

# **Comp Photography (Spring 2015) Final Project**

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# Tone Mapping

Extending HDR Assignment to include Tone Mapping for addressing the strong contrast reduction and the loss of detail observed seen with straight normalization of HDR output.

# The Goal of Your Project

In Assignment 10 we created a HDR image. However we did not finish the final step of making the HDR image viewable. We just normalized the radiance map to output an image. The result was washed out(contrast loss) image that did not look good. So I took on the challenge expressed in the note in the assignment:

*Note(2): We do not perform tone mapping which is an additional step of HDR images due to filters which are not readily available in the libraries we use. There are great resources for how to do this but the output image will give you a decent idea of how tone mapping can be performed. This is why the output will not have as many bright tones as some HDR algorithms output.*

## Assignment 10

### Output: HDR



## Goal: Output From Prof. Essa

### From CP-05-04 Slides



## Assignment 10

### Output: HDR

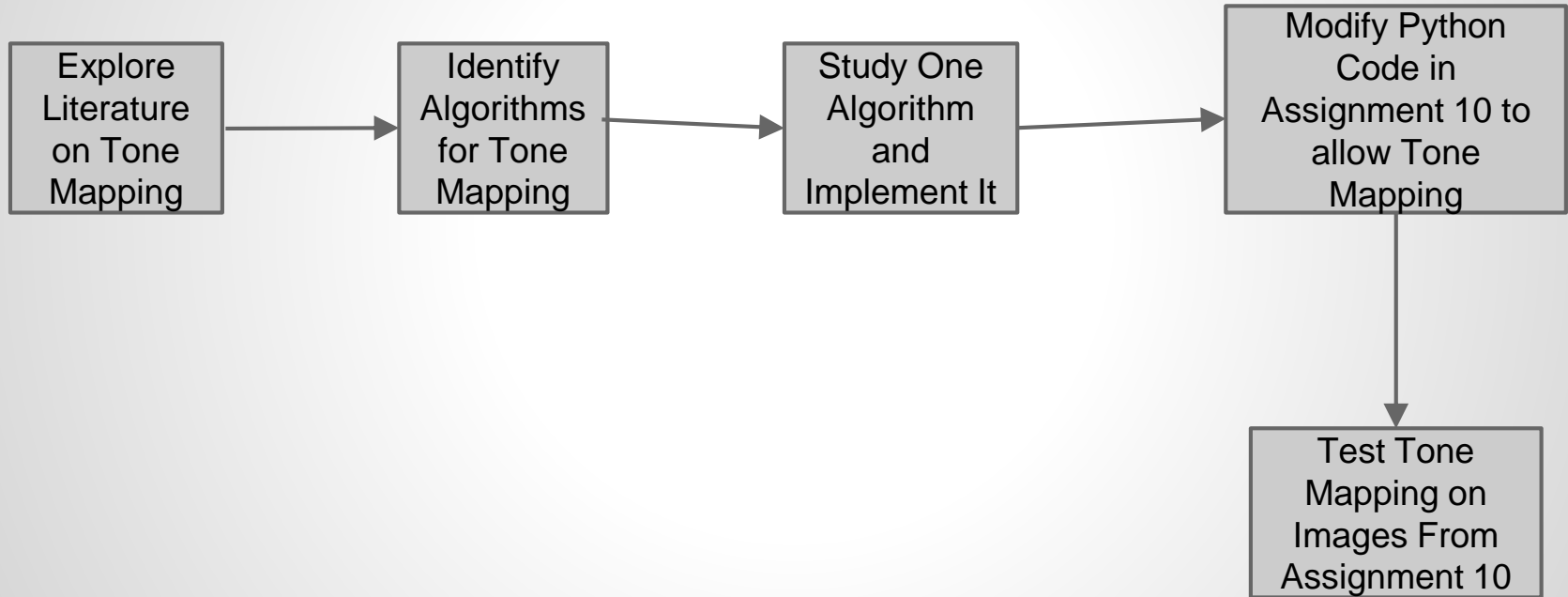


## This Project Result

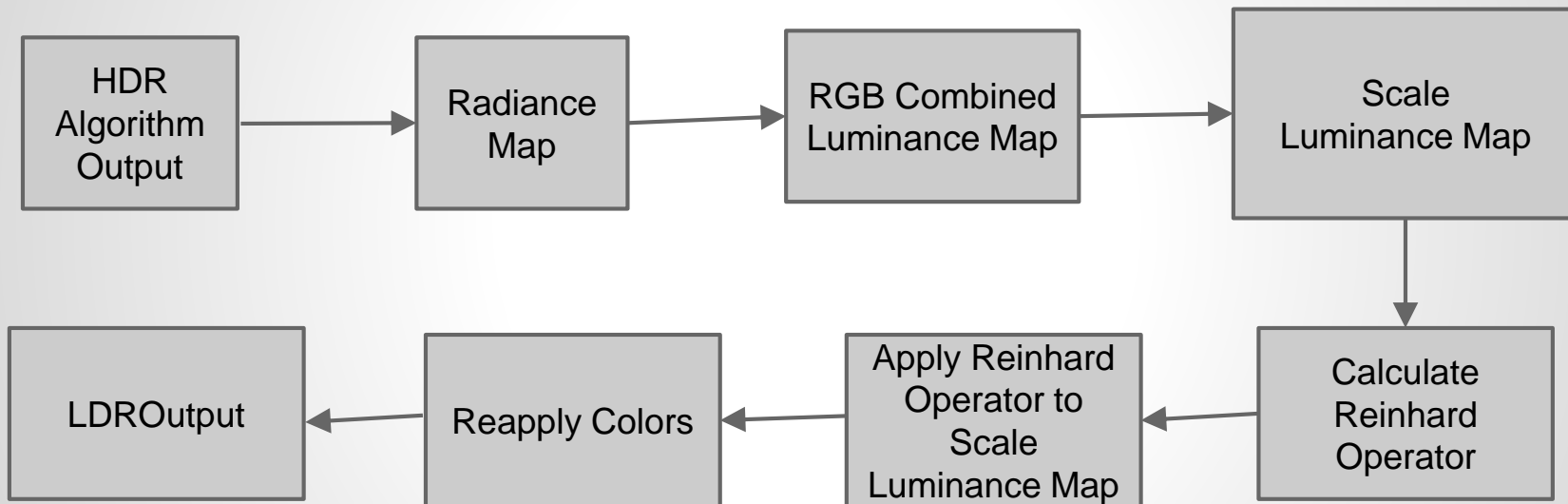
### LDR: Tonemapped



# Project Pipeline



# Tone Mapping Pipeline



# Python Code Pipeline

readImages()

computeResponseCurve()

computeRadianceMap()

computeLDR()

computeImage()



# Project Links

- This Report

[https://github.com/muraligit/6475Project/blob/master/6475/Final\\_Report.pptx](https://github.com/muraligit/6475Project/blob/master/6475/Final_Report.pptx)

- Python Code:

<https://github.com/muraligit/6475Project/blob/master/6475/final.py>

- Input Images:

<https://github.com/muraligit/6475Project/tree/master/6475/input>

- Output Images:

<https://github.com/muraligit/6475Project/tree/master/6475/output>

# What worked

- Improved Color Reproduction  
(Example See the wall, carpet, and wall painting colors)
- Improved Detail  
(For Example: Lawn Chairs outside, Paintings on the wall, leaves)
- Improved Contrast  
(Washed-Out before to Good-Contrast after, For Example see the carpet and cieling)

Before



After



# What did not work?

- Result was not as good as the output

Prof. Essa showed in class (Color reproduction and contrast was not as good, more shadows were also retained)

- So I used matlab build in Image processing toolbox to generate another tone mapped image
- My result appears to be in between the two results

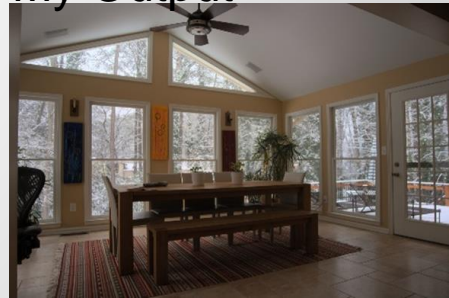
Prof. Essa Output



Matlab hdr/tonemap



My Output



# Needed Improvements

- I tweaked the parameters of Reinhard operator only a little but optimizing these parameters further would improve the result (saturation, key factor, and proportion of RGB to Luminance Map)
- I implemented the simple Reinhard Operator; The improved Reinhard Operator seems to address the issues raised in the previous slide.
  - Used Operator:  $Ld(x, y) = L(x, y) / (1 + L(x, y))$
  - Improved Operator:  $Ld(x, y) = L(x, y) / (1 + V(x, y, s))$   
 $V(x, y, s) = L(x, y) \otimes R_l(x, y, s)$  is the local average luminance,  $R_l$  is a *Gaussian*

# Needed Improvements

- Try Bi-Lateral Filter ( Study of the results published shows that this is a good alternative to try, I started implementing and wanted to present additional results from this also but ran out of time due to the finals)

Durand and Dorsey, Fast Bilateral Filtering for the Display of High-Dynamic-Range Images (<http://people.csail.mit.edu/fredo/PUBLI/Siggraph2002/>)

# References

Tone Mapping Algorithm: E. Reinhard et al. - [Photographic Tone Reproduction for Digital Images](#)

Durand and Dorsey, Fast Bilateral Filtering for the Display of High-Dynamic-Range Images  
(<http://people.csail.mit.edu/fredo/PUBLI/Siggraph2002/>)

CS Notes

# Credits/Thanks

- Prof. Erfan Essa for the motivation and images
- 6475 TA(s) for help with starter HDR code and implementation
- E. Reinhard et al. for the algorithm