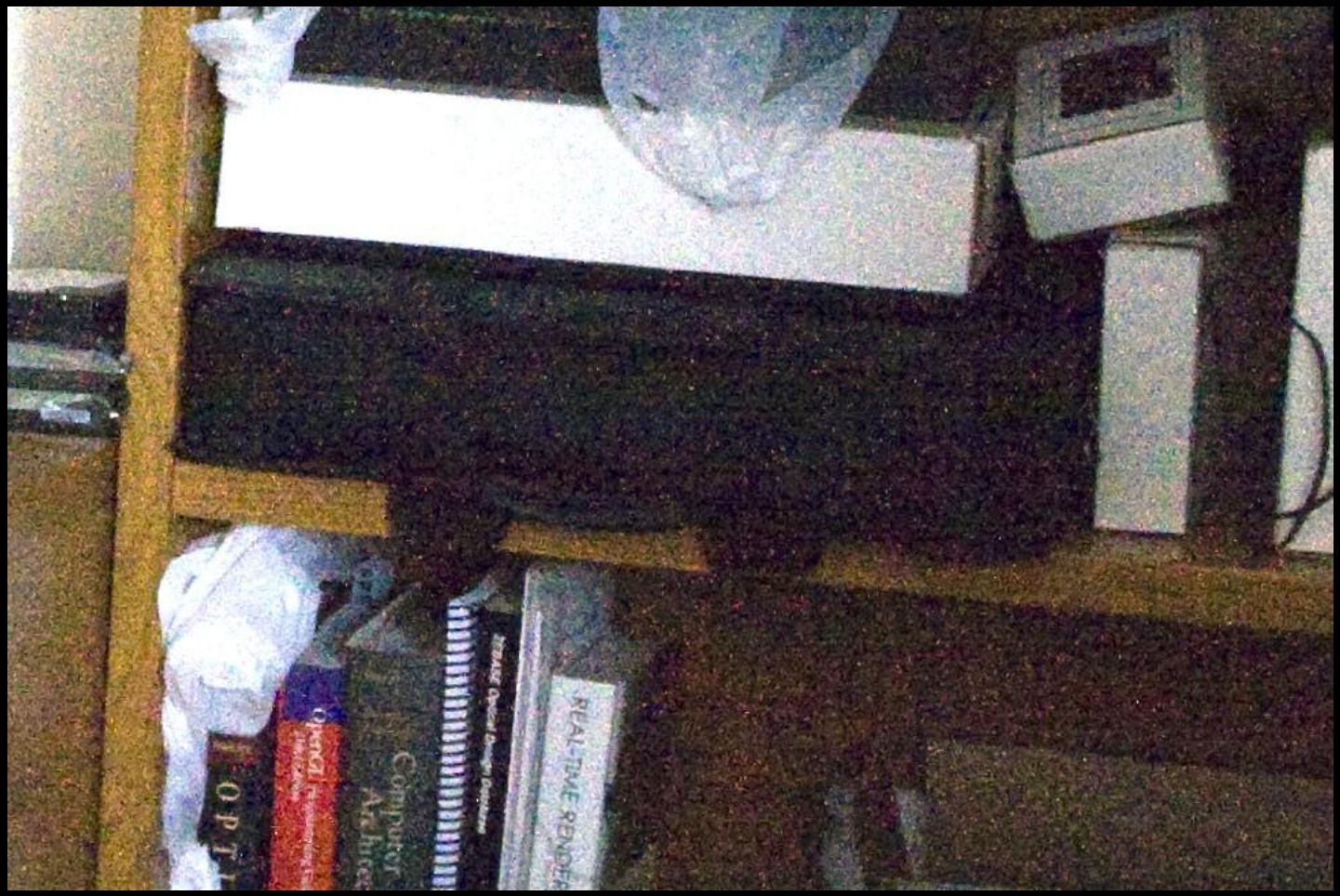
CS448f: Image Processing For Photography and Vision

Blending and Pyramids

Blending

- We’ve aligned our images. What now?
- Averaging
- Weighted averaging
- min/max/median

Noise reduction by Averaging



2 Shots

4 Shots

8 Shots

16 Shots

Noise Reduction by Averaging

- We're averaging random variables X and Y
- Both have variance S^2
- Variance of X+Y = $2S^2$
- Std.Dev. of X+Y = sqrt(2) . S
- Std.Dev of (X+Y)/2 = sqrt(2)/2 . S
- Ie, every time we take twice as many photos, we reduce noise by sqrt(2)

Noise Reduction by Averaging

- Average 4 photos: noise gets reduced 2x
- Average 8 photos: noise gets reduced 3x
- Average 16 photos: noise gets reduced 4x

Noise Reduction by Median

- (demo)

Median v **Average**

Median v Average

Can we identify the bad pixels?

- They’re unlike their neighbours
- Instead of averaging, weighted average
  - where weight = similarity to neighbours

Weighted Average

Can we identify the bad pixels?

- They’re unlike their neighbours
- Instead of averaging, weighted average
  - where weight = similarity to neighbours
- Favors blurriness ☹

Input

Other uses of Median

- Removing Transient Occluders
- (live demo)
- (Gates demo)
- (surf demo)

Panorama Stitching

Panorama Stitching

Panorama Stitching

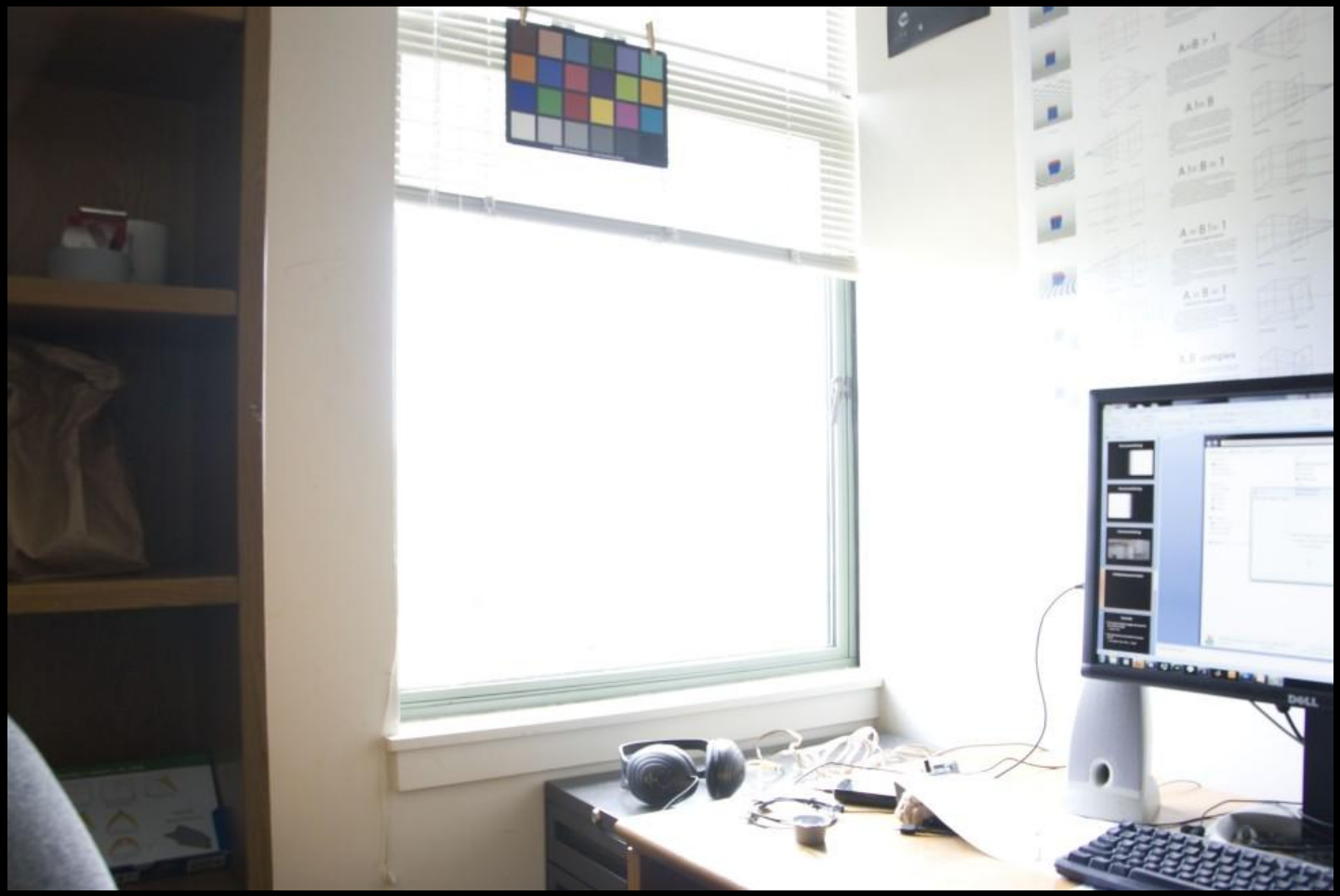
Panorama Stitching

Panorama Stitching

Multiple Exposure Fusion

Multiple Exposure Fusion

Multiple Exposure Fusion



Multiple Exposure Fusion

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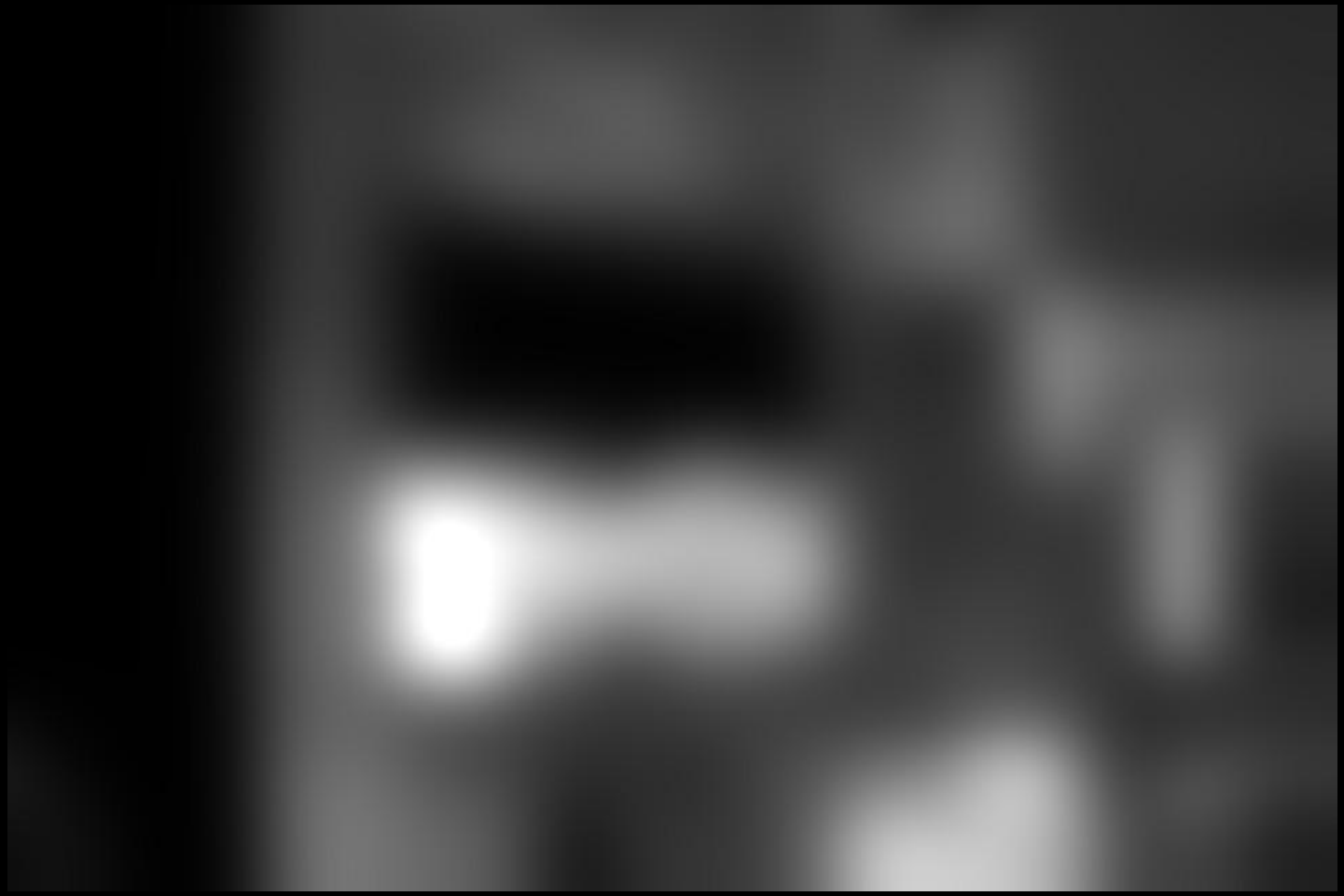
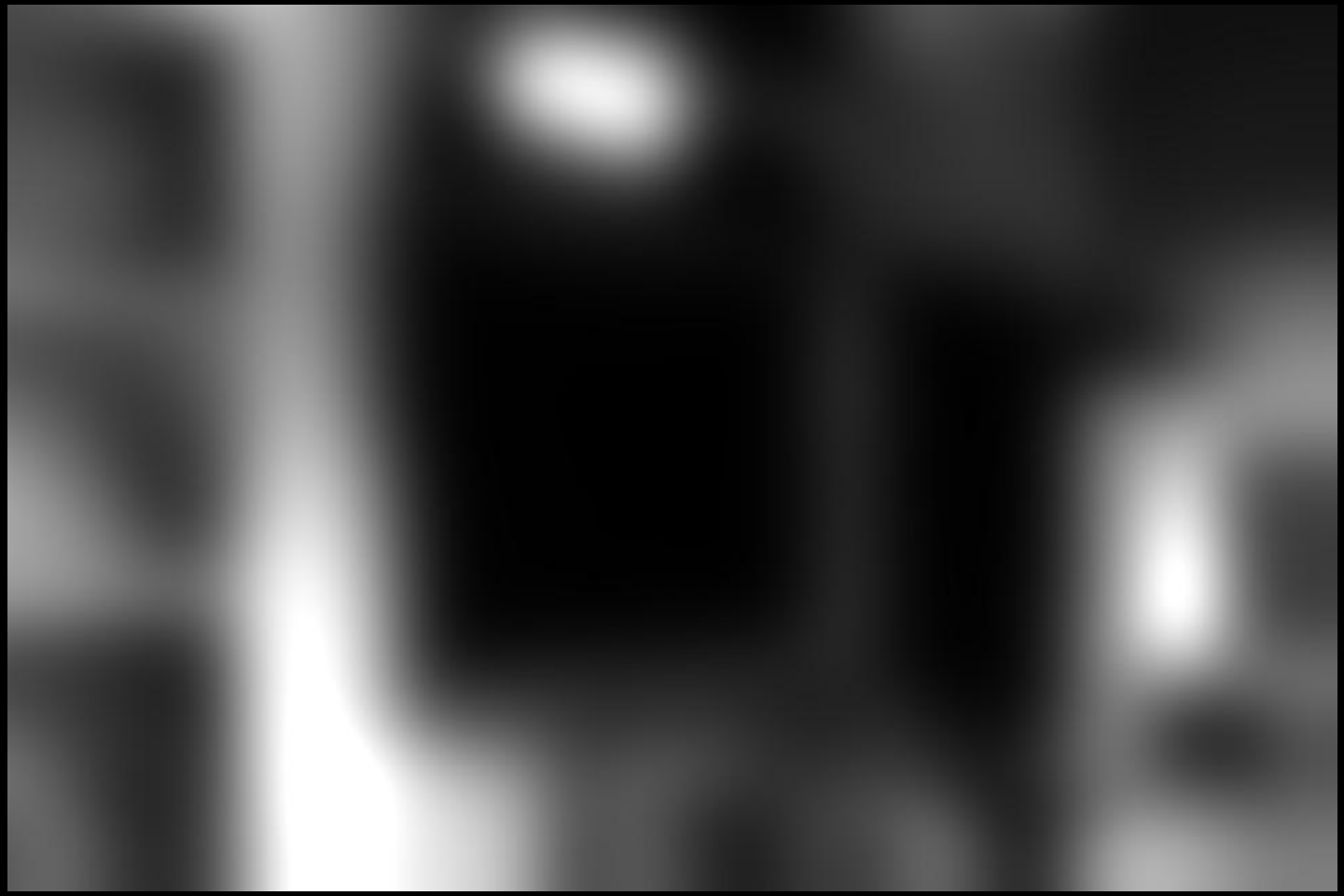
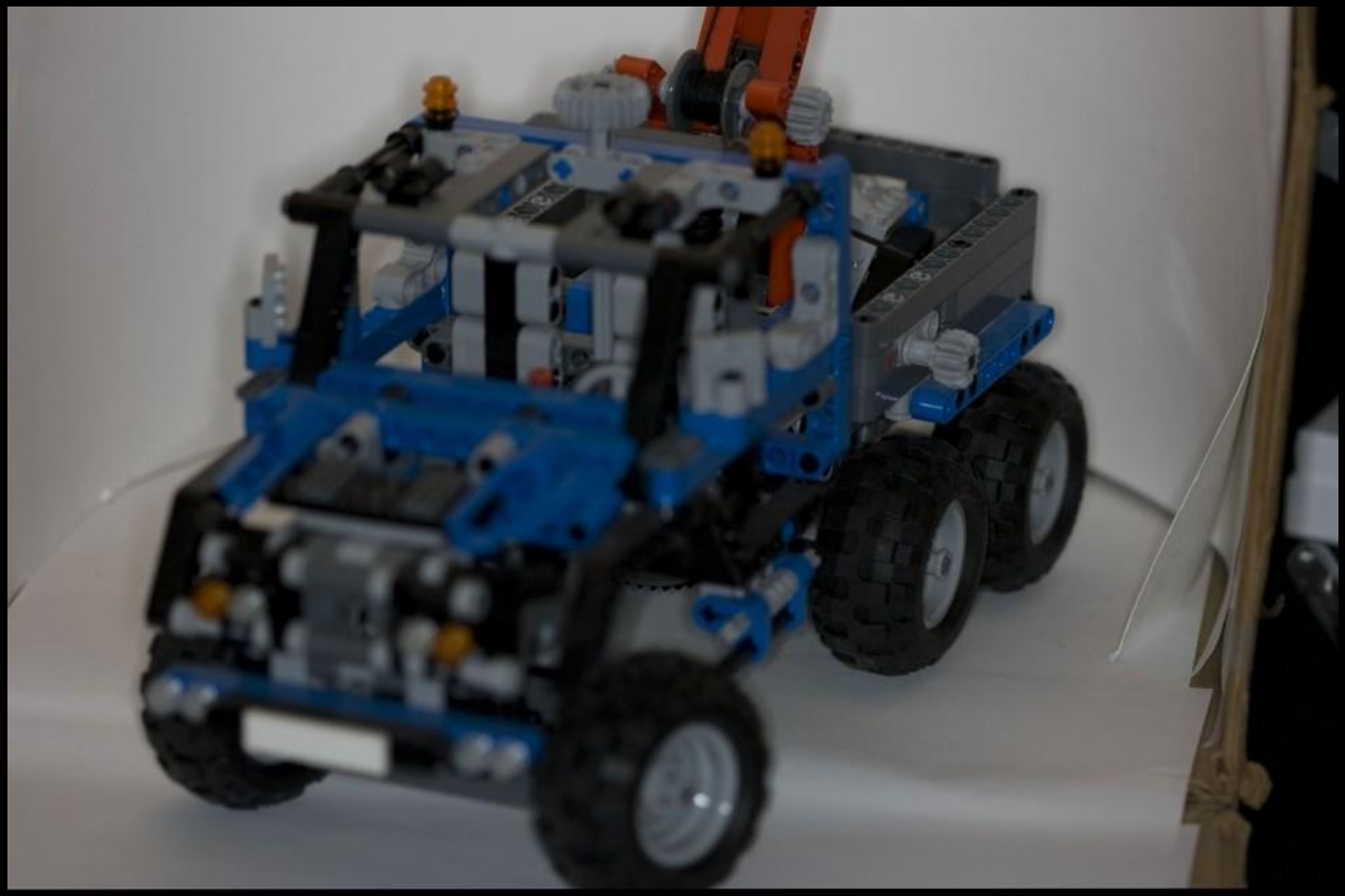


Multiple Exposure Fusion

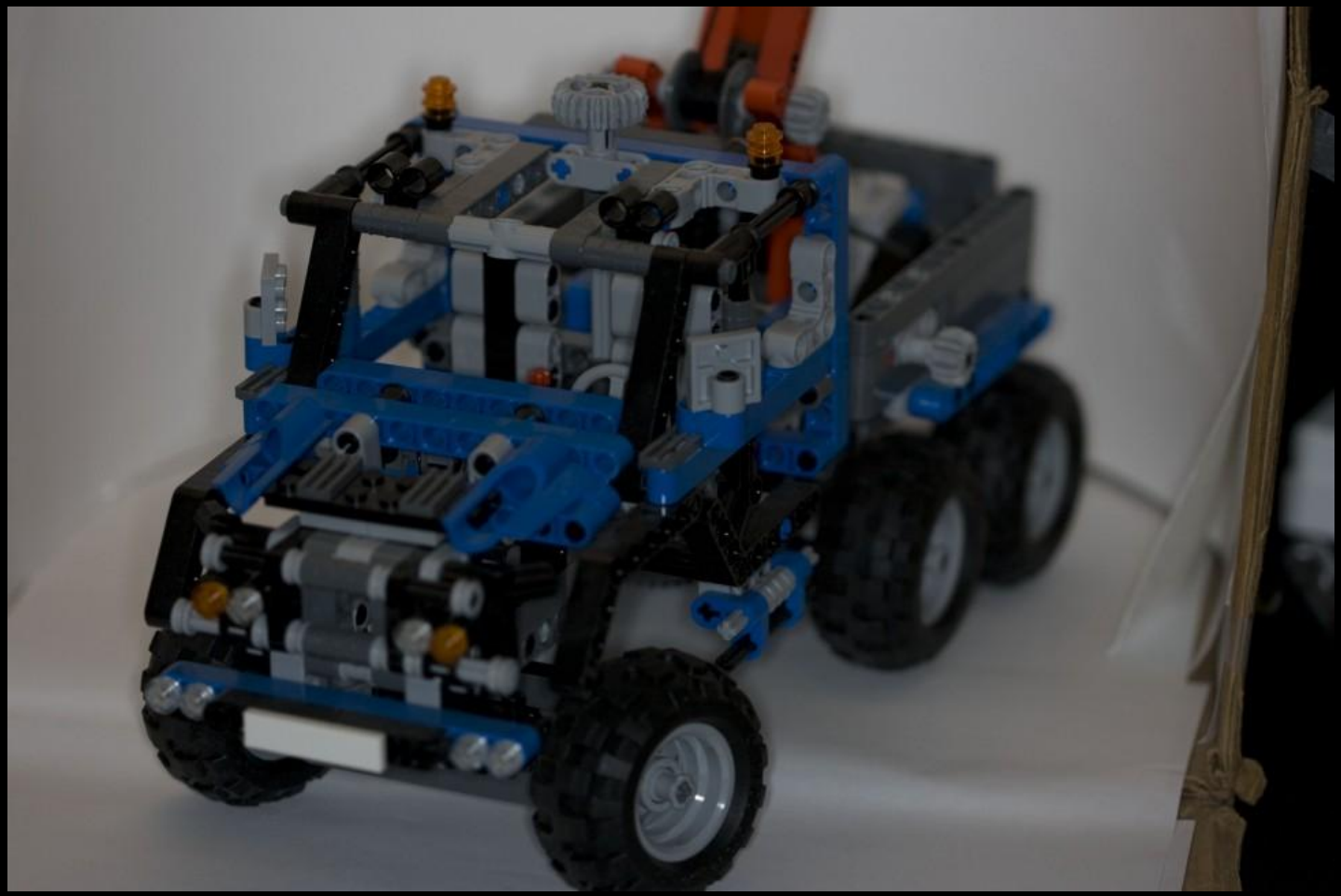


Multiple Exposure Fusion

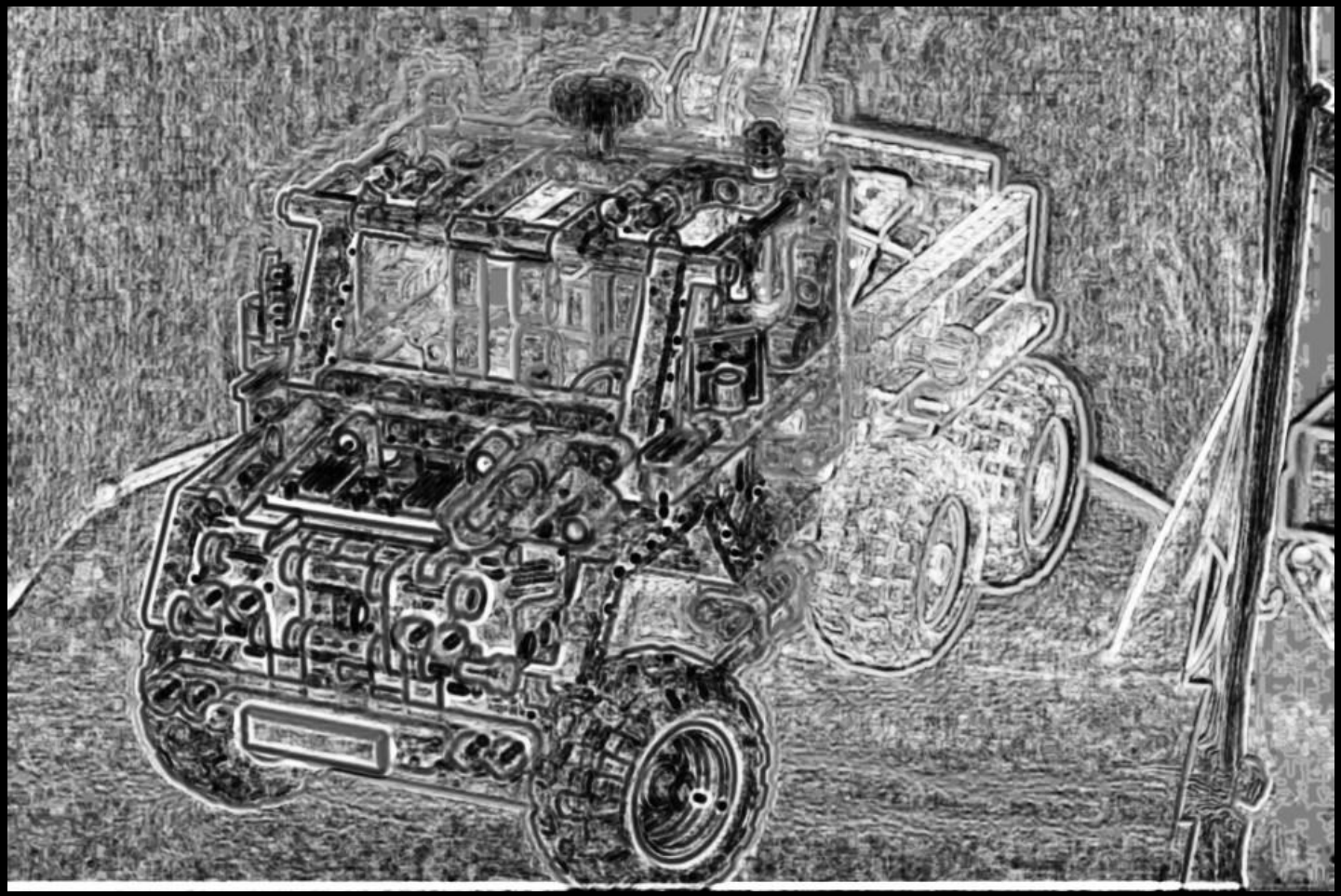
Focus Fusion



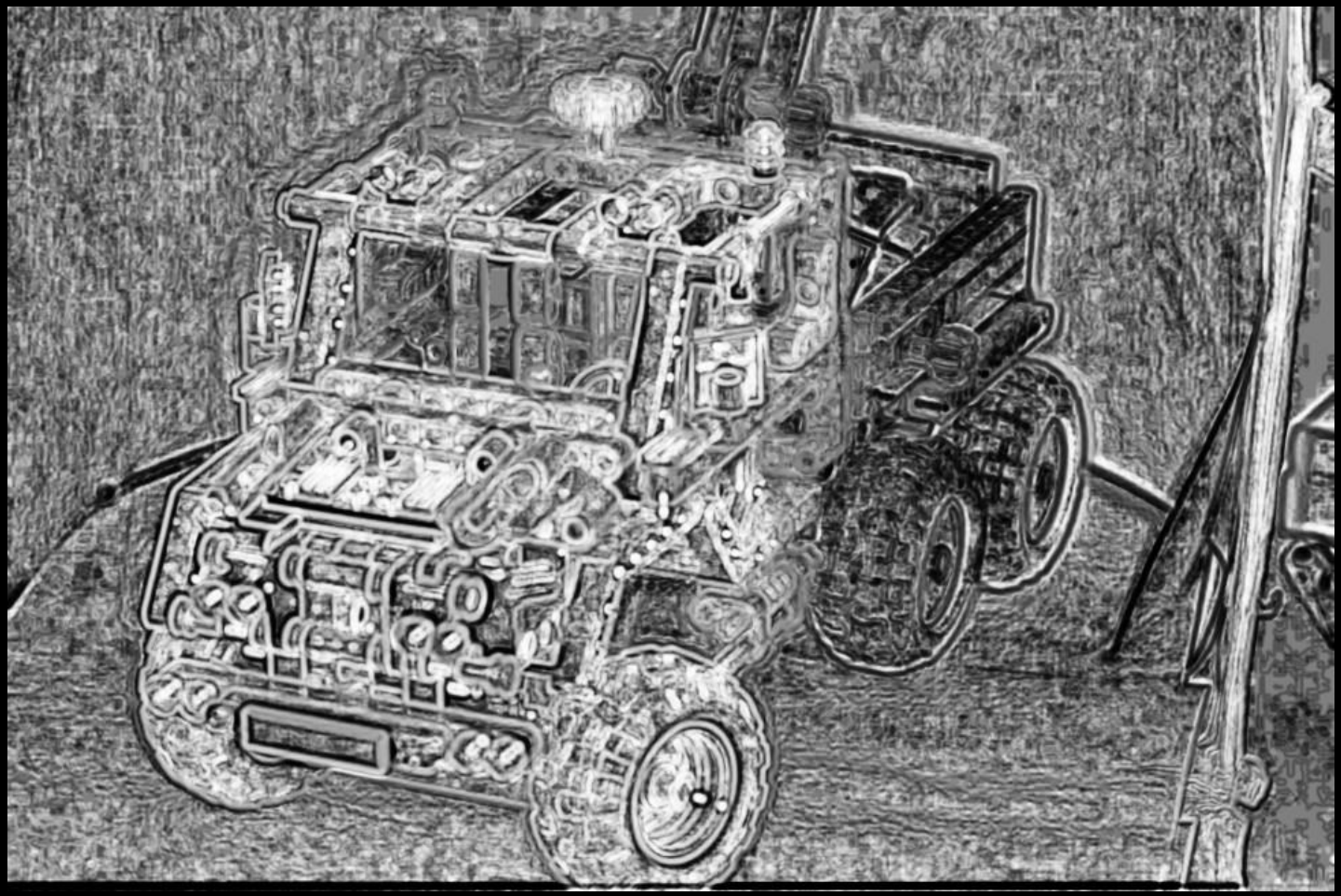
Focus Fusion



Focus Fusion



Focus Fusion



Focus Fusion

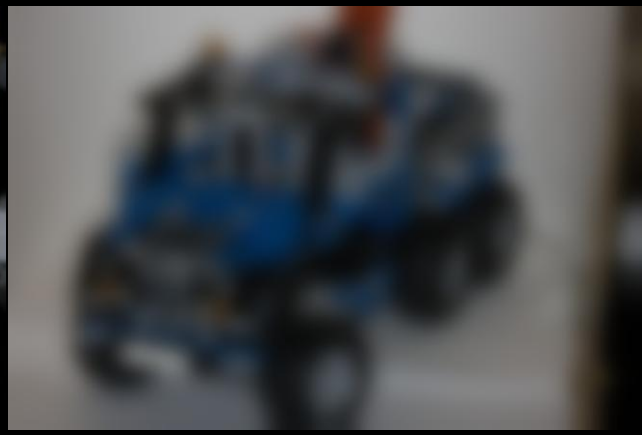
Pyramids

- We've been breaking images into two terms for a variety of apps
  - Coarse + Fine
- More generally we can break it into many terms:
  - Very coarse + finer + finer ... + finest.

Pyramids

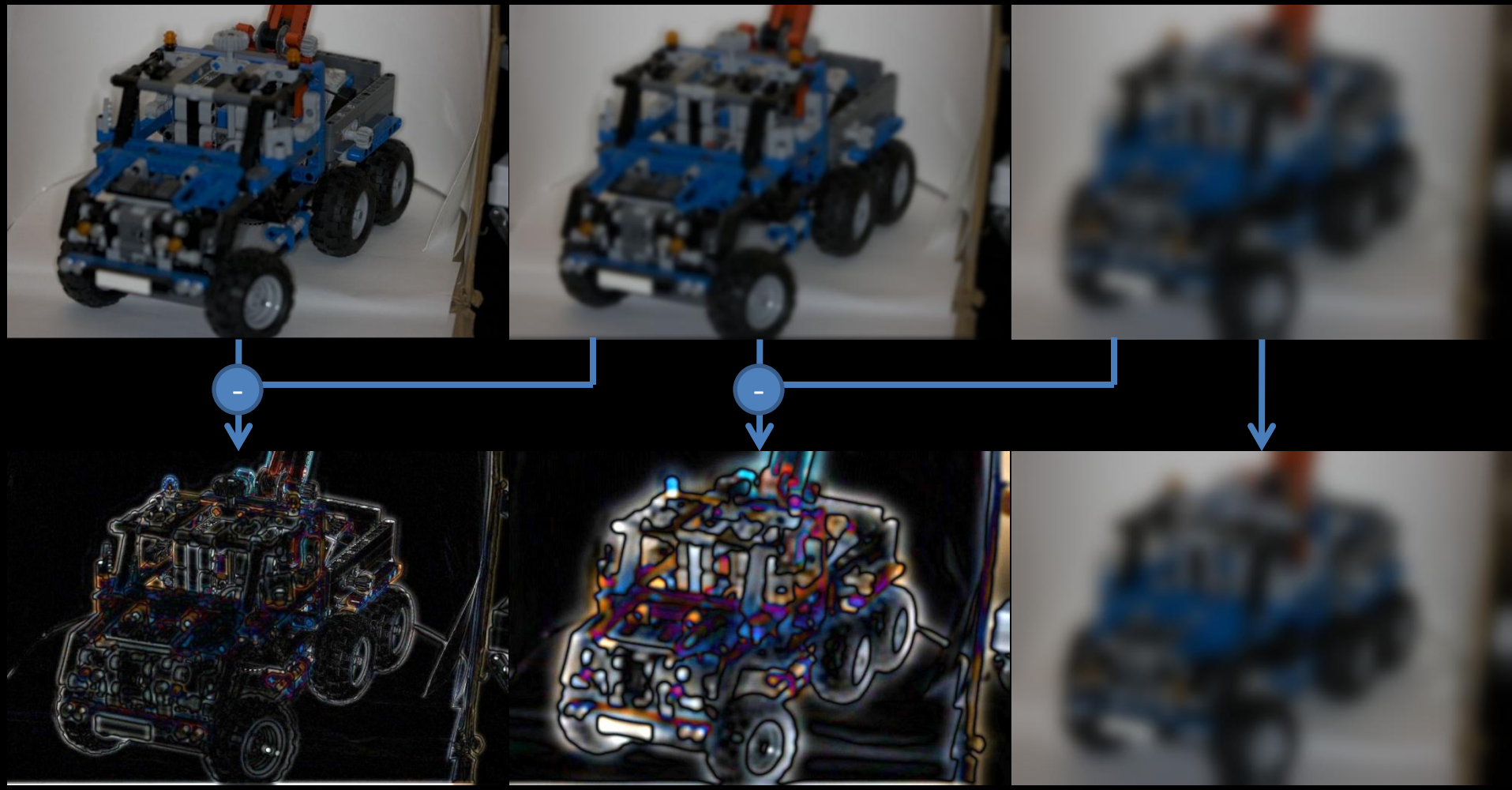
- We can do this by blurring more and more:





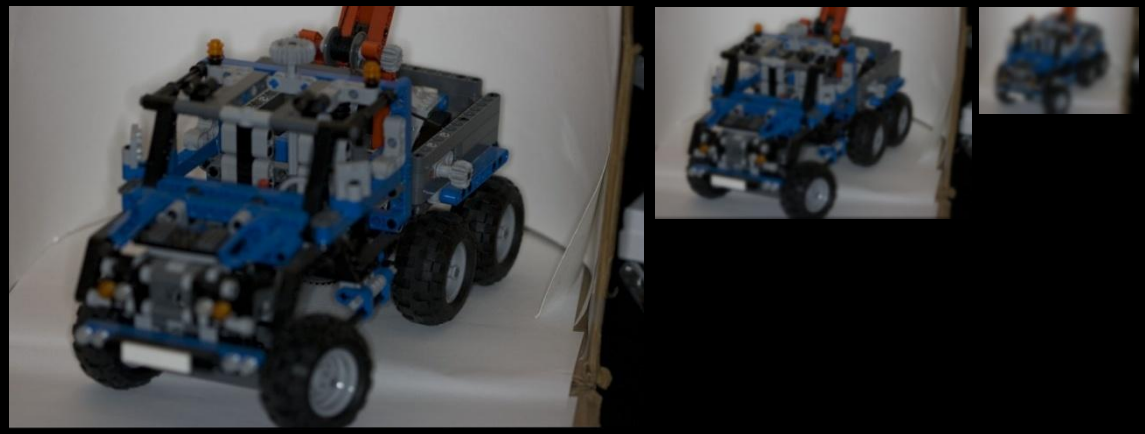
Pyramids

- And then (optionally) taking differences

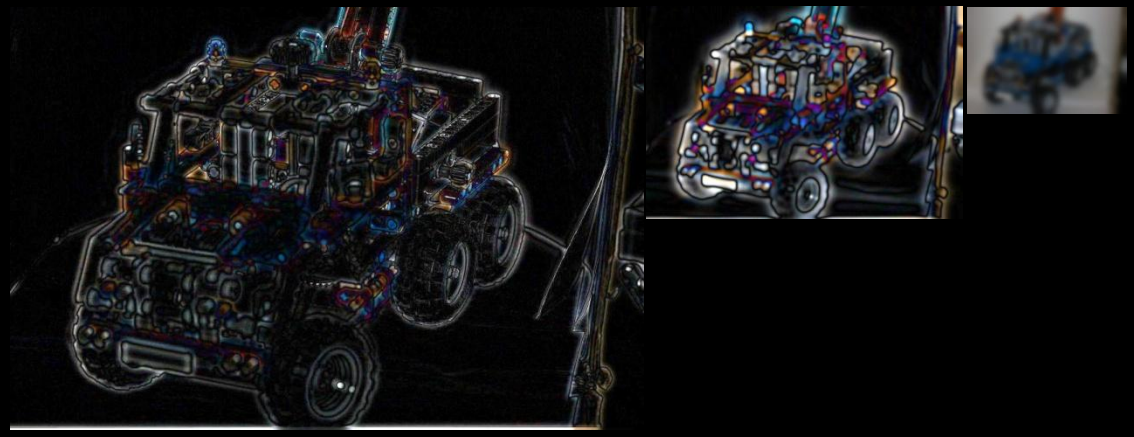


Pyramids

- The coarse layers can be stored at low res.



Gaussian Pyramid



Laplacian Pyramid

Pyramids

- How much memory does this use?






Pyramid Uses:

- Sampling arbitrarily sized Gaussians
- Equalizing an image
  - The different levels represent different frequency ranges
  - We can scale each frequency level and recombine
- Blending multiple images

Pyramid Blending

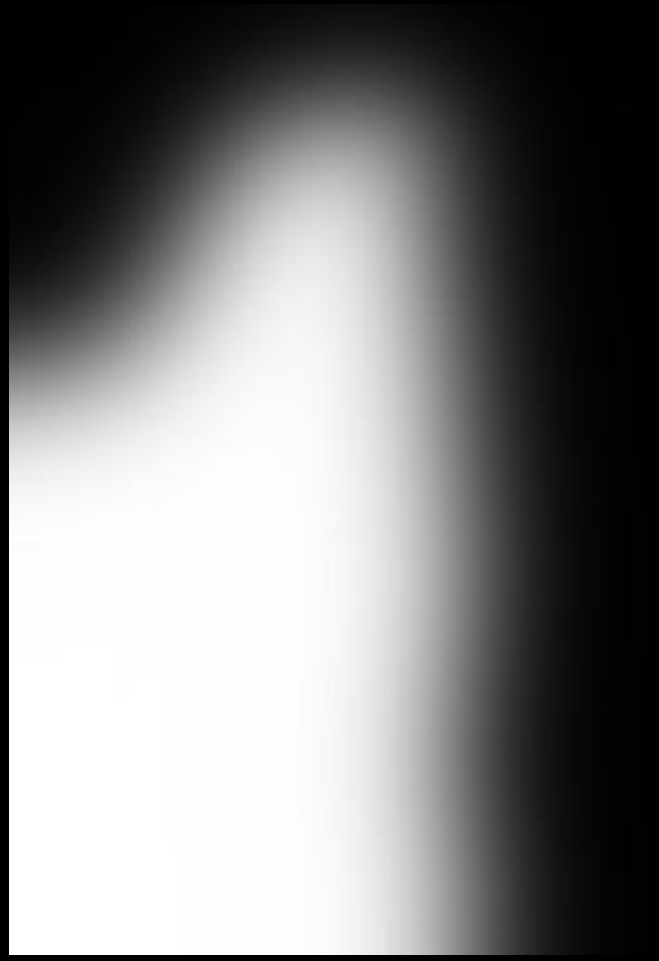
- Key Insight:
  - Coarse structure should blend very slowly between images (lots of feathering), while fine details should transition more quickly.

- More robust to tricky cases than plain old compositing

Inputs:

Compositing: Hard Mask

Compositing: Soft Mask



Multi-Band Blending

Exposure Fusion

- http://research.edm.uhasselt.be/~tmertens/papers/exposure_fusion_reduced.pdf