Digital Visual Effects Homework 1 - High Dynamic Range Imaging

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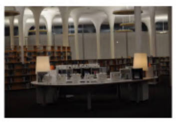
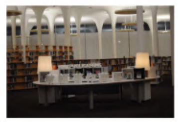
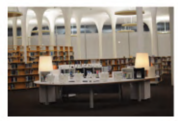
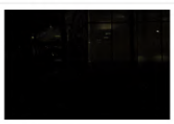
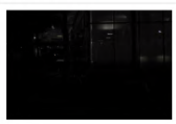
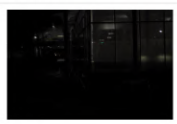
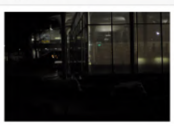
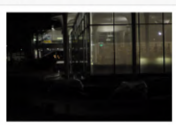
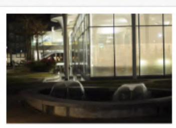
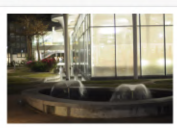
Original Image

Exposure Time

Simple (Indoor)

1 / 3200	**1 / 2000**	**1 / 1250**	**1 / 800**
			
1 / 500	1 / 320	1 / 200	1 / 125
			
1 / 80	1 / 50	1 / 30	
			

Hard (Outdoor)

1 / 500	**1 / 320**	**1 / 200**	**1 / 125**
			
1 / 80	1 / 50	1 / 30	1 / 20
			
1 / 13	1 / 8	1 / 5	
			

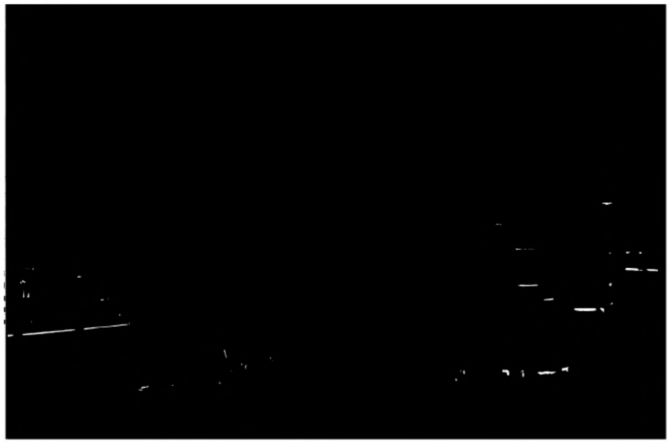
Preprocessing

Median Threshold Bitmap Alignment - MTB (Bonus)

We utilize Median Threshold Bitmap Alignment (MLB) as a means of aligning images. This technique involves employing median thresholding to generate comparable binary images from varying exposure images. The advantage of using this method is that even the images with the highest and lowest exposure levels yield very similar thresholding output, resulting in accurate alignment. Additionally, MLB is a robust method that can effectively handle noise and outliers in the image data, further enhancing the alignment quality.

Mask High Variance (Bonus)

Implemented masking technique helps maintain high precision in assembling high dynamic range (HDR) images by removing high variance pixels from input images. This technique reduces errors and prevents degradation of image quality that may occur during the HDR assembly process. It is useful when working with images that contain noise or other image artifacts that can lead to errors in HDR assembly. Selectively removing these pixels results in a high-quality HDR image that accurately reflects the original scene. Additionally, this masking technique can be adjusted to suit different applications by varying the threshold for masking high variance pixels, depending on the desired level of precision and image quality.

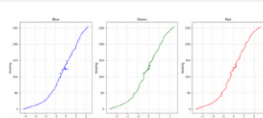
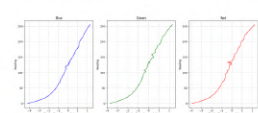
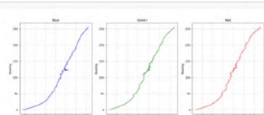
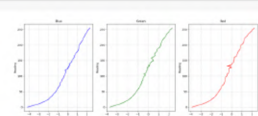
Type	Image
Simple	
Hard	

Assemble HDR images

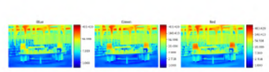
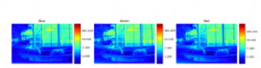
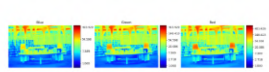
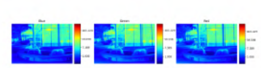
Paul Debevec's methods

The technique developed by Paul Debevec involves the use of a set of sample points to estimate the response curve. In my implementation of this method, we employed 256 sample points selected at random to perform this estimation. Upon experimentation, we discovered that increasing the number of sample points resulted in a smoother response curve. This finding suggests that a higher number of sample points can contribute to more accurate and precise estimations.

Response Curve

Method	Image (Simple)	Image (Hard)
With Mask		
Without Mask		

Radiance Map

Method	Image (Simple)	Image (Hard)
With Mask		
Without Mask		

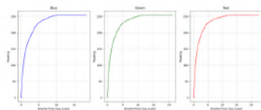
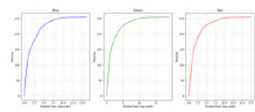
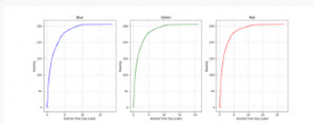
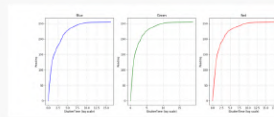
Robertson's method (Bonus)

Robertson's method utilizes all the pixels present in the images to estimate the response curve. This method employs an iterative optimization scheme that gradually approaches the response curve. In our implementation, we chose to initialize the response curve with a straight line. This choice of initialization led to rapid convergence of the response curve, with minimal changes observed after only a few iterations. The efficiency of this approach underscores the importance of carefully selecting the starting point for iterative optimization algorithms. It is noteworthy that the choice of the initialization function can significantly impact the speed and accuracy of the optimization process.

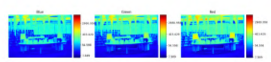
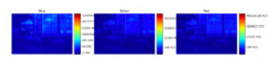
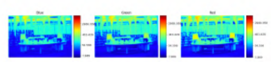
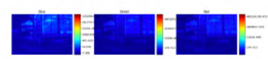
Weighting Function (Bonus)

In addition, we have experimented with four distinct weight function approaches, including 'uniform', 'triangle', 'gaussian', and 'trapezoid'. Out of these options, we have found that the 'triangle' function performs the best.

Response Curve

Method	Image (Simple)	Image (Hard)
With Mask		
Without Mask		

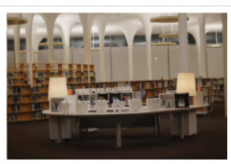
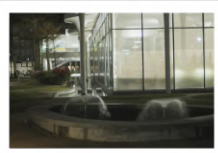
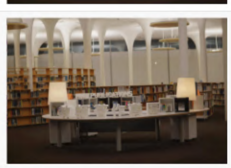
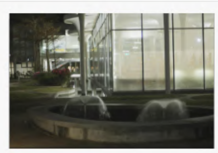
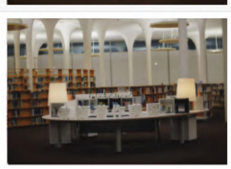
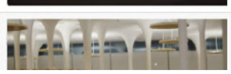
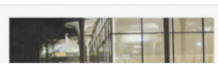
Radiance Map

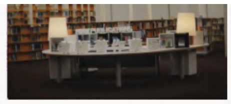
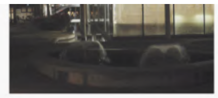
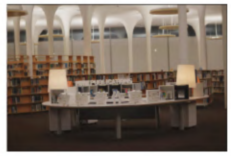
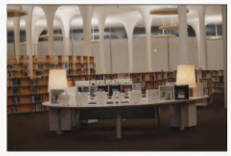
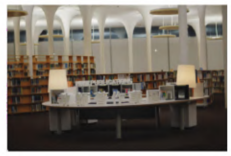
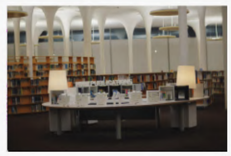
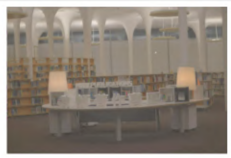
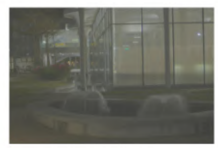
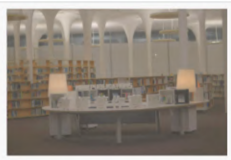
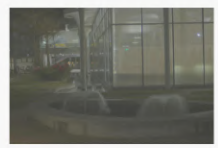
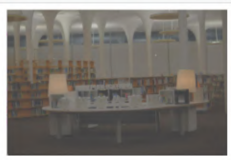
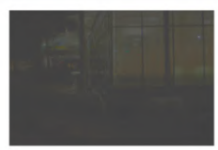
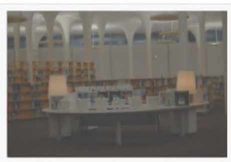
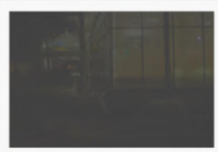
Method	Image (Simple)	Image (Hard)
With Mask		
Without Mask		

Radiance map

Tone mapping method (Bonus)

We implemented Reinhard's tone-mapping technique transforms high dynamic range images into low dynamic range ones without compromising visual quality, enhancing display on devices with limited dynamic range. It maps image pixels based on logarithmic average of luminance values and standard deviation of log-luminance, resulting in visually pleasing images with improved brightness and contrast while maintaining color and overall appearance.

Operator	HDR Method	Mask	Image (Simple)	Image (Hard)
Global	Paul Debevec	True		
Global	Paul Debevec	False		
Global	Robertson	True		
				

Global	Robertson	False		
Local	Paul Debevec	True		
Local	Paul Debevec	False		
Local	Robertson	True		
Local	Robertson	False		
Bilateral	Paul Debevec	True		
Bilateral	Paul Debevec	False		
Bilateral	Robertson	True		
Bilateral	Robertson	False		

Conclusion

Initially, we use Median Threshold Bitmap Alignment to align the image, ensuring that the pixels are consistent for the HDR method. Next, we apply a mask to filter out pixels with high variance to improve the stability of HDR. We then utilize two HDR methods, namely Paul Debevec's and Robertson's methods, to create HDR images. In addition, we conduct experiments using different weighted functions. Finally, we recover the Radiance Map and use tone mapping to obtain the HDR images.
Regarding the tone mapping methods, it's worth noting that they all have numerous parameters to adjust. Consequently, it becomes more challenging to compare them as variations in the parameters could account for the dissimilarities. In our opinion, the Bilateral Operator was the least helpful, while the Local Operator produced the best image. The Local Operator yielded the most robust contrast, and we believe it displayed more intricate details within the image.