Syllabus Notes

• We are finishing texture (New material from today’s lecture will not surface in midterm).
• Recommended reading: Much of the texture chapter.
Representing textures (review)

- Collections of responses to a variety of filters
- Generally need a collection of spots and bars at various scales and orientations (for the bars), but it is not so critical how one gets the spots and bars.
- Thus the filter banks are typically chosen based on other (often relatively arbitrary) considerations.
Representing textures (review)

- Associate texture with statistics of the conglomerate of responses over some scale (window size)
- Simplest statistic is mean (square) response for each filter
- Including standard deviation helps
- More sophisticated approaches include looking at histogram of responses over window (can often use fewer filters in this case)
Very simplified example (two filters)

(scale implies a window)
Spots and oriented bars at one scale (see page 191 for details of the construction of these filters).
A typical filter bank

*Figure 4.* Left: Filter set $f_i$ consisting of 2 phases (even and odd), 3 scales (spaced by half-octaves), and 6 orientations (equally spaced from 0 to $\pi$). The basic filter is a difference-of-Gaussian quadrature pair with 3 : 1 elongation. Right: 4 scales of center-surround filters. Each filter is $L_1$-normalized for scale invariance.

From Malik et al., “Contour and texture analysis for image segmentation”

(We have an implementation for this filter bank, as part of the N-cuts software from Berkeley).
The Gaussian (scale) pyramid

- Smooth with gaussians, because
  - a gaussian*gaussian=another gaussian
- Representation is redundant
- Allows easy analysis across scales
The Laplacian Pyramid (§9.2.1)

- Recall that the Laplacian of Gaussian (LOG) is approximated by difference of Gaussians (DOG)
- To recover the Gaussian pyramid we can “add up” the DOG pyramid
- In particular, we add lower layers to “up-sampled” versions of the current layer.
- Up sampling means we just duplicate the value
- Down sampling means we select a value from a block
(Note that plots are in the frequency domain)

(Spot detectors)  (Oriented bar detectors)
Oriented pyramids

- Laplacian pyramid is orientation independent
- Apply an oriented filter to determine orientations at each layer
  - by clever filter design, we can simplify synthesis
  - this represents image information at a particular scale and orientation
Yet another way to create filters

Gabor filters at different scales and spatial frequencies

Basically a sine or cosine multiplied by a Gaussian to localize it.

Easy to make oriented versions

Bottom six are more localized (smaller Gaussian sigma)
Final texture representation

- Form an oriented pyramid (or equivalent set of responses to filters at different scales and orientations).
- Square the output
- Take statistics of responses
  - simplest is mean of each filter output (are there lots of spots?)
  - next most convenient enhancement is to look at standard deviation of each filter output
  - more complicated schemes are important in practice
Texture synthesis

• Use image as a source of probability model
• Choose pixel values by matching neighbourhood, then filling in
• Matching process
  – look at pixel differences
  – count only synthesized pixels

Regrettably, the text is not legible. It appears to contain a discussion of texture synthesis and non-parametric sampling techniques, as well as possibly some case studies or examples. However, due to the poor quality of the image, a detailed transcription is not possible. The reference to the conference and the authors is clear, indicating that the content pertains to computer vision research on texture synthesis.