281 Live Session

Week 2 — 23/1/18

Agenda

Review — Perspective Projection

Applications Example

Overview of Assignment 2

Group Exercise — Transformations in 2D

Perspective Projection

1: Perspective Projection

2: Image Formation

3: Image Artifacts

4: Convolution

5: Fourier

6: Pyramids, Edges, and Features

7: Image Analysis

8: Least-Squares

9: Total and Iterative Least-Squares

10: Clustering

11: Dimensionality Reduction

12: Linear Classifiers

13: Nonlinear Classifiers

1.2 Image Formation

1.3 Camera Obscura

1.4 Perspective Projection, 2-D (With Exercise)

1.5 Perspective Projection, Inverted

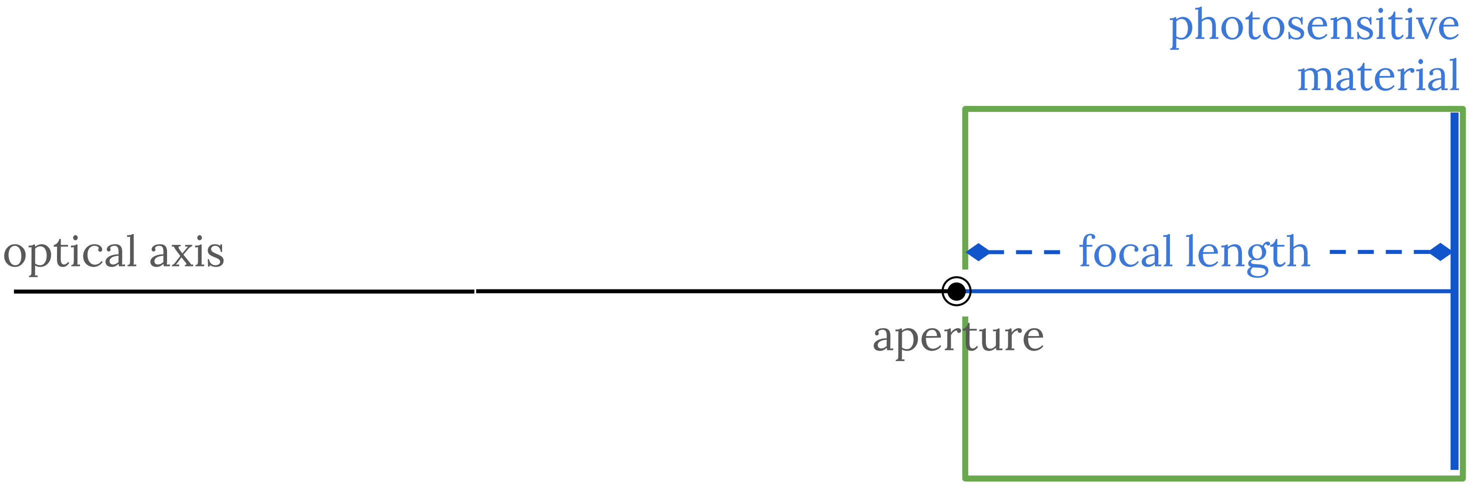
1.6 Perspective Projection, Generalized

1.7 Perspective Projection, 3-D (With Exercise)

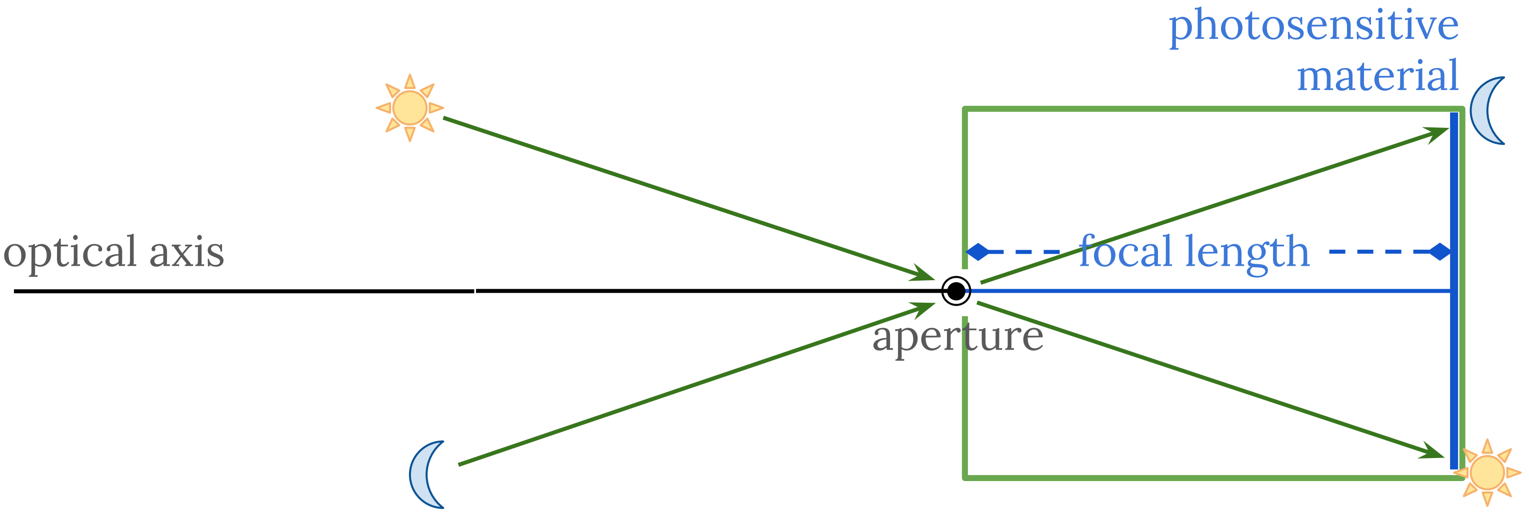
Discussion Questions

- Why is the image on the sensor inverted?
- How does the size of the aperture change the image?
- What is the focal length?
- How does the focal length change the image?
- What ambiguities arise from a projective image?
- What additional information is needed to overcome those ambiguities?

Perspective Projection

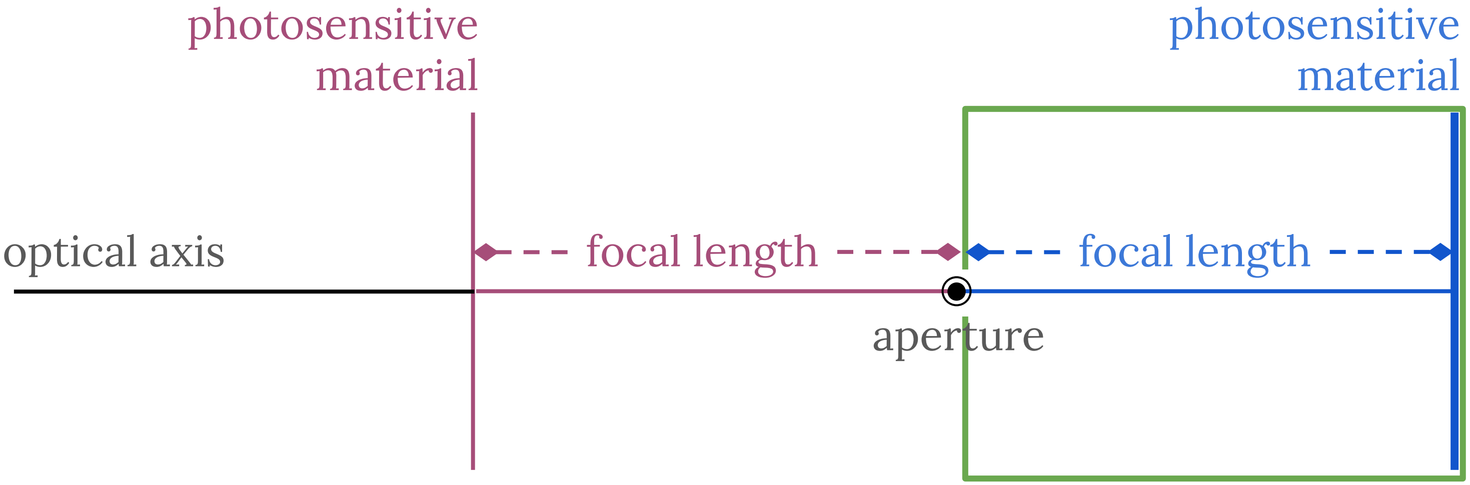


Perspective Projection



Perspective Projection

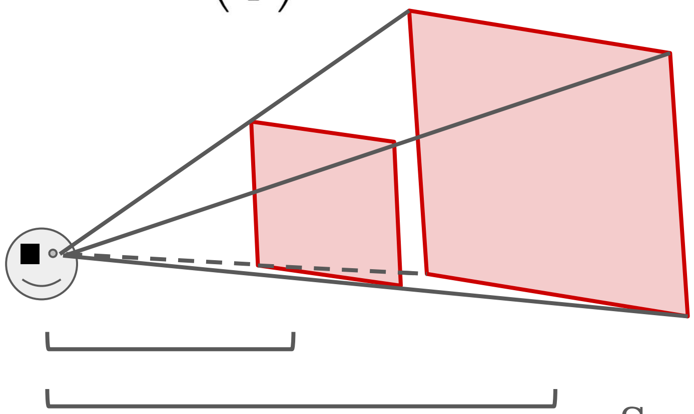
Sign change is for convenience, the two configurations are equivalent



Understanding ‘s’

Homogeneous coordinates are ambiguous up to an unknown scale factor

$$\begin{pmatrix} x_s \\ s \end{pmatrix} = \begin{pmatrix} \lambda f & c_x \\ 0 & 1 \end{pmatrix} \begin{pmatrix} \cos(\theta) & -\sin(\theta) & t_X \\ \sin(\theta) & \cos(\theta) & t_Z \end{pmatrix} \begin{pmatrix} X_w \\ Z_w \\ 1 \end{pmatrix}$$



Same object but closer?
Or larger object farther away?
There is no way to know

Understanding ‘s’

Homogeneous coordinates are ambiguous up to an unknown scale factor

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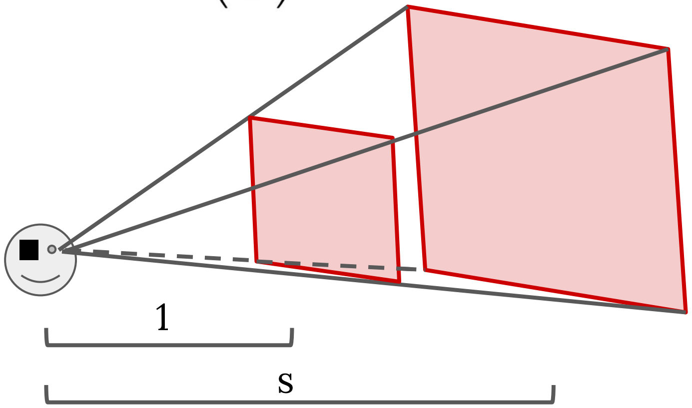
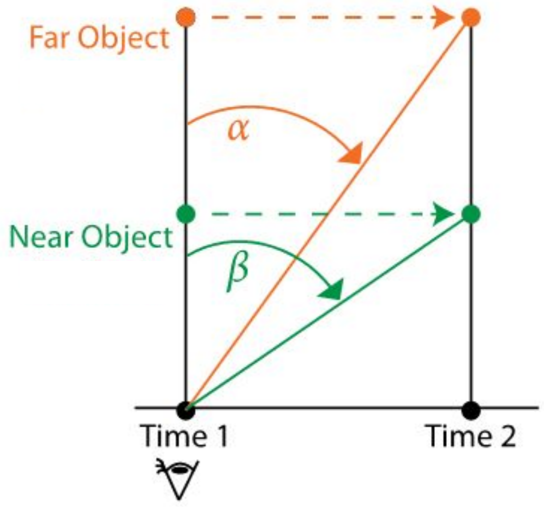


After transforming a point from world to sensor, we divide by ‘s’ to rescale our transformed coordinates to the normalized scale of the sensor

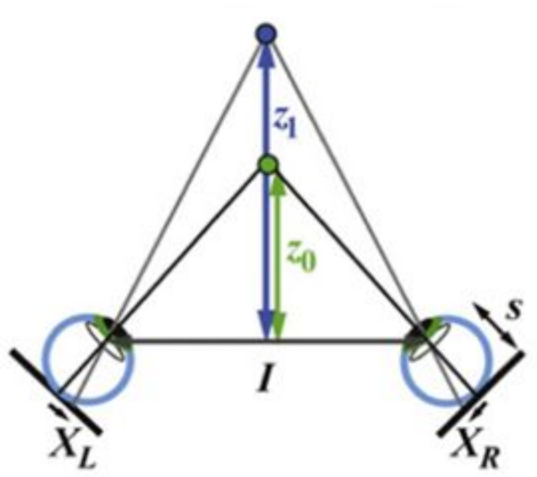
Triangulation Cues

Ambiguity is solved by 2+ observations

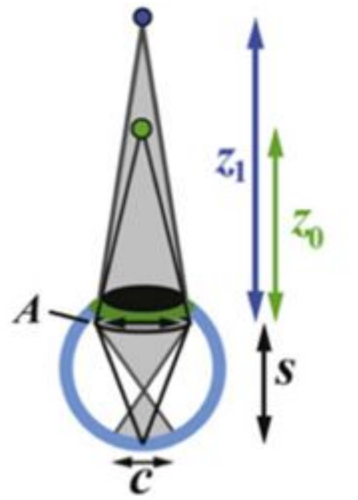
Motion Parallax



Disparity



Blur



Source: Held, Cooper, & Banks (2012)

Perspective Projection

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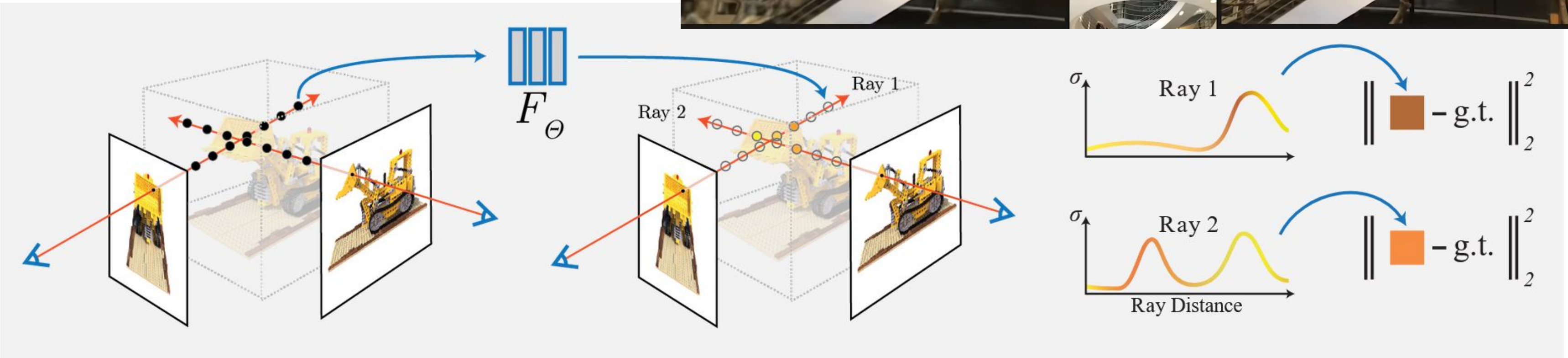
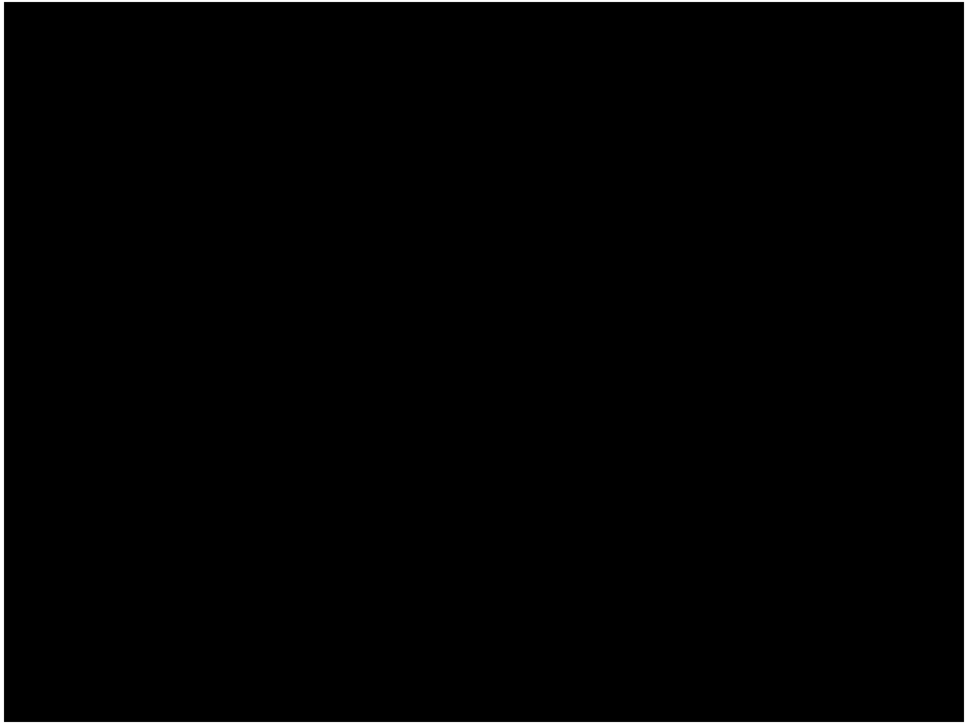
NeRFs — Neural Radiance Fields

Multi-view geometry allows reconstruction of complex scenes



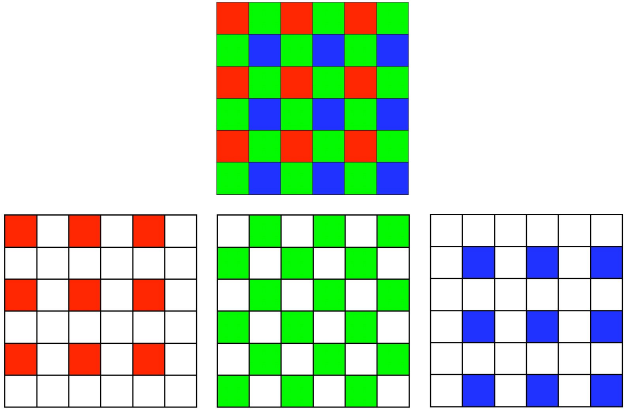
Source: www.matthewtancik.com

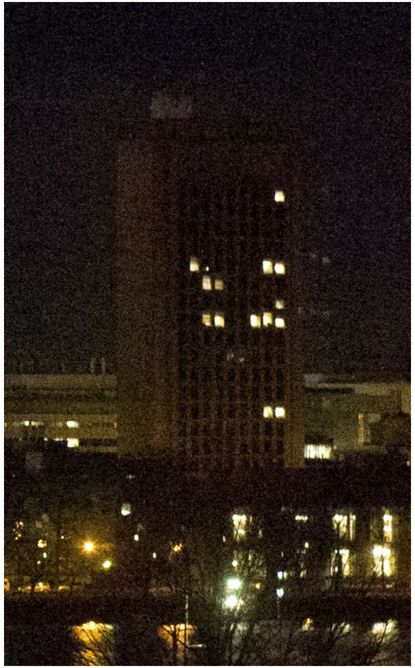
NeRFs — Neural Radiance Fields

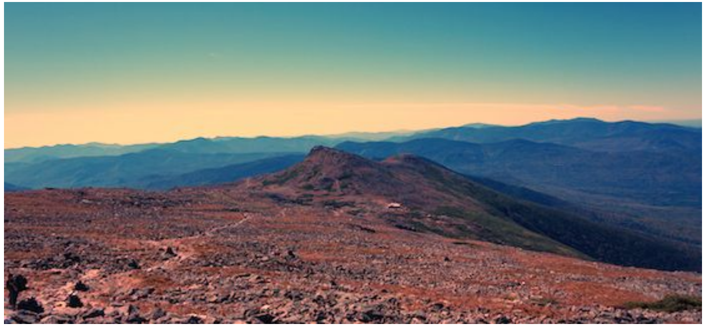


Source: www.matthewtancik.com

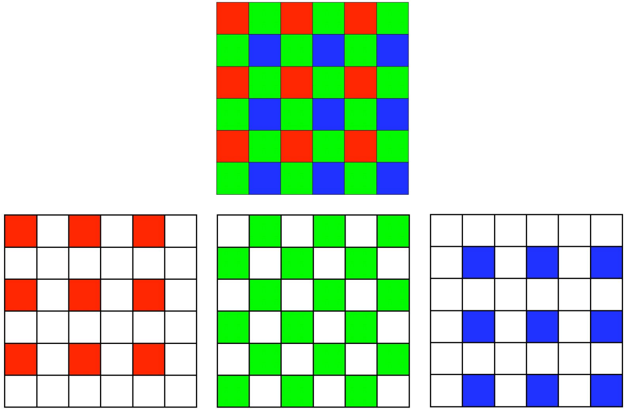
Assignment 2 — Imaging Pipeline





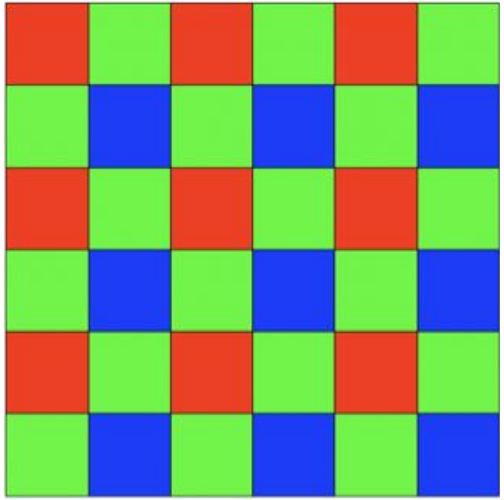


Part 1 — Demosaicing

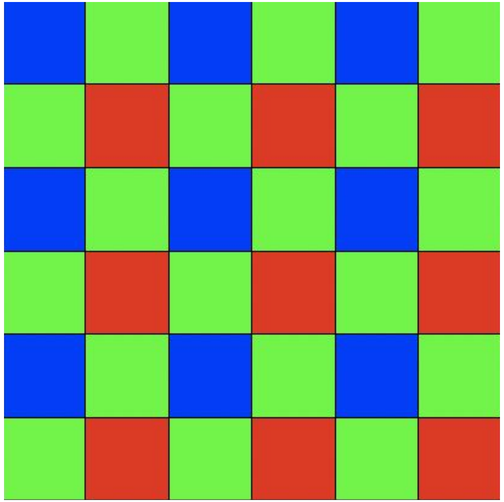


Part 1 — Demosaicing

Notice Bayer pattern offsets



red offset = (0,0)
blue offset = (1,1)
green offset = 1



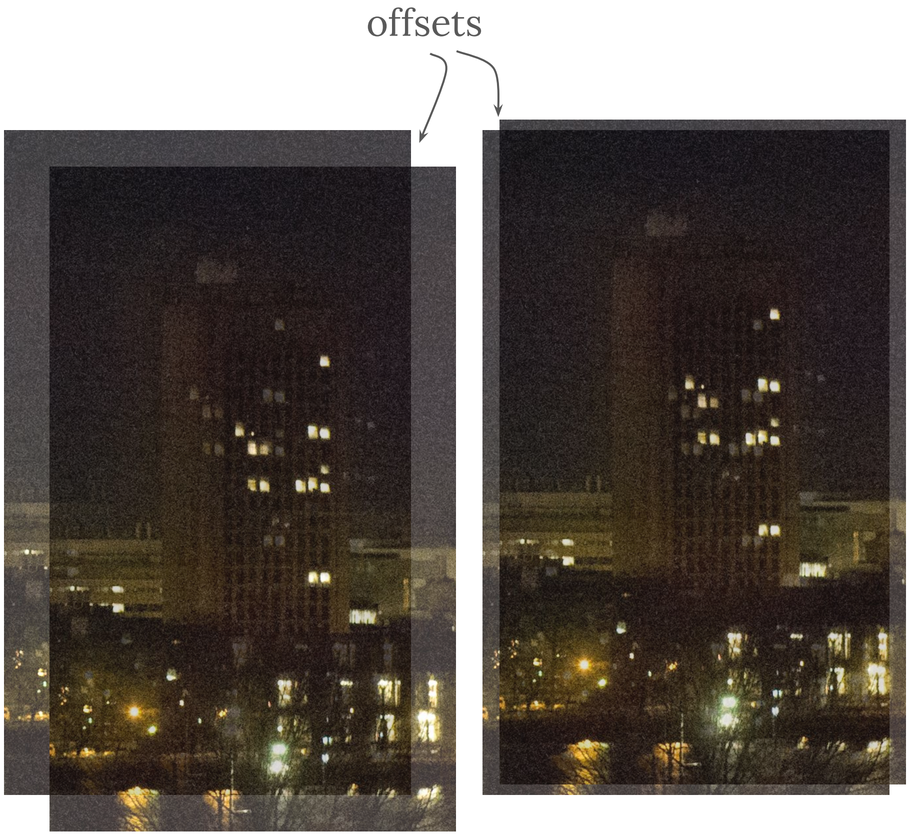
red offset = (1,1)
blue offset = (0,0)
green offset = 1

Part 2 — Denoising

Align all images to the first image

Alignment error == RMS error

Once aligned, average pixels to reduce noise



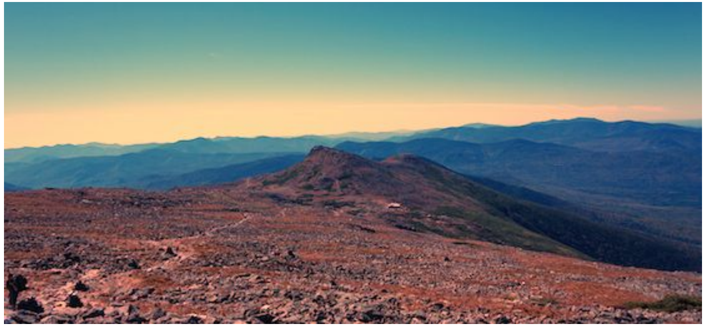
Part 3 — White Balance

Gray World

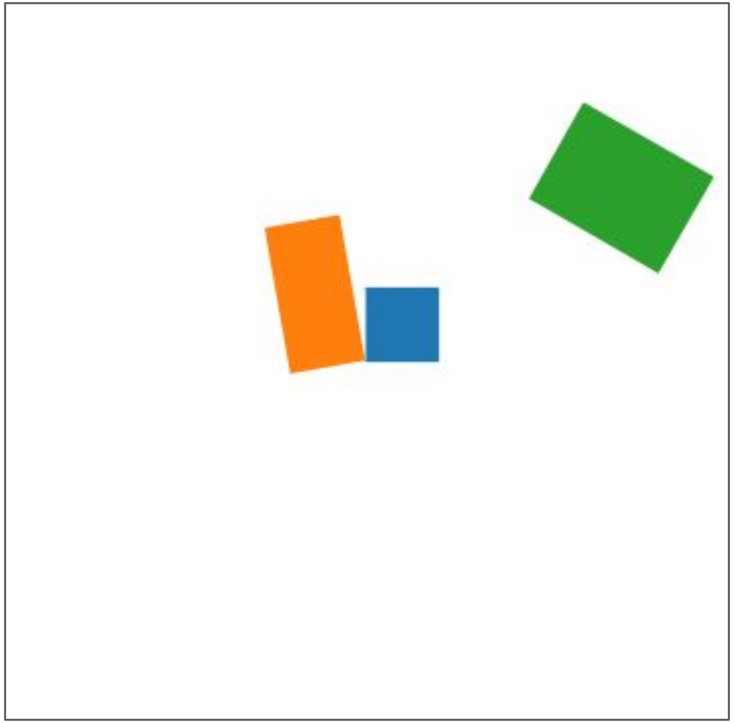
- Get average of each color channel
- Calculate proportional difference of green vs red & blue
- Multiply inverse proportion by red and blue channels

White Patch

- Choose a point
- Calculate average color of region around point
- Multiply inverse proportion of region average by each channel



Group Exercise



Upcoming ToDo's

Assignment 1 due January 30th

Watch async lectures for Unit 2

Accept Assignment 2 on GitHub (due February 6th)

NOTE: Turn in assignments by posting the link to your github repository on the digital campus interface