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 $X+Y = \sqrt{2} \cdot S$
• Std.Dev of $(X+Y)/2 = \sqrt{2}/2 \cdot S$
• I.e., 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)
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 😞
Other uses of Median

• Removing Transient Occluders
• (live demo)
• (Gates demo)
• (surf demo)
Panorama Stitching
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Multiple Exposure Fusion
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Multiple Exposure Fusion
Multiple Exposure Fusion
Multiple Exposure 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.
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
Compositing: Hard Mask
Compositing: Soft Mask
Multi-Band Blending
Exposure Fusion