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**CS 445 - Project 4: Image Based Lighting**

Complete the claimed points and sections below.

| | |
|---|---|
| **Total Points Claimed** | **[ 140 ] / 210** |
| **Core** | |
| 1. Recovering HDR maps | |
| a. Data collection | [ 20 ] / 20 |
| b. Naive HDR merging | [ 10 ] / 10 |
| c. Weighted HDR merging | [ 15 ] / 15 |
| d. Calibrated HDR merging | [ 15 ] / 15 |
| e. Additional HDR questions | [ 15 ] / 10 |
| 2. Panoramic transformations | [ 10 ] / 10 |
| 3. Rendering synthetic objects | [ 30 ] / 30 |
| 4. Quality of results / report | [ 10 ] / 10 |
| **B&W** | |
| 5. Additional results | [ 20 ] / 20 |
| 6. Other transformations | [ 0 ] / 20 |
| 7. Photographer & Tripod removal | [  ] / 25 |
| 8. Local tone-mapping operator | [ 0 ] / 25 |

## 1. Recovering HDR maps

Include

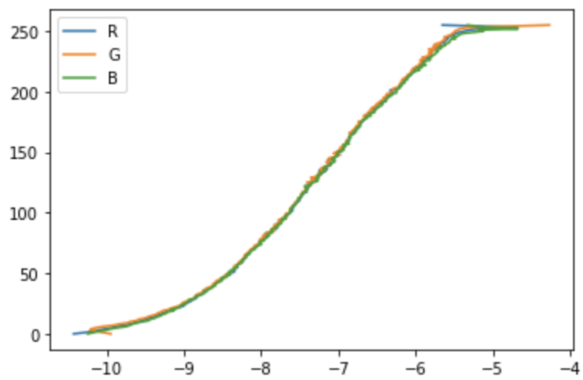
- (a) Your LDR images (if you took your own)

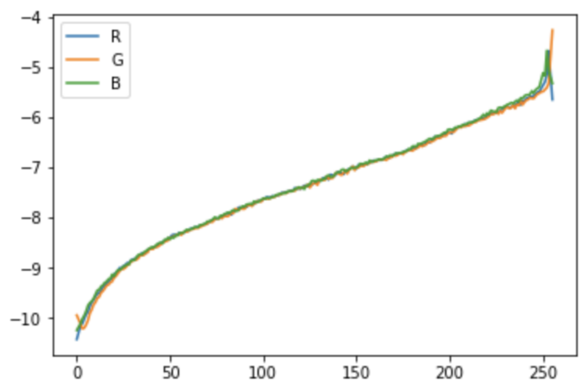
- (b) Figure of rescaled log irradiance images from naive method

- (d) Figure of rescaled log irradiance images from calibration method

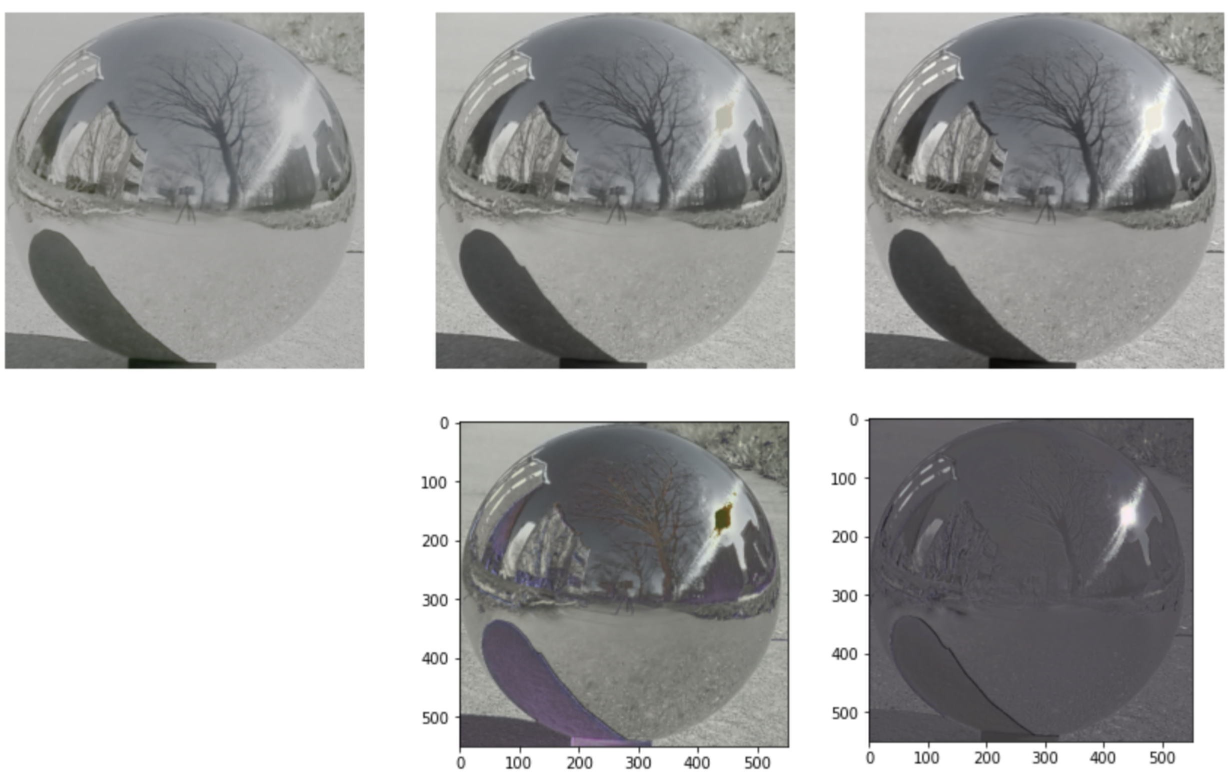
- (d) Plots of g vs intensity and intensity vs g

Lambda: 10




- (b-d) Figure comparing the three HDR methods (bottom row is difference from naive HDR)



Note: Multicolored blotch is due to extremely high brightness (where values approach 1). This is where the sun is reflected off the sphere. TA said it is ok.

- (b-d) Text output comparing the dynamic range and RMS error consistency of the three methods

```
naive:          log range =  4.216      avg RMS error =  0.454
weighted:       log range =  4.466      avg RMS error =  0.407
calibrated:     log range =  5.395      avg RMS error =  6.404
```

- (e) Answers to the questions below

*Note if you claim credit for data collection, you must use your own images for parts 1-3*

Answer these questions:

1. For a very bright scene point, will the naive method tend to over-estimate the true brightness, or under-estimate? Why?

The naive method will underestimate the overall brightness. This was demonstrated during this MP, where my scene was taken outdoors in full sunlight (and the sun was reflected on the sphere). The entire image appeared somewhat washed out, almost as if it was a faded painting on a white canvas. The naive method assumes a linear relationship between intensity and total exposure, which breaks down when pixels get very bright. The pixels' increase in brightness slows down as exposure times keep going down (especially when the pixels approach complete whiteness), yielding a much higher irradiance. This skews the average irradiance to be higher, which in turn results in results in a brighter image with overestimated brightness.

2. Why does the weighting method result in a higher dynamic range than the naive method?

The weighting function assigns higher weights to pixels if they are closer to the "middle" (aka a=128) in brightness. This lessens the "impact" of very dark or very light pixels when compositing takes place, allowing for the image to overall have a higher dynamic range and display colors across the dynamic range. Brighter and darker spots get "smooshed" closer to the center (a=128) due to the weights.

3. Why does the calibration method result in a higher dynamic range than the weighting method?

The calibration method attempts to generate radiances for each image calibrated across all other images. The intent is to yield a final image that has a high dynamic range by calibrating the pixels to be darker or lighter depending on the overall image. The weighting method attempted to do this in a much simpler way by simply weighting the pixels (with higher weights for pixels closer to medium brightness), but the calibration method does the calibration across ALL images (this is why a pixel sample from ALL images was passed into the function) and assigns g-scores for each channel for each brightness level. By taking into account all images, the best dynamic range can be assigned across all three methods.

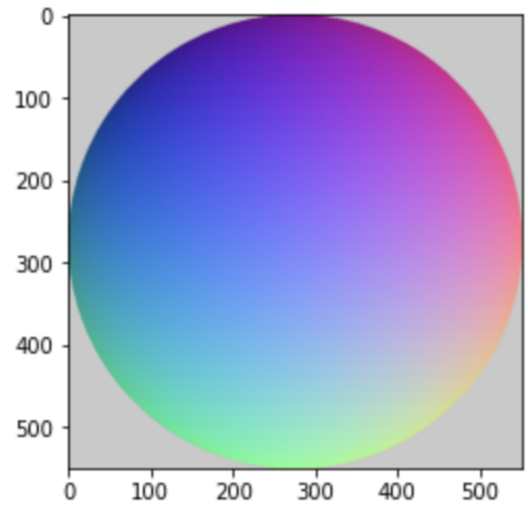
4. Why does the calibration method result in higher consistency, compared to the weighting method?

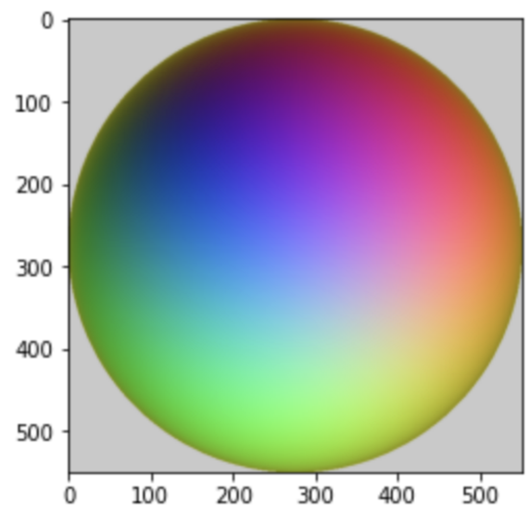
The calibrated image varies more from the original images (and irradiances) due to the fact that it is a composite of several radiances that have been calibrated to each image. The overall image is visually more pleasing, but the original images had a much lower dynamic range, meaning that the calibrated image will differ more from the originals and have a higher RMS error consistency. In a sense, the composited image almost appears to combine the darker parts of the long exposure images with the brighter parts of the short exposure images.

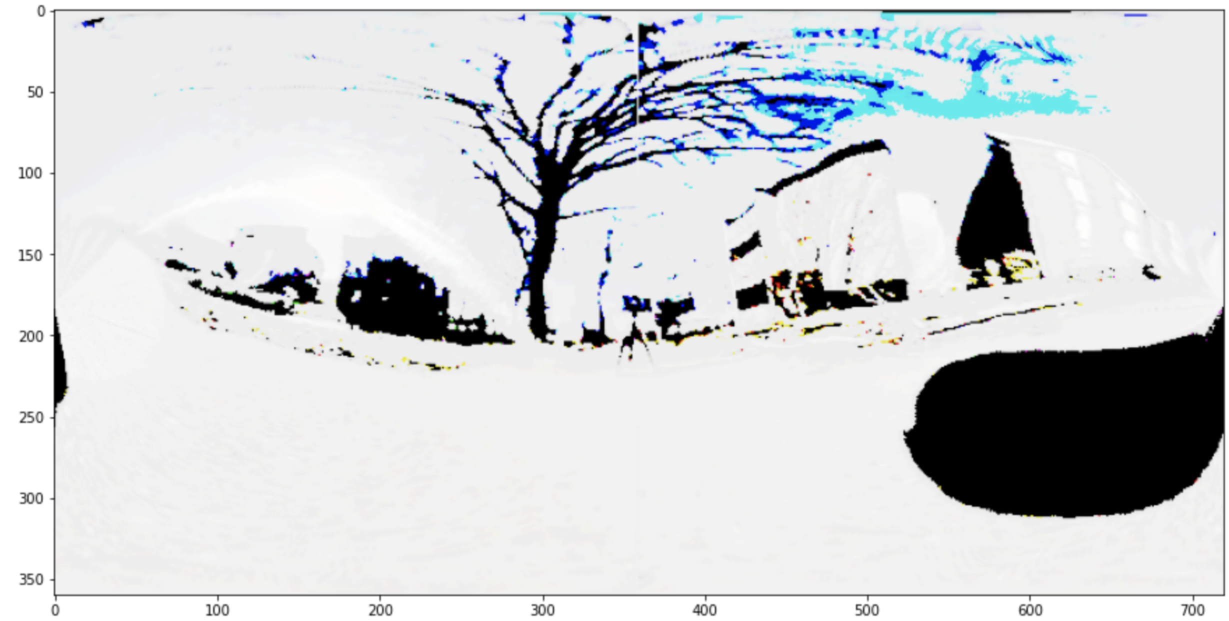
**2. Panoramic transformations**

Include:

- The images of normal vectors and reflectance vectors
- The equirectangular image from your calibration HDR result






Note: high brightness due to display function and fact that image was taken outdoors in full sunlight. Actual rendering (next step) works well if strength is set to 200.

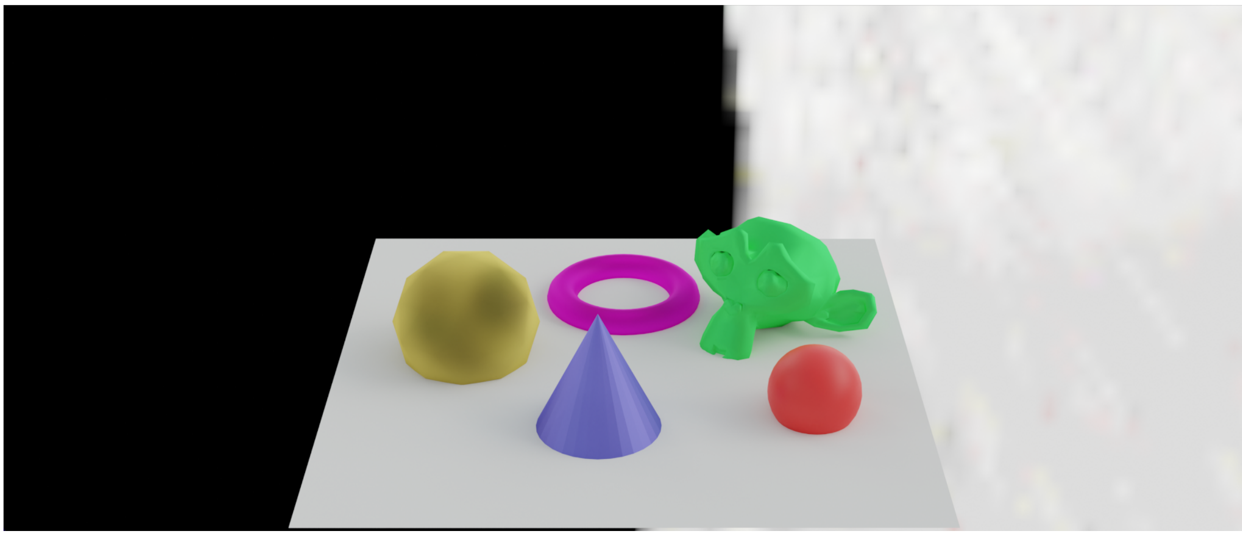
### 3. Rendering synthetic objects

Include:

- Component images: (1) Background image; (2) Rendered image with objects; (3) Rendered image with local geometry (e.g. support plane); (4) Rendered mask image
- Final composited result

Background image:

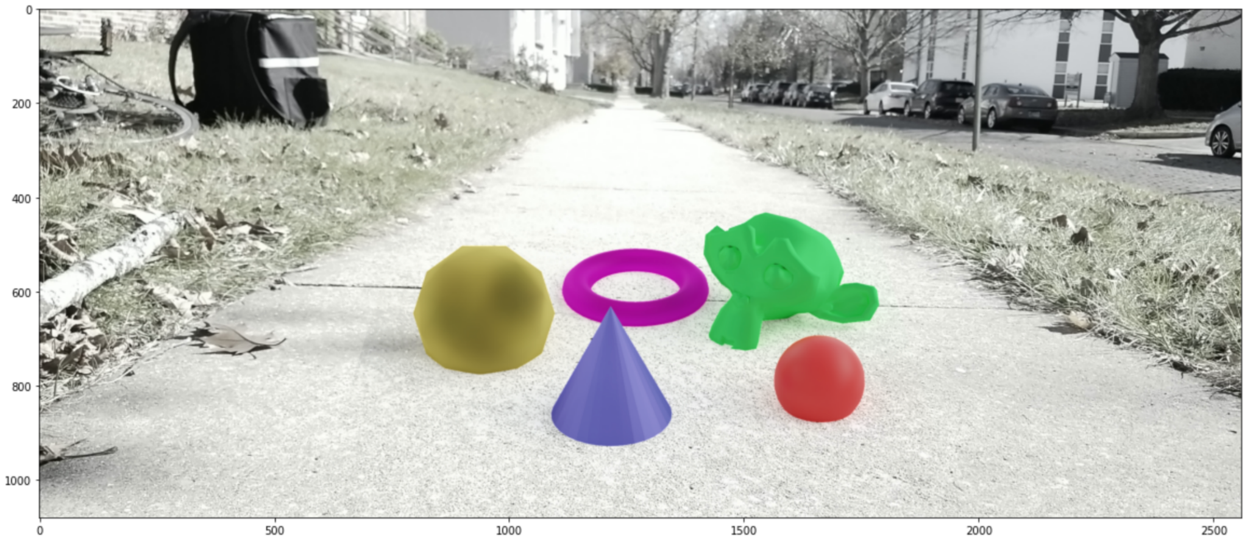
Rendered image with objects (background strength = 200):



Rendered image with local geometry:

Mask:

Final composited image:



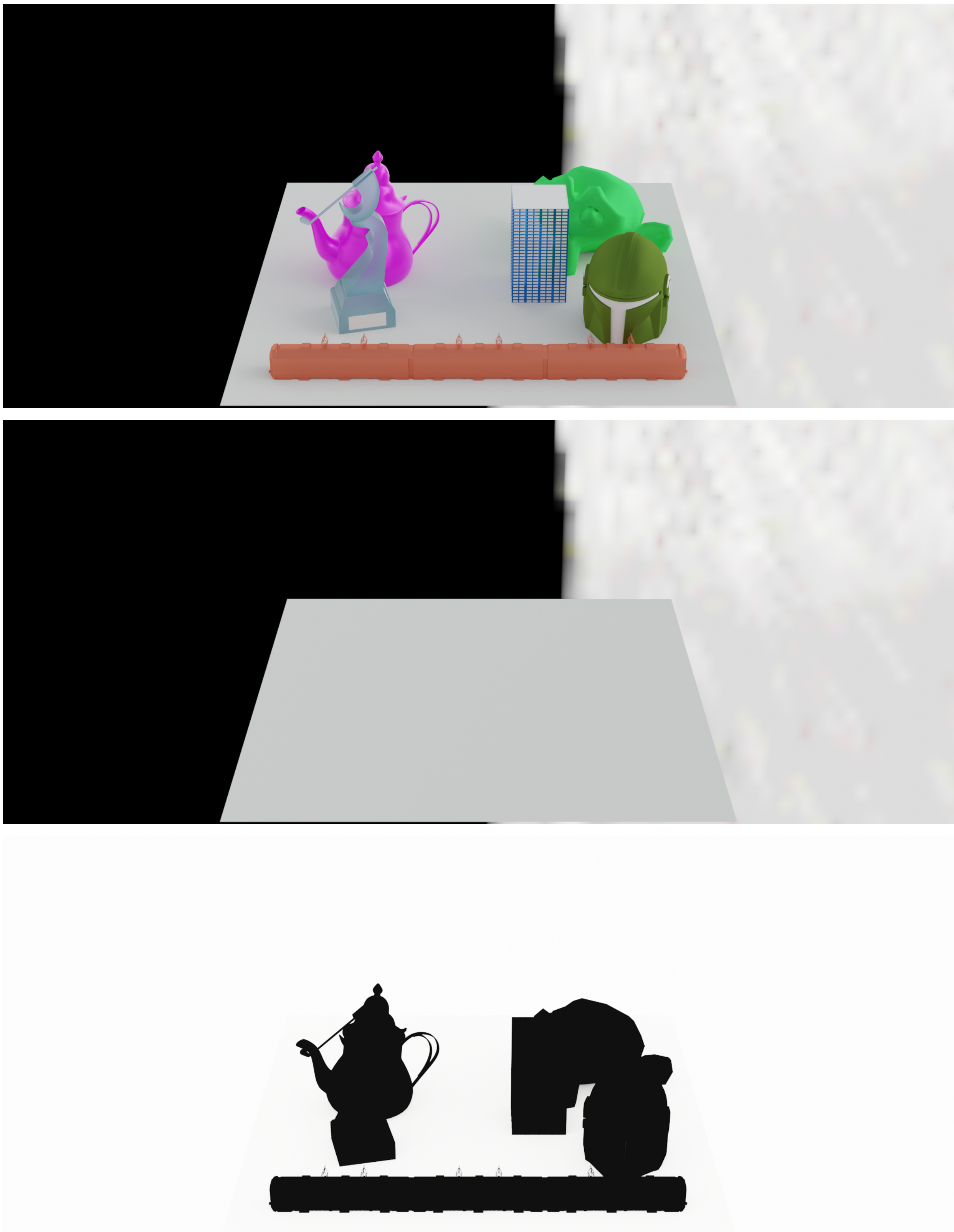

**4. Quality of results / report**

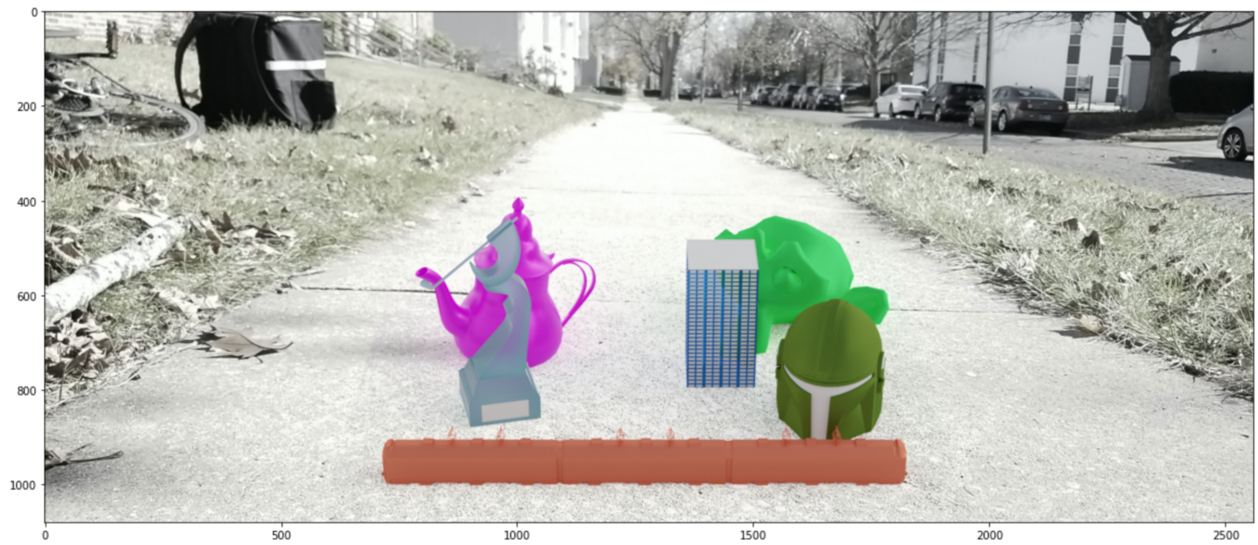
Nothing extra to include (scoring: 0=poor 5=average 10=great).

**5. Additional results (B&W)**

Include background image and final composited result image for: (10 pts each)

- New objects, same environment map

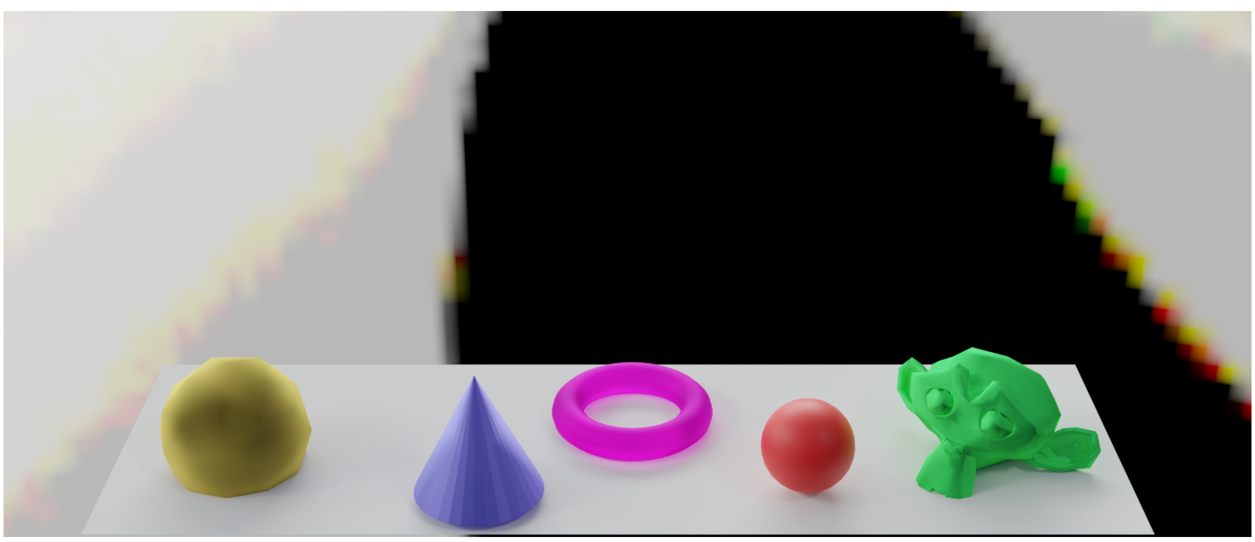





- New environment map, same objects

Images used for new environment map:




### 6. Other transformations (B&W)

Include (10 pts each)

- Angular environment map
- Vertical cross environment map

### 7. Photographer and tripod removal (B&W)

Include:
- Original LDR images
- Equirectangular image created from your own photos without photographer
- Explain your method

**8. Local tone-mapping operator (B&W)**

Include:
- Displayed HDR image, computed as linearly rescaled log of HDR image
- Your HDR image display improved by tone mapping
- Explain your method

**Acknowledgments / Attribution**

List any sources for code or images from outside sources