image pyramids

Aliasing does not occur if samples are taken at the Nyquist frequency or higher

Image Downsampling → to reduce resolution

- Aliasing may occur

Naive approach: Throw away every other row and column.

→ The image will be 1/4 of the original image. As a result, the image will have less data.

Aliasing → the pixelated effect on images.

- Images are discrete representation of a continuous world. So when we subsample, aliasing may occur.

Anti-Aliasing

Approach 1: Oversample the image → memory problems

Approach 2: Smooth the signal (→ remove detail effects) → more effective.

Pyramids

- Each level of pyramid is 1/4 of the size of previous level.
- The lowest level is of the highest resolution.

Gaussian Image Pyramid → sequence of subsampled images

- Gaussian blurring is low-pass filtering.

By blurring we try to sufficiently decrease the Nyquist frequency to avoid aliasing.

- Smooth the image with Gaussian
- Throw away every other row and column.

- The details get smoothed out as we move to higher levels.
- Mostly large uniform regions in the image preserved at higher levels.
- We cannot reconstruct the original image.

Laplacian Image Pyramid → lossless

- it saves only the details → edges { most of the pixels are zero.
- it's easy to reconstruct the original image.

Laplacian images + base level Gaussian → residual + smallest image

- Blur and subsample the image by factor of 2
- Store it in the next level of pyramid.

Steps:

1- interpolate a lower resolution image → to obtain reconstruct low-pass filter version.

2- Subtract this low-pass from original image → to yield band-pass Laplacian image.

Another version:

- low-pass is taken from blurred image → rather than reconstructed pyramid.
- Less aliasing → cause it avoids one downsampling and upsampling round.
- it's not possible to reconstruct the image.

Gaussian vs. Laplacian

If you store matrixes of images as they were, Laplacian and Gaussian takes the same amount of space. But if you compress, gaussian will take more space than Laplacian.

Laplacian of Gaussian

As we derivative, we can combine Laplace filtering with Gaussian filtering.

Wavelets

- filters that localize a signal in space and frequency.
- Provides a smooth way to decompose a signal into frequency components.
- keeps the size of the decomposition the same as the original image → traditional pyramids use more pixels than the original image to represent decomposition. (overcomplete)