ECE 468: Digital Image Processing

Lecture 18

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Outline

- Multiresolution image processing (Textbook 7.1)
- Image Pyramids (Textbook 7.1.1)

Multiresolution Image Processing

- Informal motivation:
  - Images may show both very large and very small objects.
  - It may be useful to process the images at different resolutions.

Multiresolution Image Processing

- A more formal motivation:
- An image is a 2D random process with locally varying statistics of pixel intensities
- Analysis of statistical properties of pixel neighborhoods of varying sizes may be useful

Histogram of Small Pixel Neighborhoods

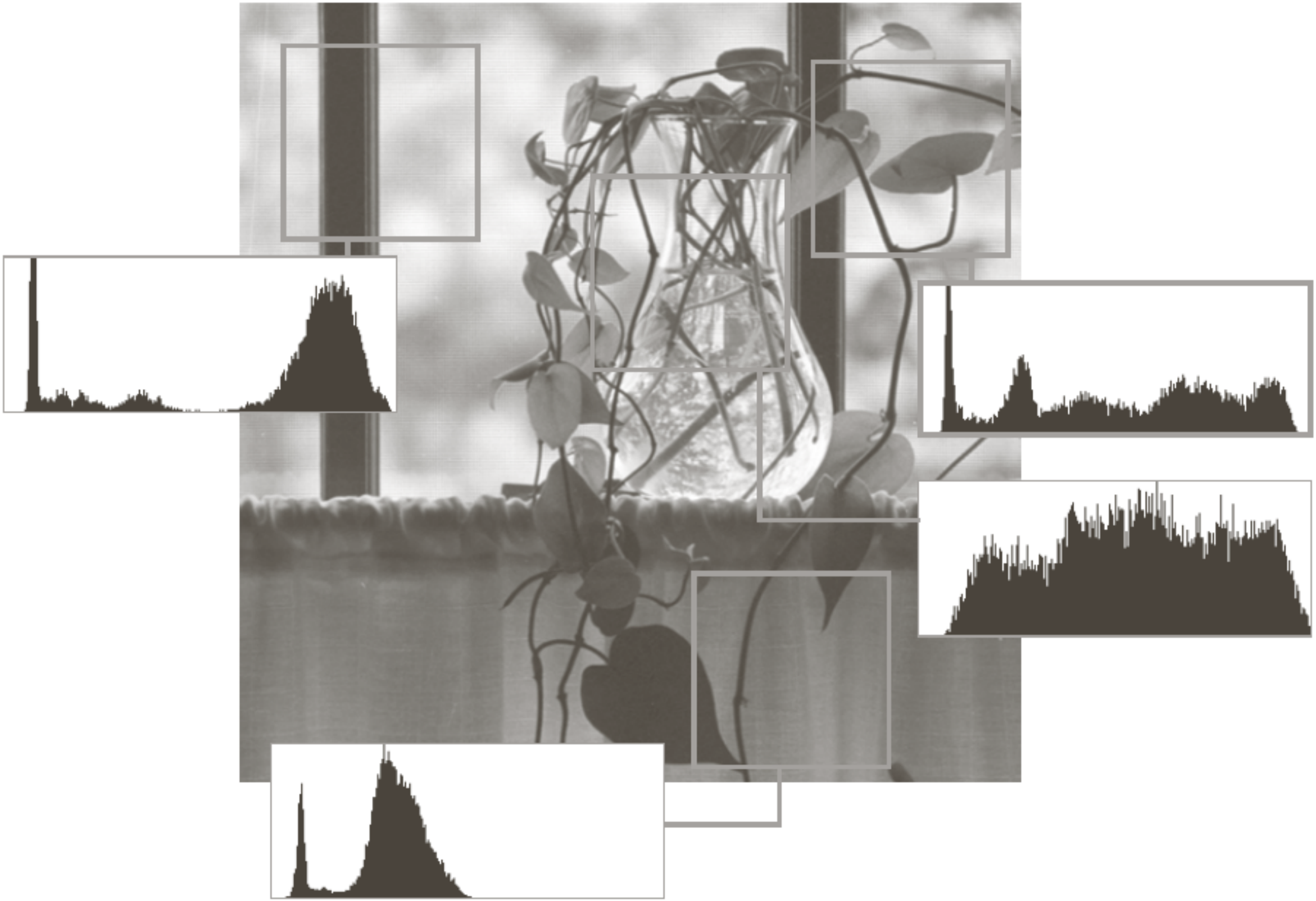
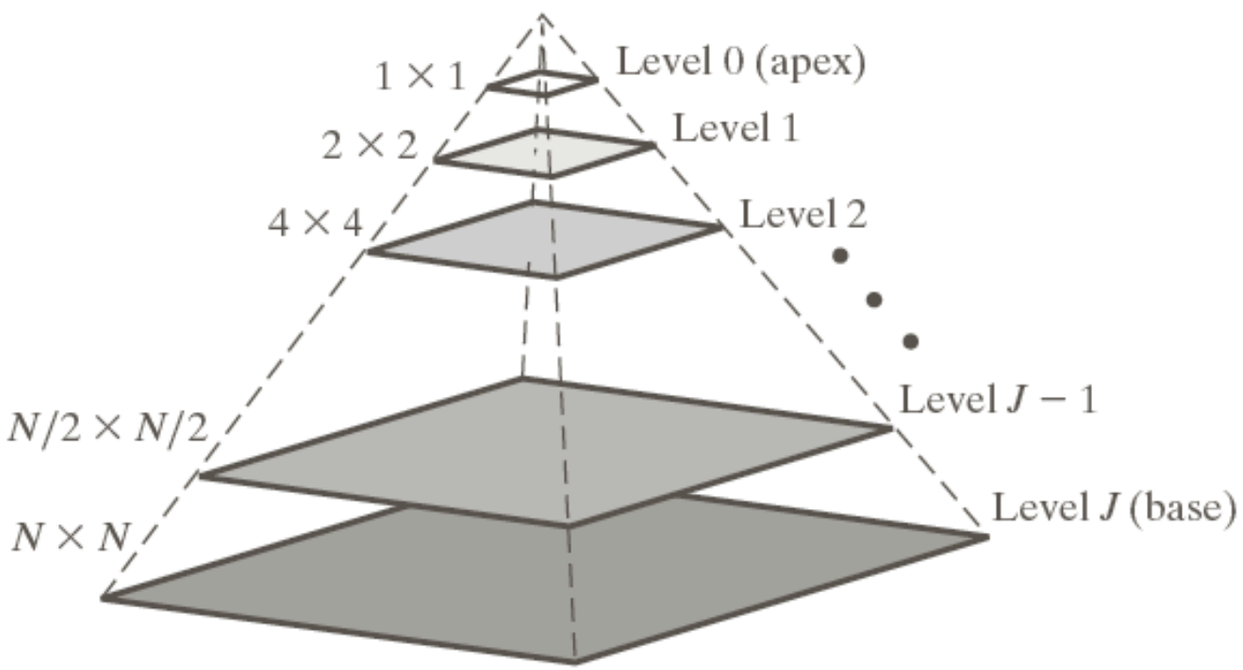
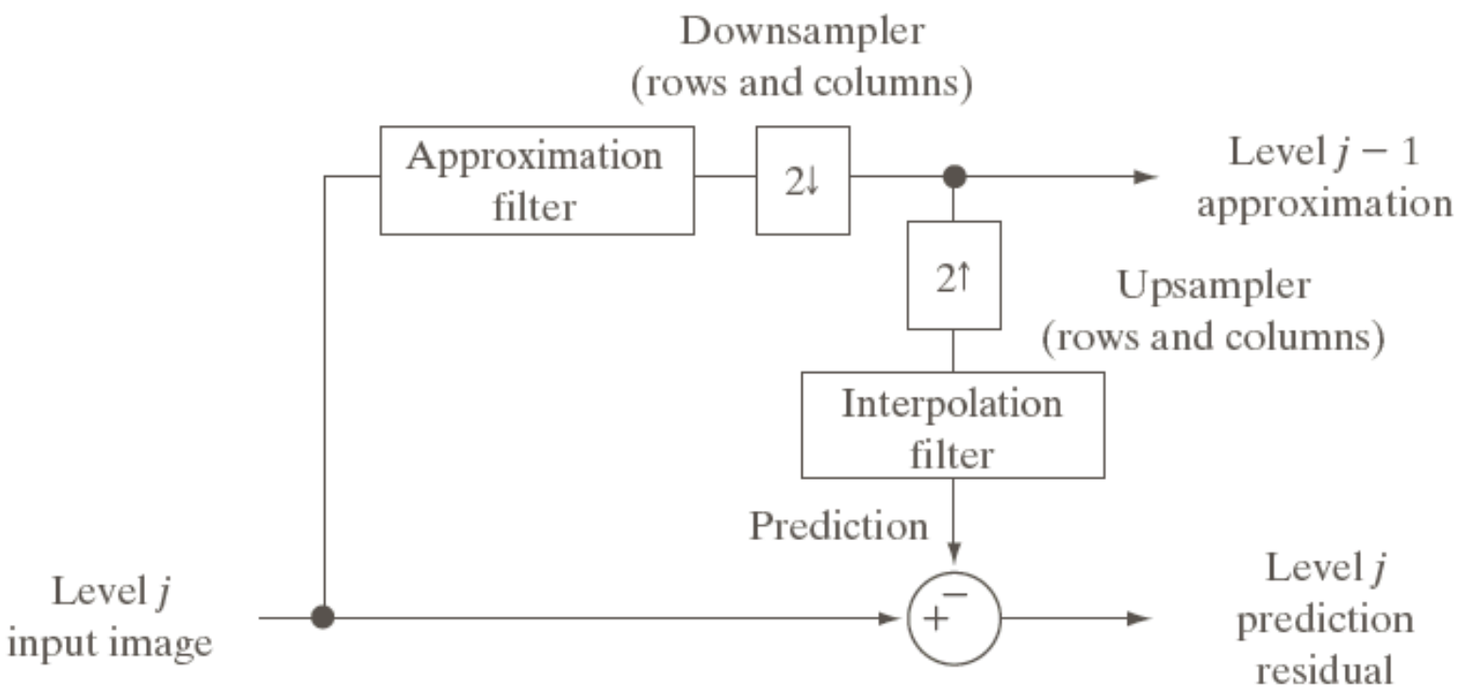


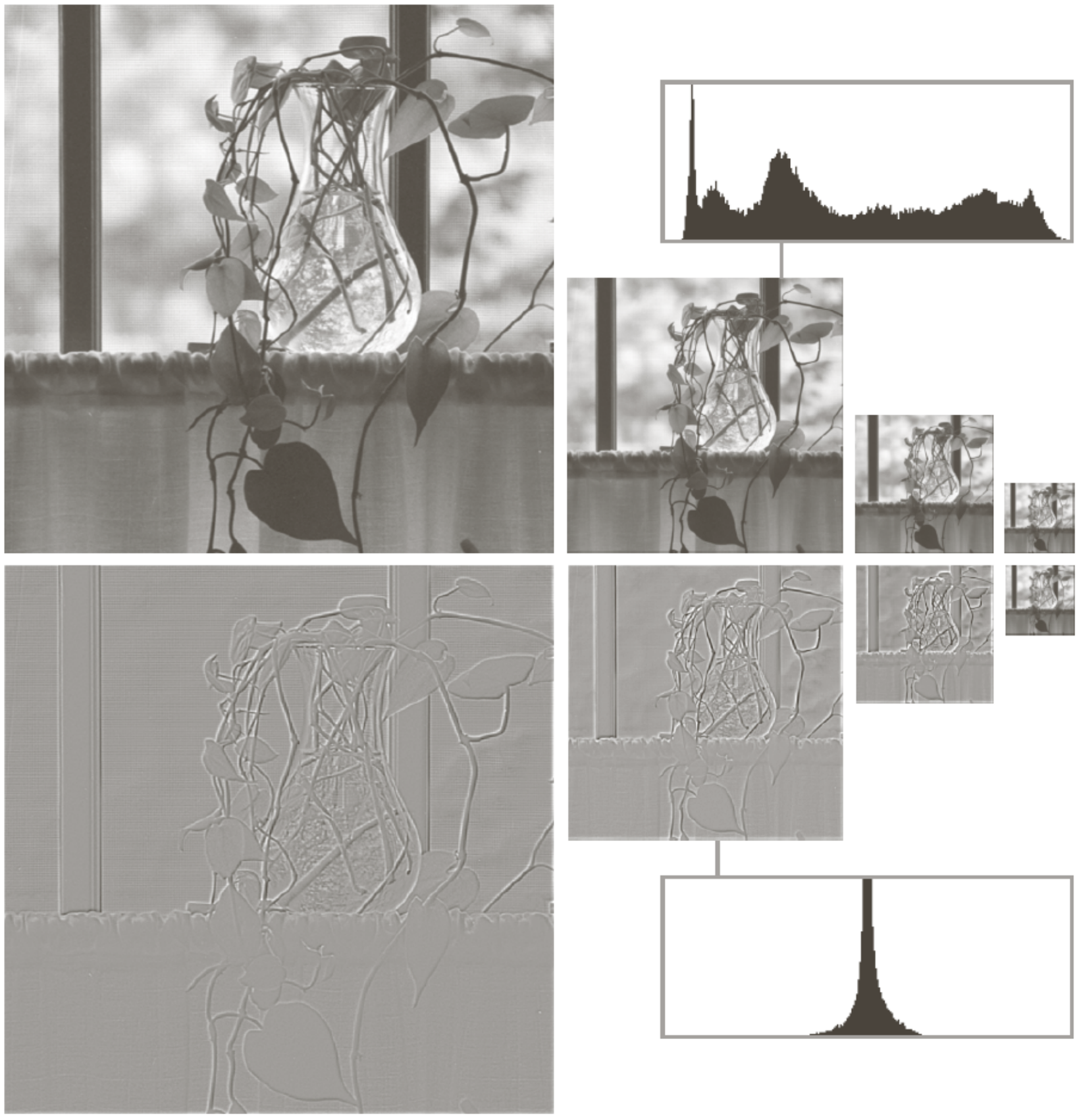
Image Pyramids

- A representation of the image that allows its multiresolution analysis





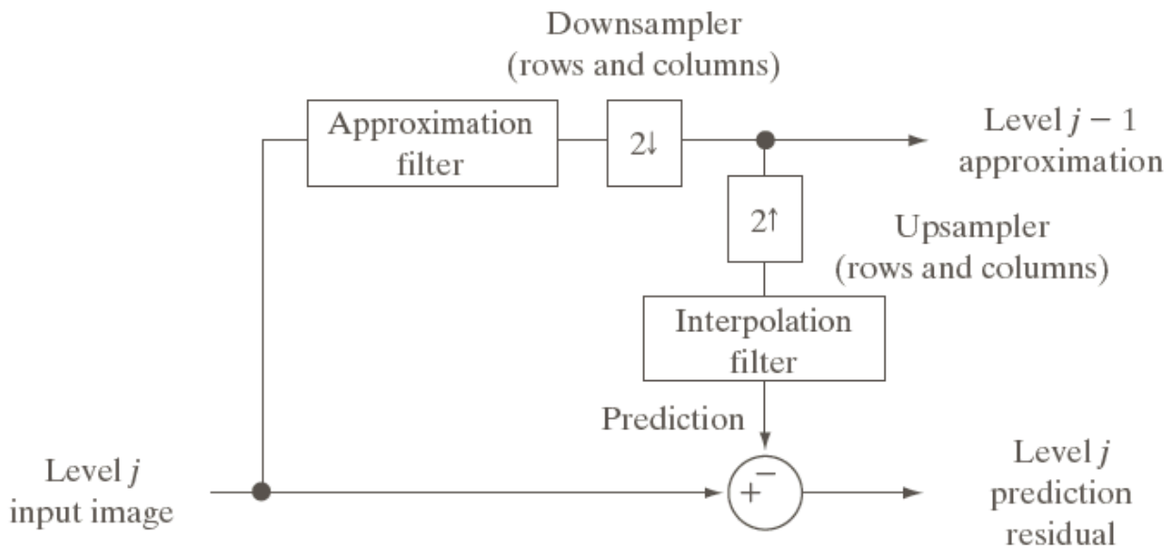
Example: Image Pyramids



a
b

FIGURE 7.3
Two image pyramids and their histograms: (a) an approximation pyramid; (b) a prediction residual pyramid.

Steps to Construct the Image Pyramid



1. Given an image at level j
2. Filter the input and and downsample the filtered result by a factor of 2; This gives the image at level j-1
3. Goto 1
4. Upsample and filter the image at level j-1; this gives an approximation of the image at level j
5. Subtract this result from the image at level j; this give the prediction residual at level j
6. Goto 1

Typical Filters

- For the multiresolution pyramid, we use spatial filters:
  - Neighborhood averaging
  - Lowpass Gaussian filter
- For the residual pyramid, we use interpolation filters:
  - bilinear
  - bicubic

Upsampling/Downsampling

- Upsampling = Inserting zeros

$$f_{2\uparrow}(x,y) = \begin{cases} f(x/2, y/2) & , \quad x, y \text{ are even} \\ 0 & , \quad \text{o.w.} \end{cases}$$

- Downsampling = Discarding pixels

$$f_{2\downarrow}(x,y) = f(2x, 2y)$$

Next Class

- Haar Transform (Textbook 7.1.3)