CSCE-689 Computational Photography

Programming Assignment 5

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High Dynamic Range Imaging

Modern cameras are unable to capture the full dynamic range of commonly encountered real-world scenes. In some scenes, even the best possible photograph will be partially under or over-exposed. Researchers and photographers commonly overcome this limitation by combining information from multiple exposures of the same scene to generate an image with a high dynamic range.

Task 1

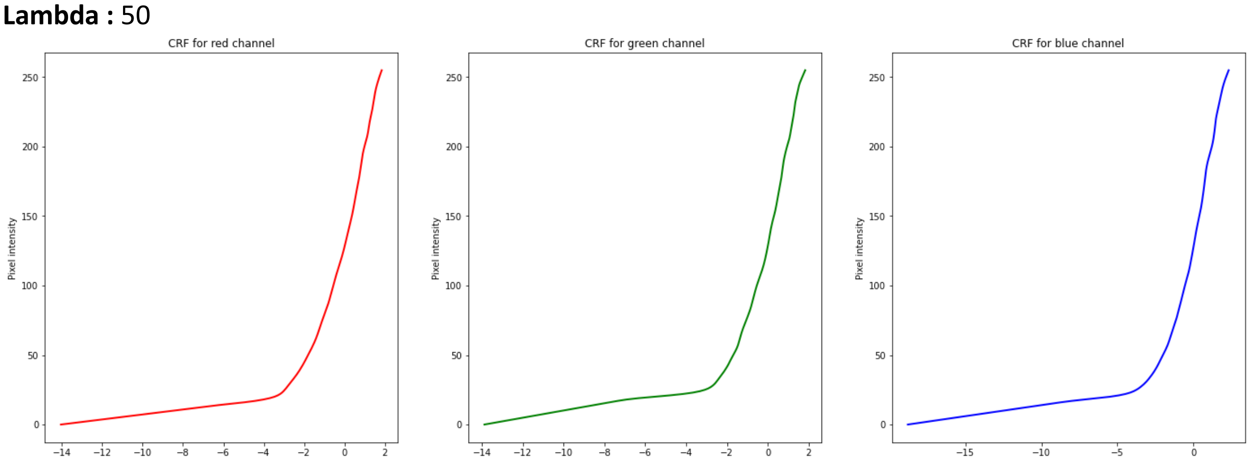
This task involves estimating the Camera Response Function (CRF) from a set of images captured with different exposure times.

Main steps in the implementation:

1. Read all the images along with their exposure times.
2. Randomly select N pixels in each image. The same N pixels must be selected in all the images. The value of N is chosen according to the formula N= 5x(256)/(P-1) where P is the number of images.
3. Triangle function is implemented to give less importance to pixels with extreme values.
4. Optimization is performed to calculate the estimate the CRF with least error. A regularization parameter is used to ensure that the CRF is smooth.

Following are the results:

Image Set: Chapel
Lambda : 50



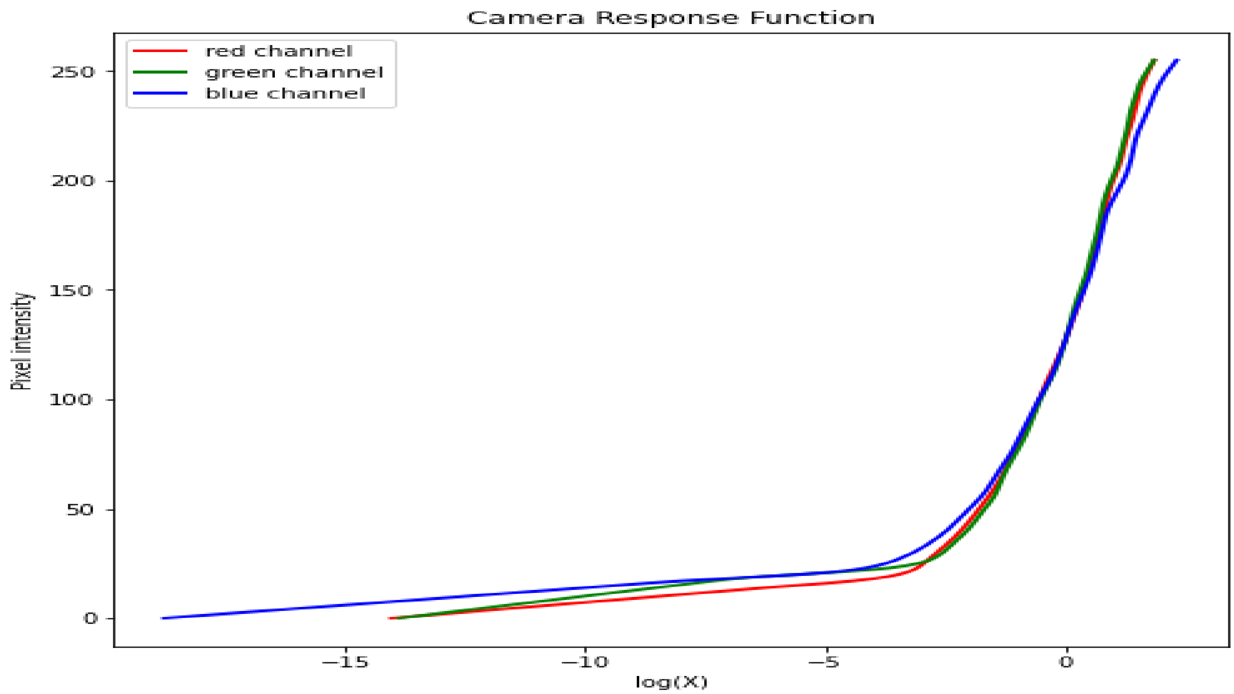
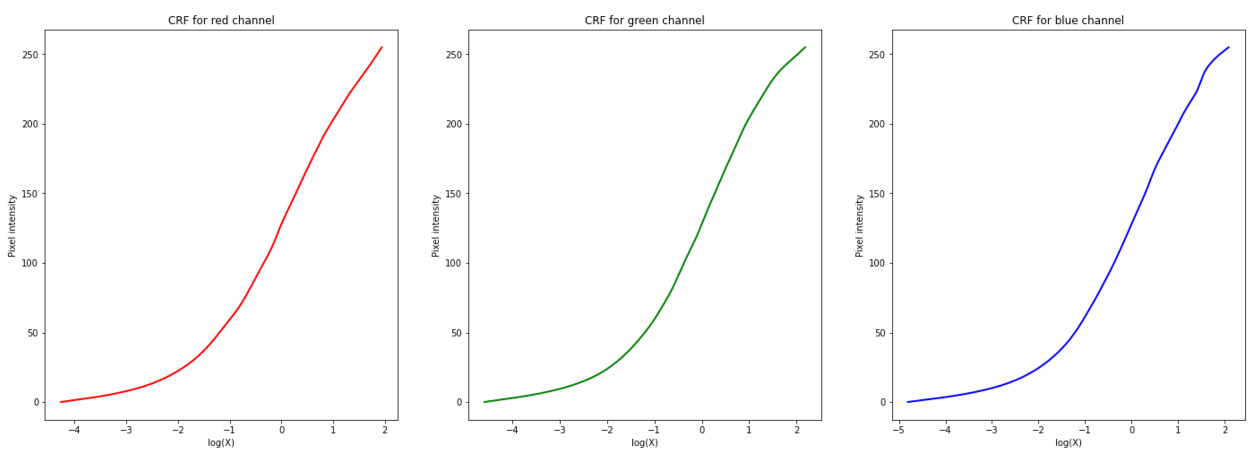
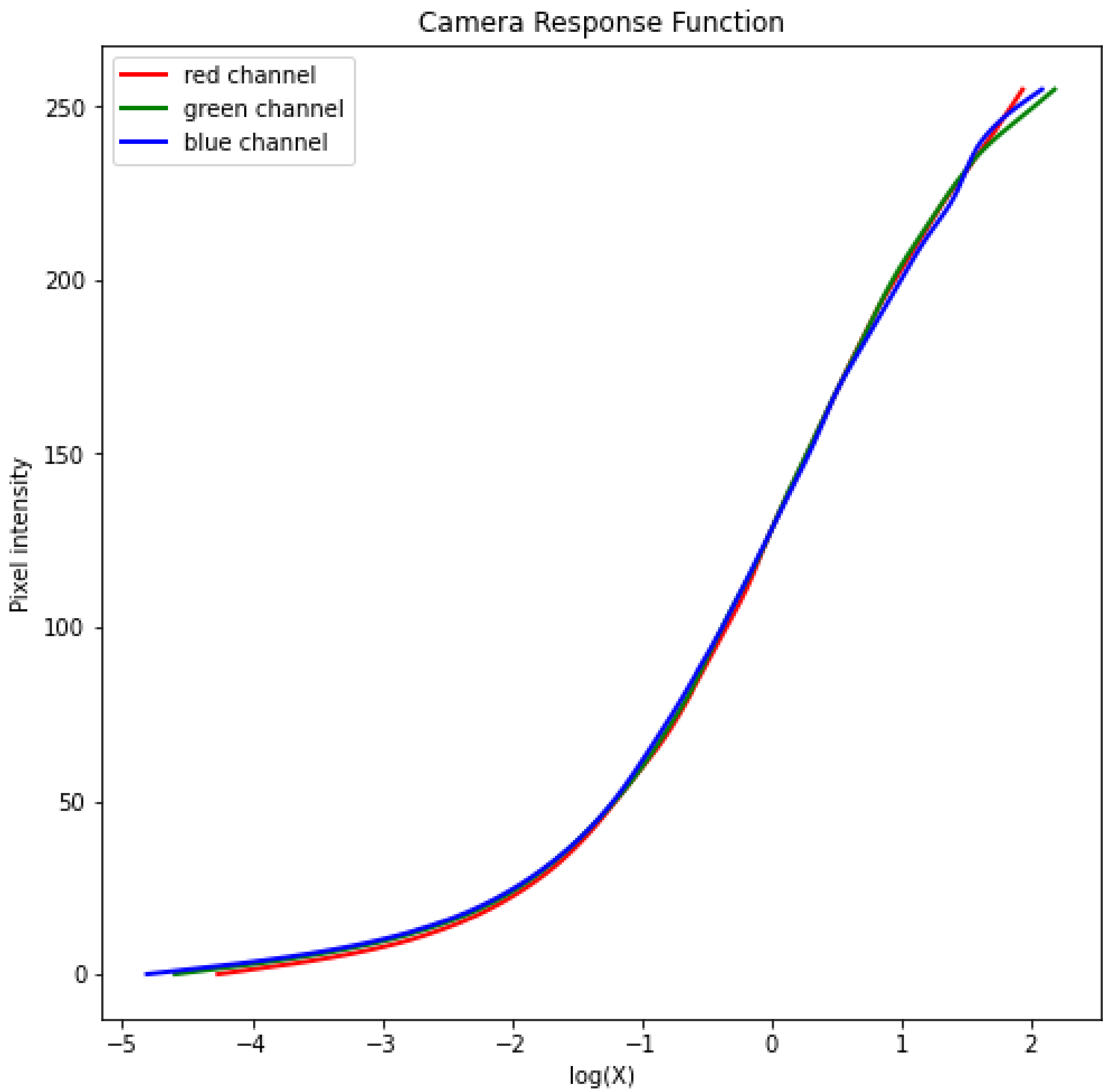


Image Set: Office
Lambda : 50





Task 2

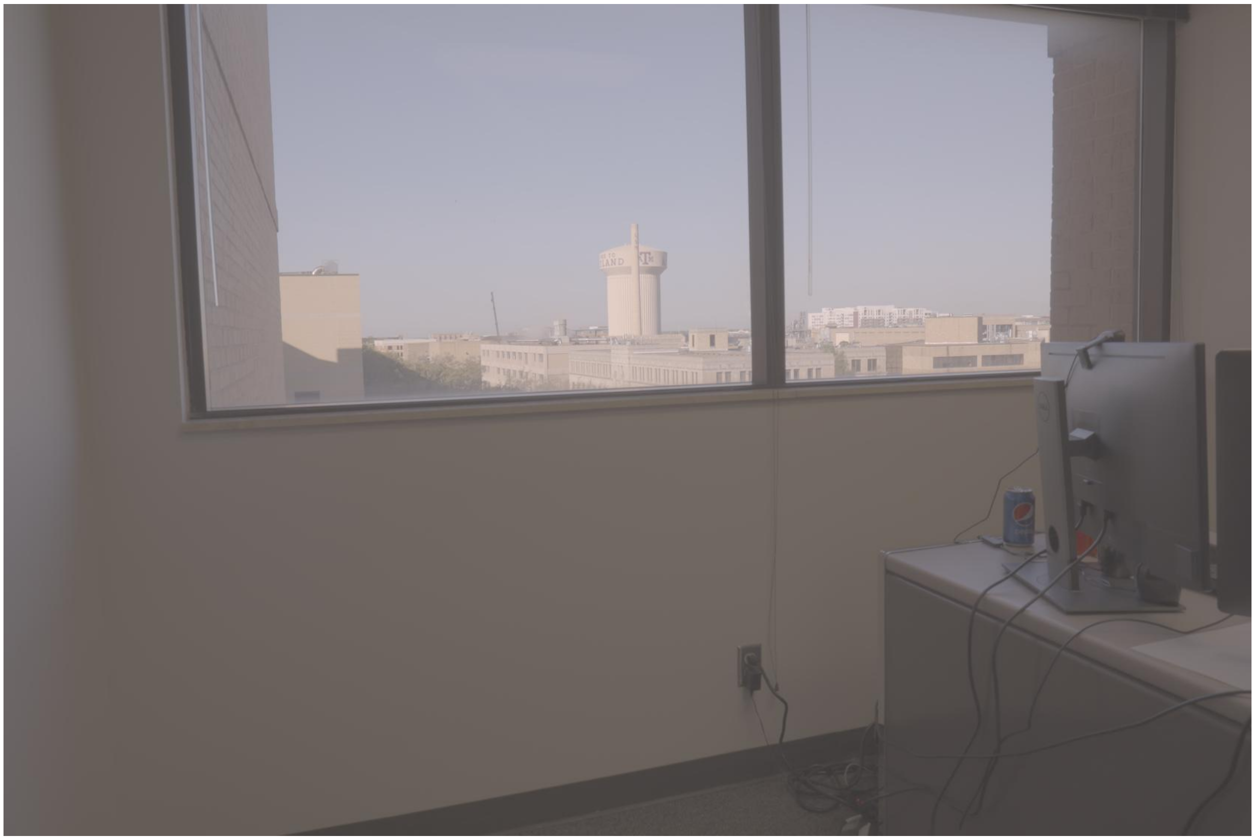
In this task, the CRF obtained earlier is used to create the irradiance map of the scene as described in the paper by Debevec. Now that we have the scene radiance information for all pixels, tonemapping is done to create a HDR image.

Two types of tonemapping are considered.

1) Global Tonemapping: The tonemapping along with gamma compression is done using the relation.

$$T = \left(\frac{E}{\max(E)} \right)^{\gamma}$$

The results are as shown below.



2) Local Tonemapping:

The steps involved are as follows:

1. The average of the three channels of the irradiance map E is computed to get the Intensity I.
2. Chroma channels are computed as $(R/I, G/I, B/I)$
3. Log of the intensity I is computed : $L = \log2(I)$
4. Gaussian filtering is done on L to get B.
5. The detail layer D is computed as $D = L-B$
6. B’ is calculated as $B' = (B - o)*s$ where o is max(B) and s= $s = dR / (\max(B) - \min(B))$
7. Reconstruct the log intensity: $O = 2^{\wedge}(B0+D)$
8. Put back the colors: $R0, G0, B0 = O * (R/I, G/I, B/I)$
9. Gamma compression is done.

Parameters like the standard deviation of the gaussian filter, dR and gamma are chosen depending on the image. The results are shown below.