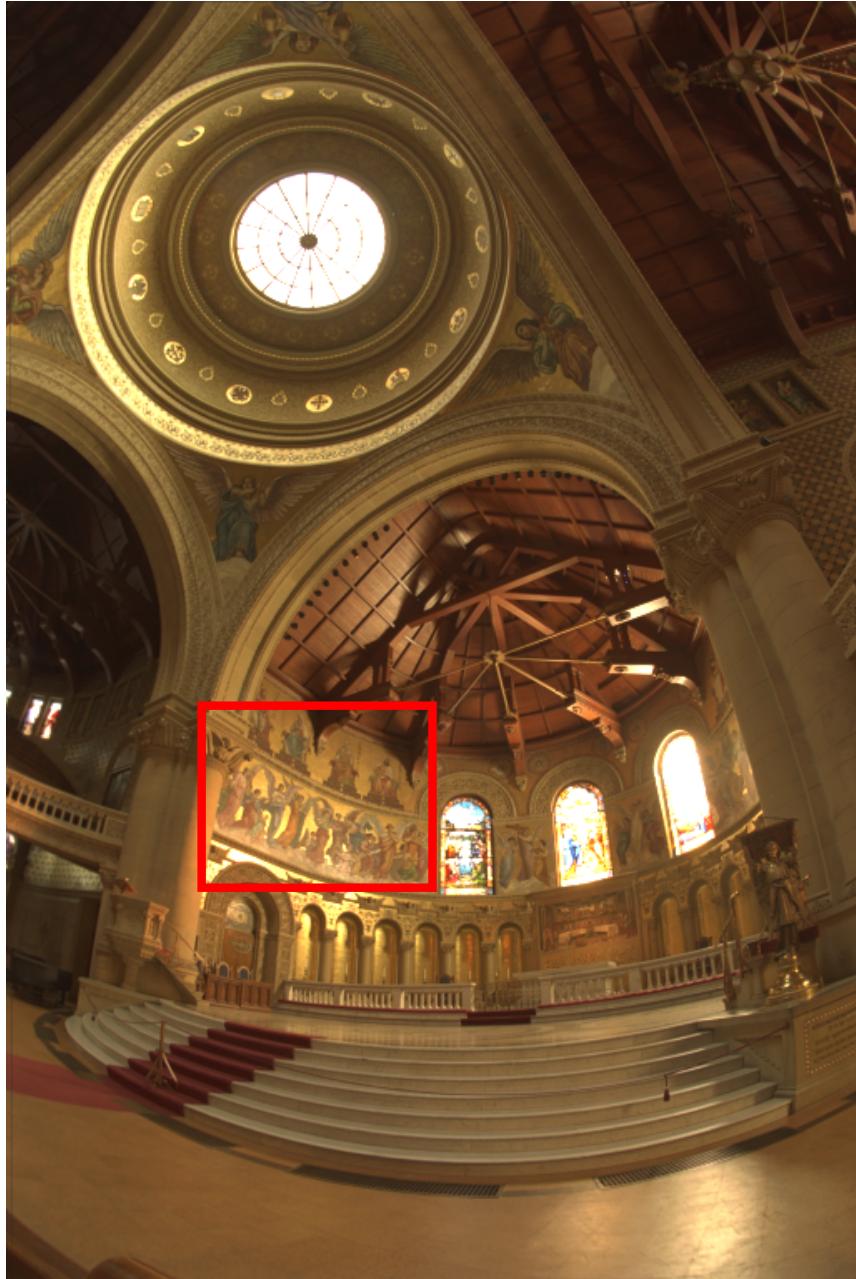


Analysis: Global Change

- With $S = 0.5$, as the intensity is over-amplified, the distribution of gradient is concentrated around 0

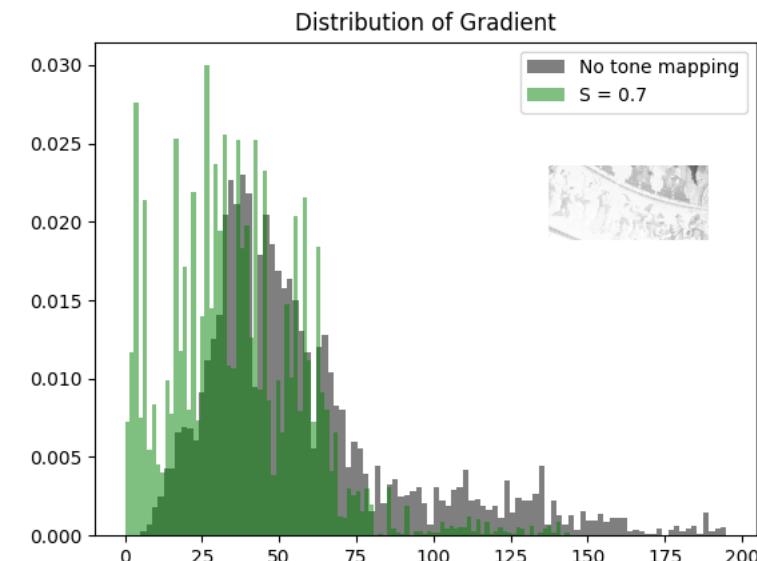
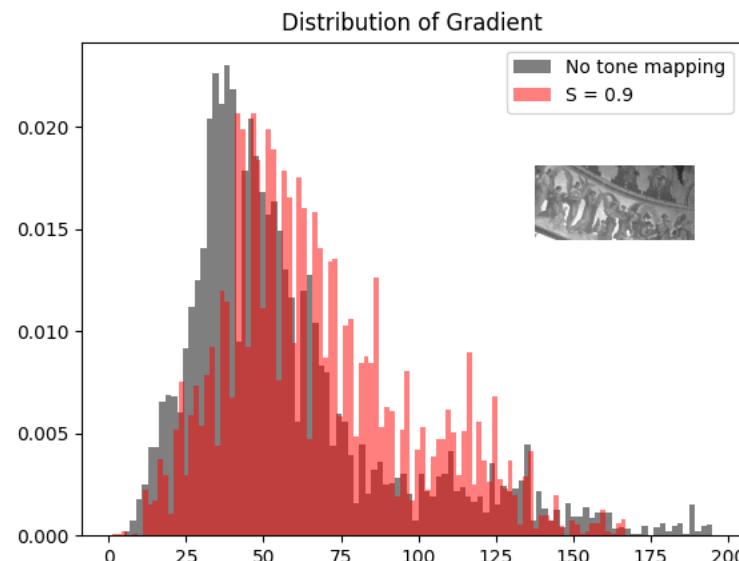


- Next, we analyze how well the details is preserved after performing global tone mapping



Analysis: Local Change

- The gradient distribution of the left image moves to the right (meaning the image becomes sharper) while the gradient distribution of the right image moves to the left (meaning the image becomes blunter)
- We may conclude that it's essential in choosing a good value for S to preserve details in an image



Local Tone Mapping

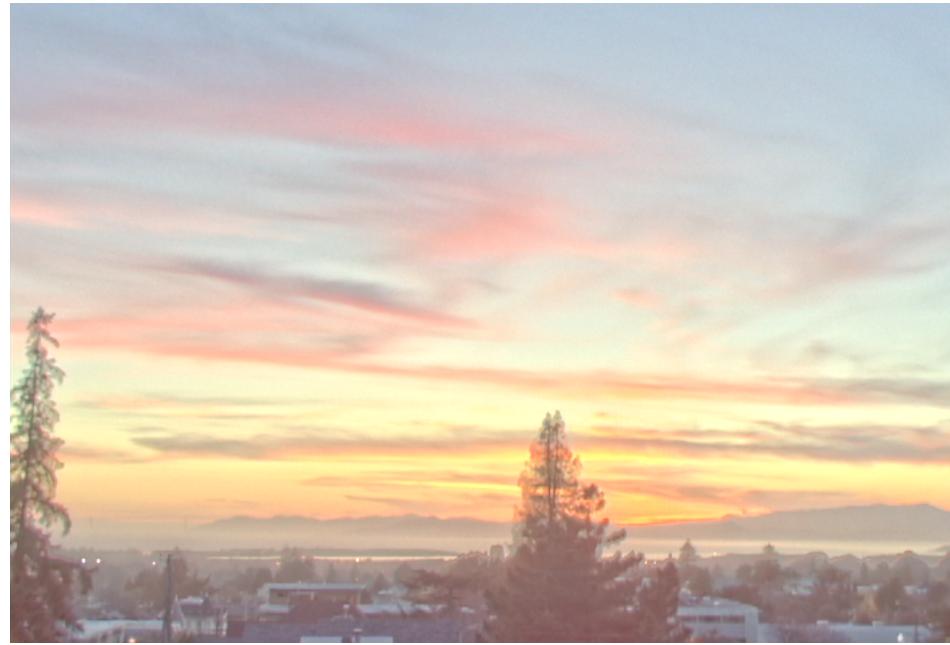
- In this part, we use two types of filter to perform local tone mapping
 - Gaussian filter
 - Bilateral filter

Result

Gaussian, window size = 35



Bilateral, window size = 35

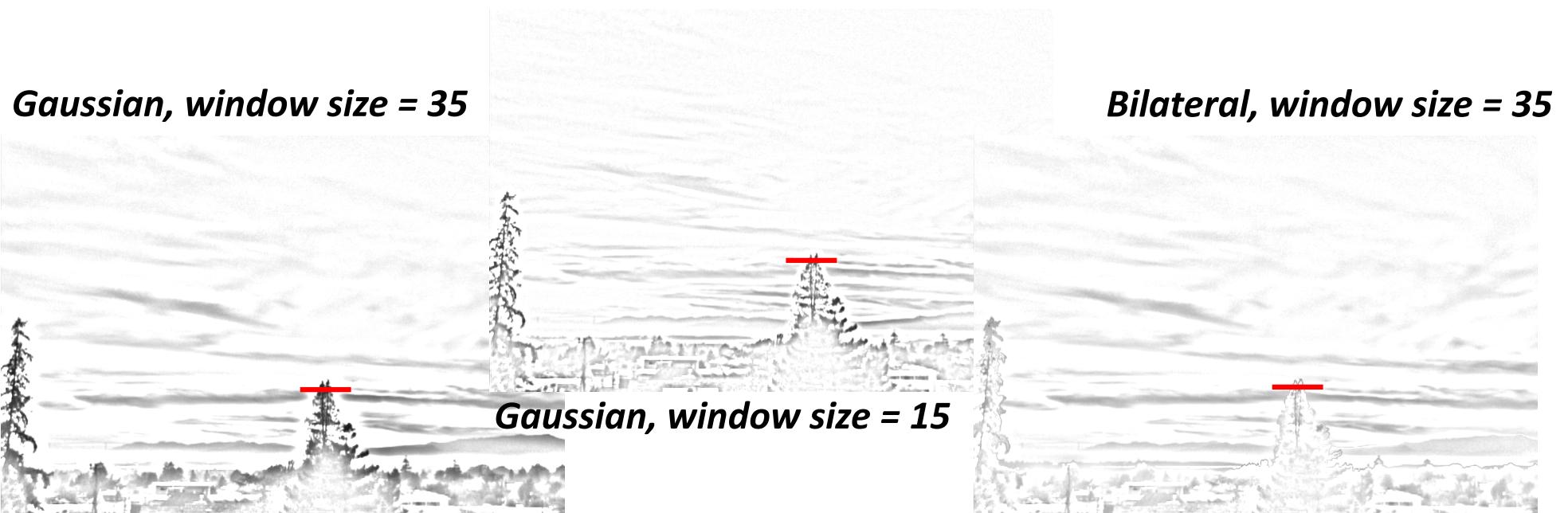


Gaussian, window size = 15



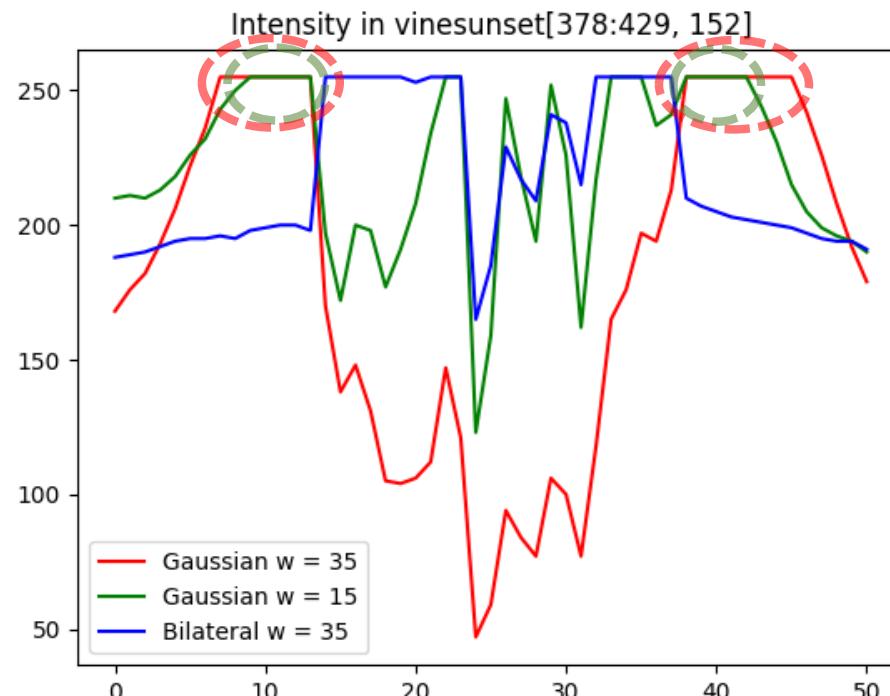
Analysis: Ringing Effect

- From the results above, we can clearly observe the *ringing effect*
- To measure ringing effect, I draw a line across three detail layers generated by different filters/parameters and record the value of each pixel in the line



Analysis: Ringing Effect

ringing effect using Gaussian filter with window size = 35



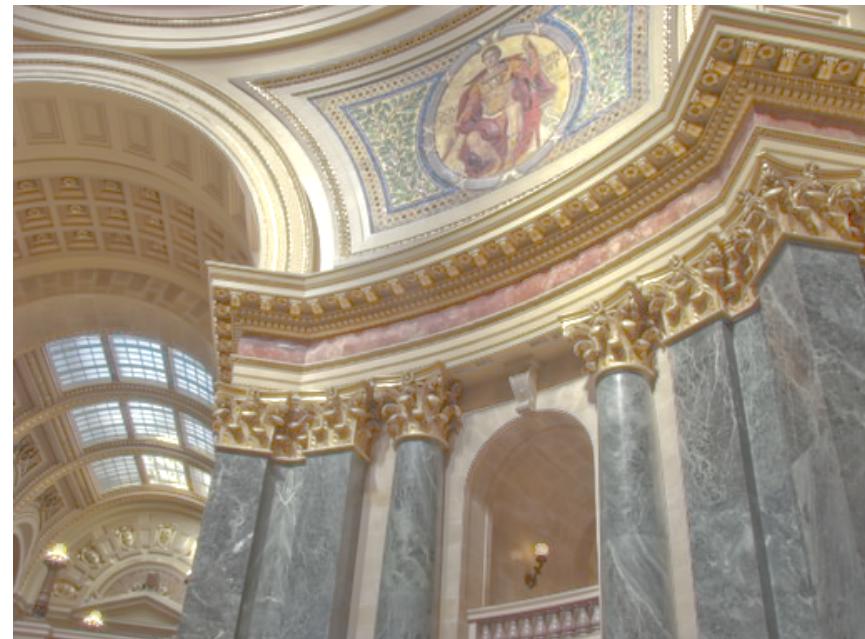
ringing effect using Gaussian filter with window size = 15

- For Gaussian filters, as the window size increases, the ringing effect also increases
- Bilateral filters have (almost) no ringing effect

Result



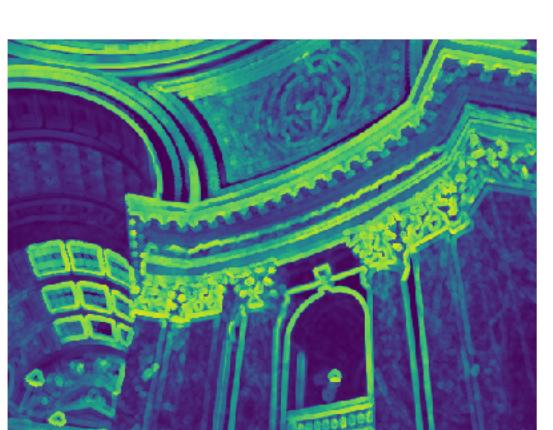
Gaussian filter



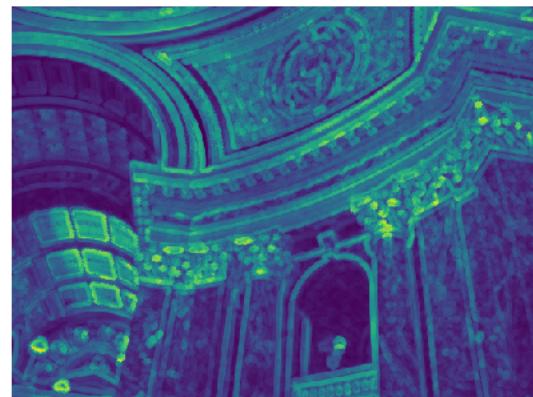
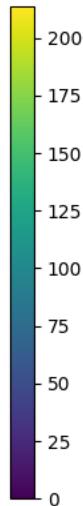
Bilateral filter

Analysis: Low Sharpness

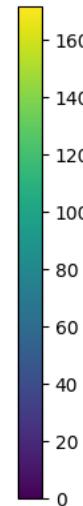
- Although bilateral filters are less affected by the ringing effect, they tends to blunt the image
- We can easily observe the fact from their gradients



Gaussian filter



Bilateral filter



Timing Analysis

	vinesunset.hdr (706x479)	memorial.hdr (512x768)
Global	0.089 s	0.107 s
Global + White Balance	0.091 s	0.111 s
Gaussian	1.793 s	2.444 s
Bilateral	320.431 s	359.954 s

Conclusion

- Global tone mappings are fast, but may not be suitable for images with many details
- Gaussian filters are efficient and detail-preserving, but may cause ringing effect near edges
- Bilateral filters preserve details and generally have no ringing effect, but at the cost of high time complexity and may decreases the sharpness of an image

Create HDR Images

- I created two HDR images from two different scenes, each scene was taken 13 photos with different exposure time

Scene 1: Afternoon Lake



Scene 2: Evening Street



Generated HDR Images



Global

*Global + White
Balance*

Gaussian

Bilateral

Analysis

- Global tone mapping results are much darker than local tone mapping results
- It seems to me that results generated by Gaussian filter are more like photos in reality whereas results generated by bilateral filter are more like photos in fantasy