

Syllabus Notes

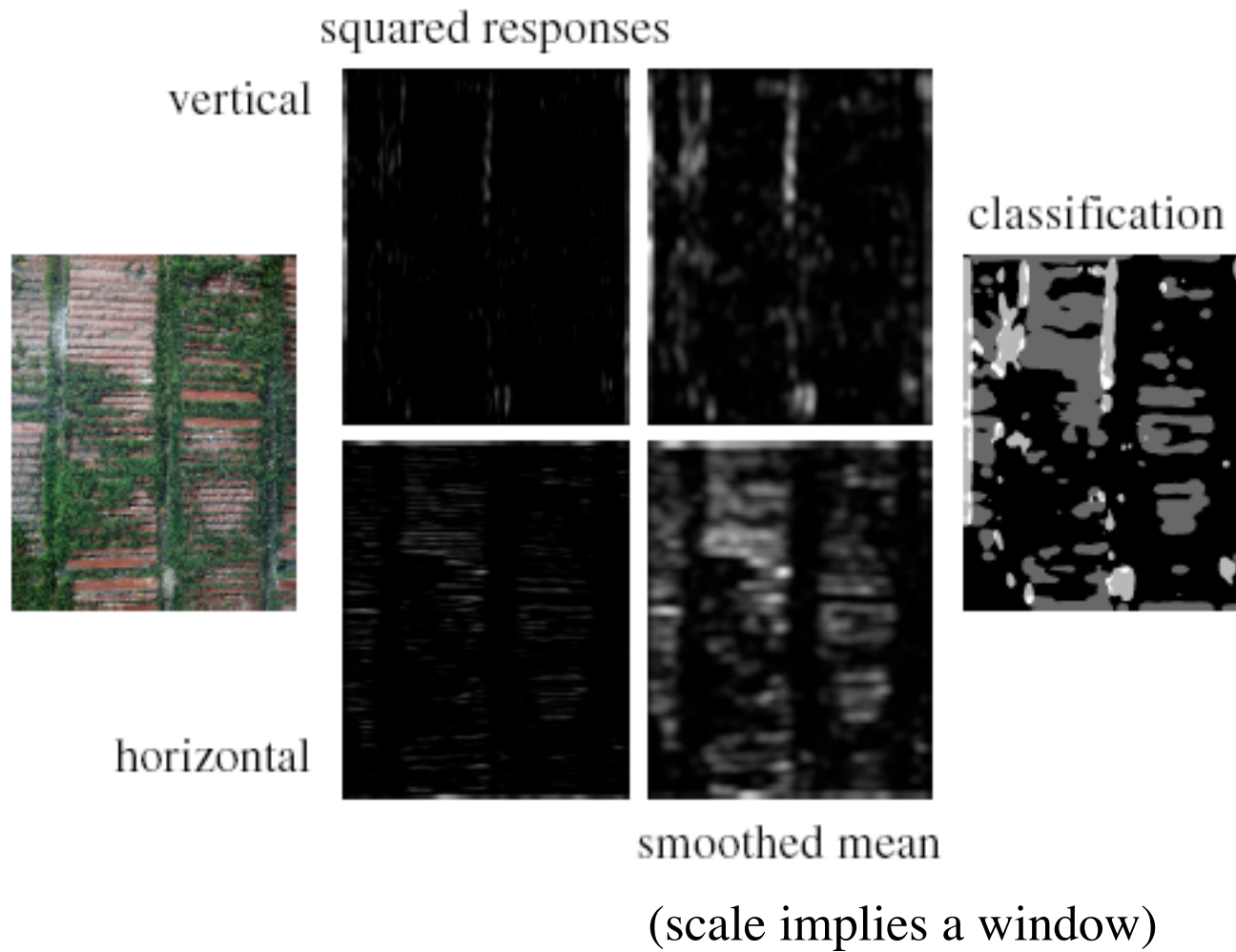
- We are finishing texture (New material from today's lecture will not surface in midterm).
- Recommended reading: Much of the texture chapter.

Representing textures (review)

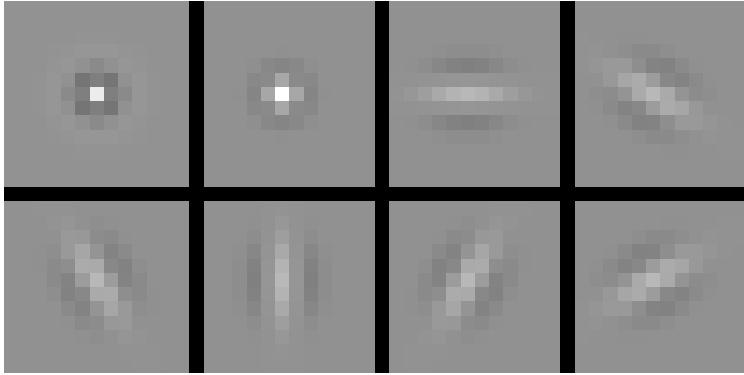
- Collections of responses to a variety of filters
- Generally need a collection of spots and bars at various scales and orientations (for the bars), but it is not so critical how one gets the spots and bars.
- Thus the filter banks are typically chosen based on other (often relatively arbitrary) considerations.

Representing textures (review)

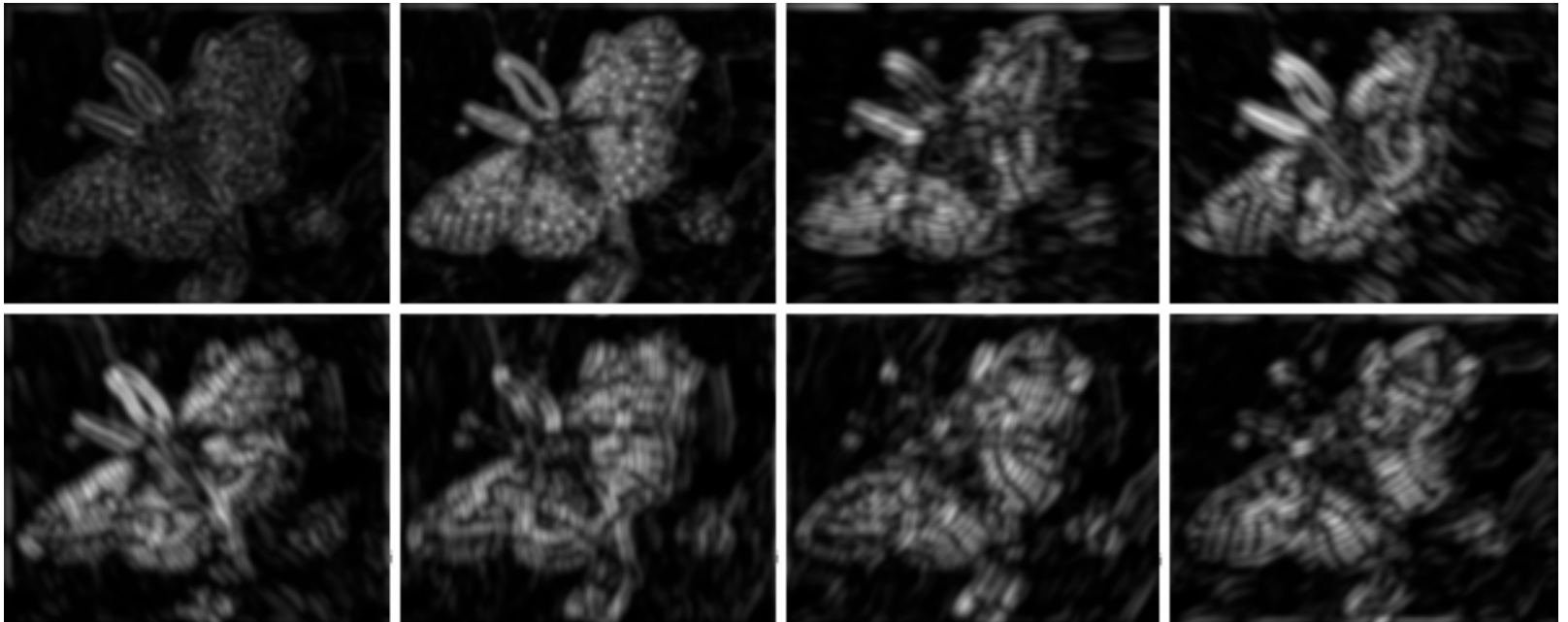
- Associate texture with statistics of the conglomerate of responses over some scale (window size)
- Simplest statistic is mean (square) response for each filter
- Including standard deviation helps
- More sophisticated approaches include looking at histogram of responses over window (can often use fewer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

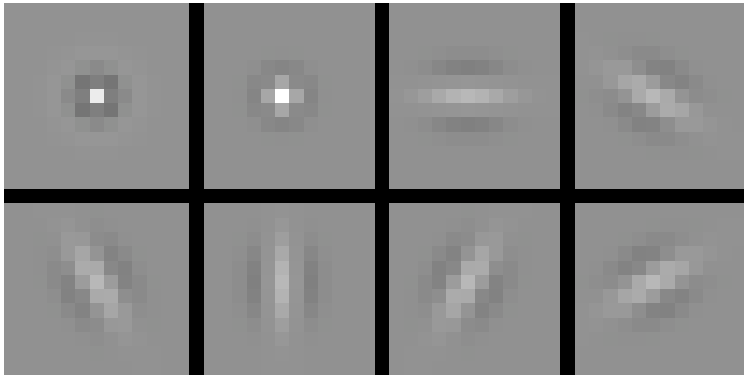


Very simplified example (two filters)

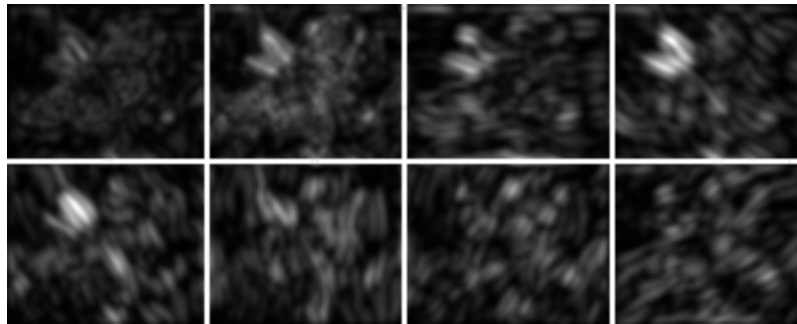


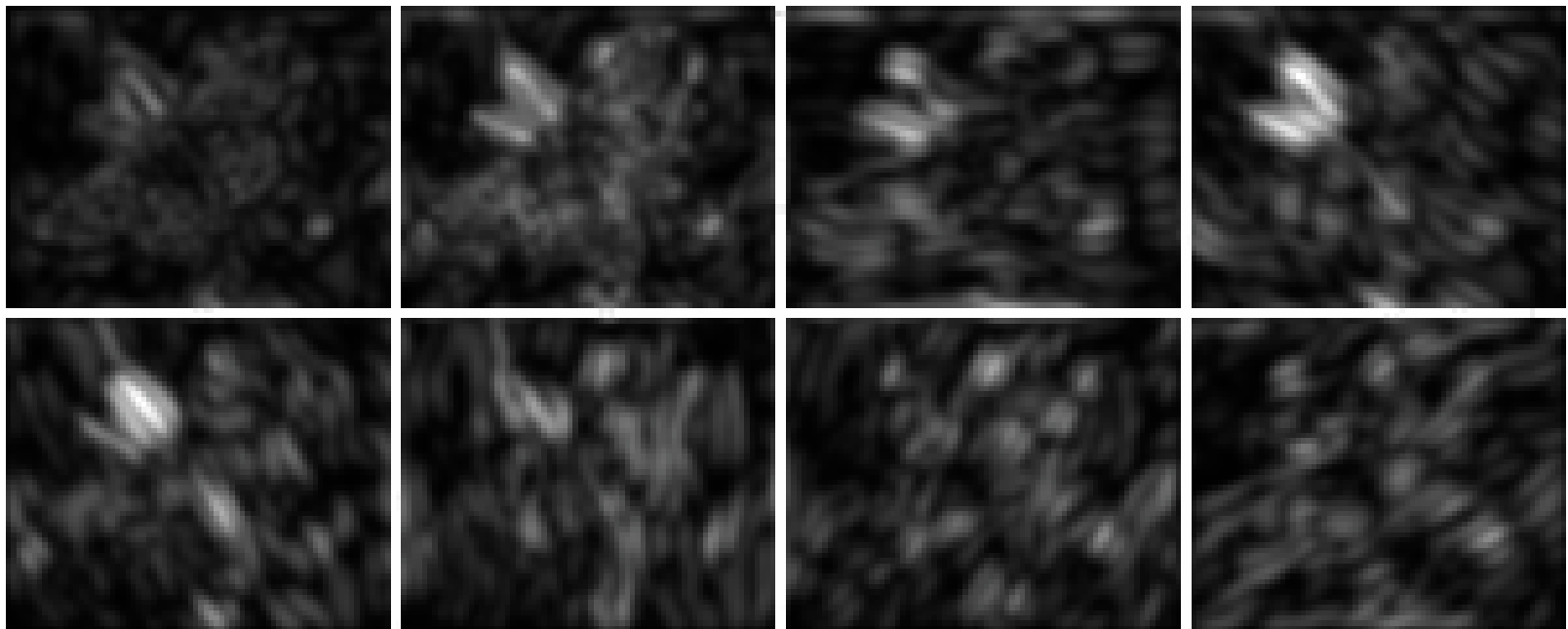
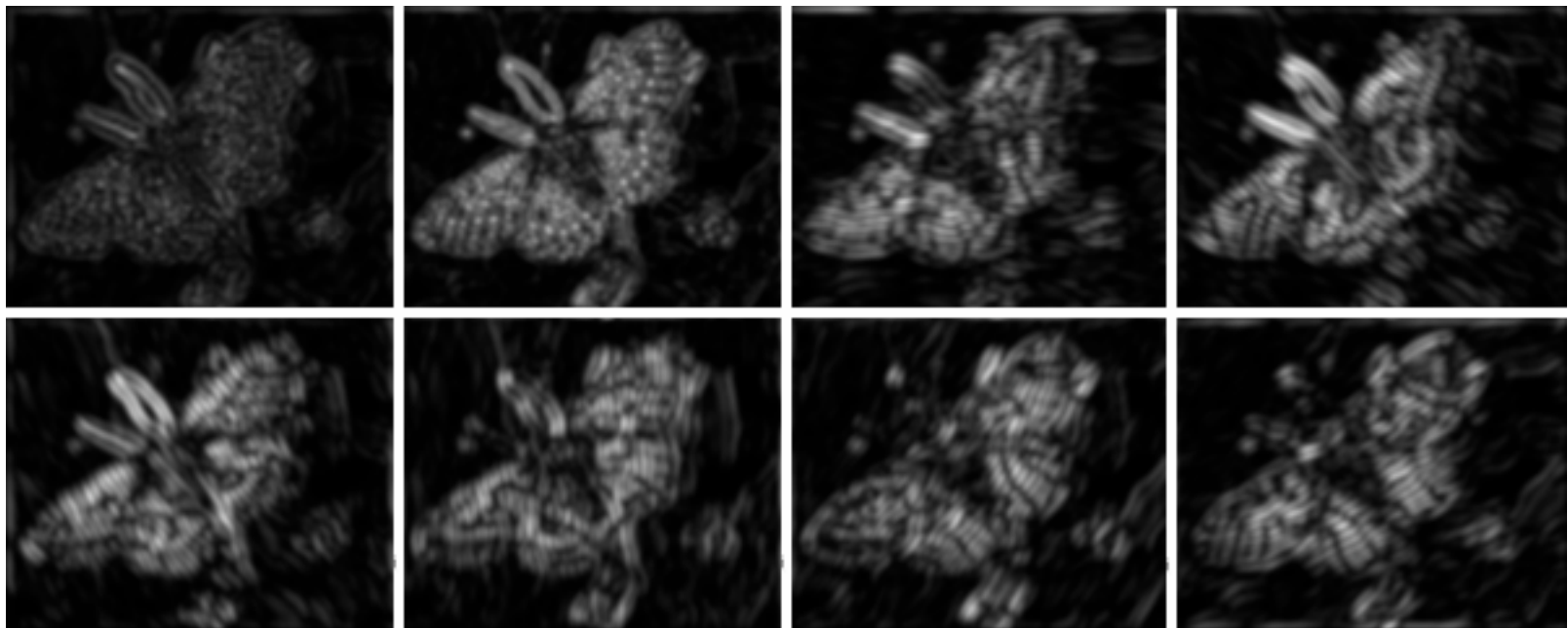
Spots and oriented bars at one scale (see page 191 for details of the construction of these filters).





Next bigger scale





A typical filter bank

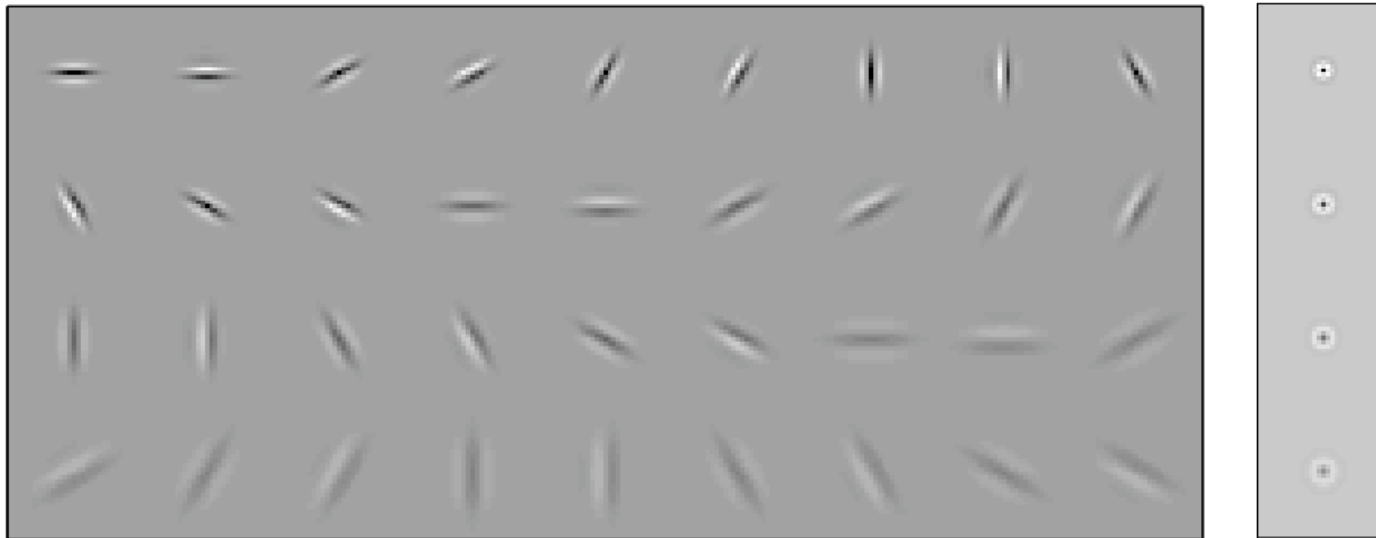


Figure 4. Left: Filter set f_i consisting of 2 phases (even and odd), 3 scales (spaced by half-octaves), and 6 orientations (equally spaced from 0 to π). The basic filter is a difference-of-Gaussian quadrature pair with 3 : 1 elongation. Right: 4 scales of center-surround filters. Each filter is L_1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



512

256

128

64

32

16

8



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



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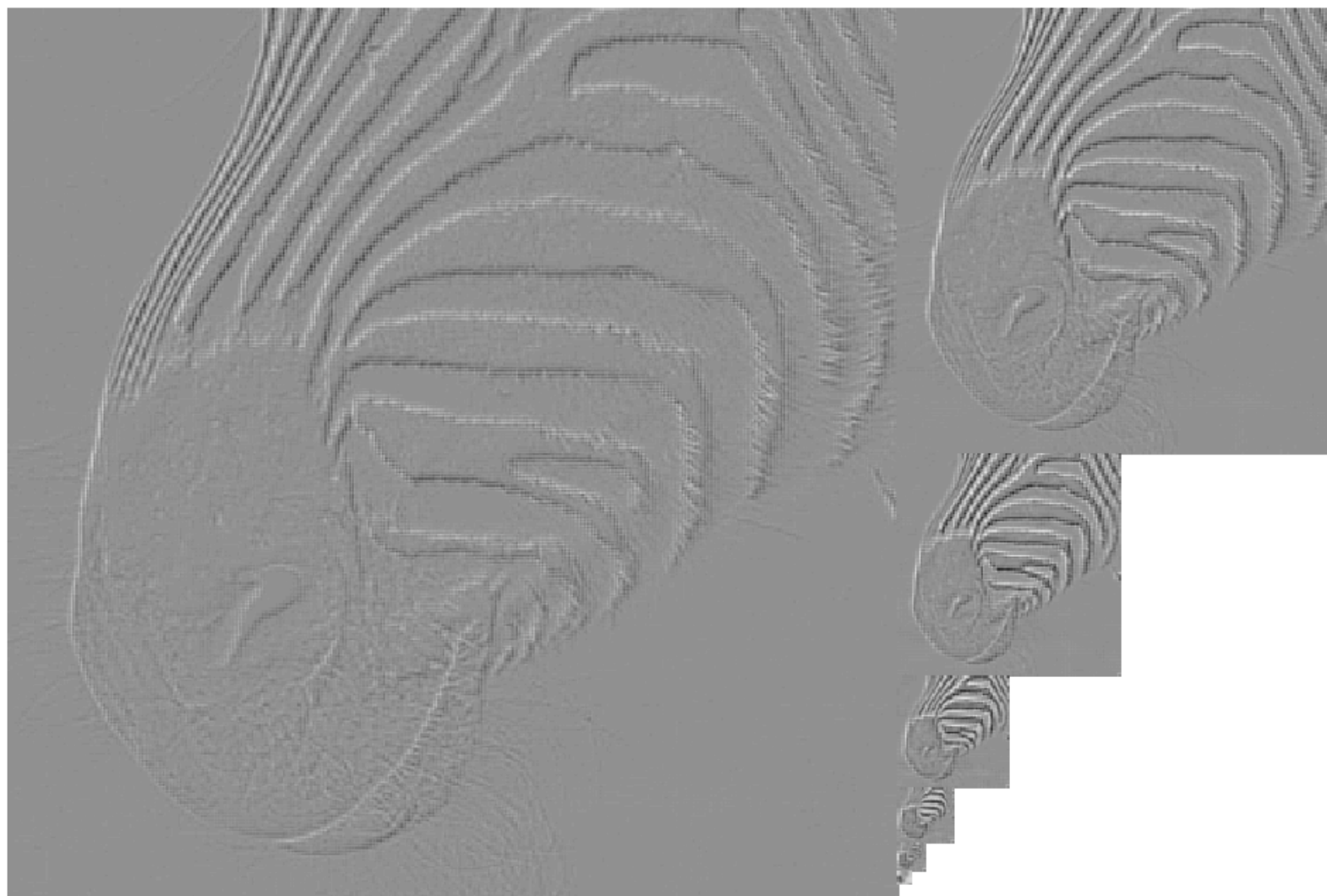
128

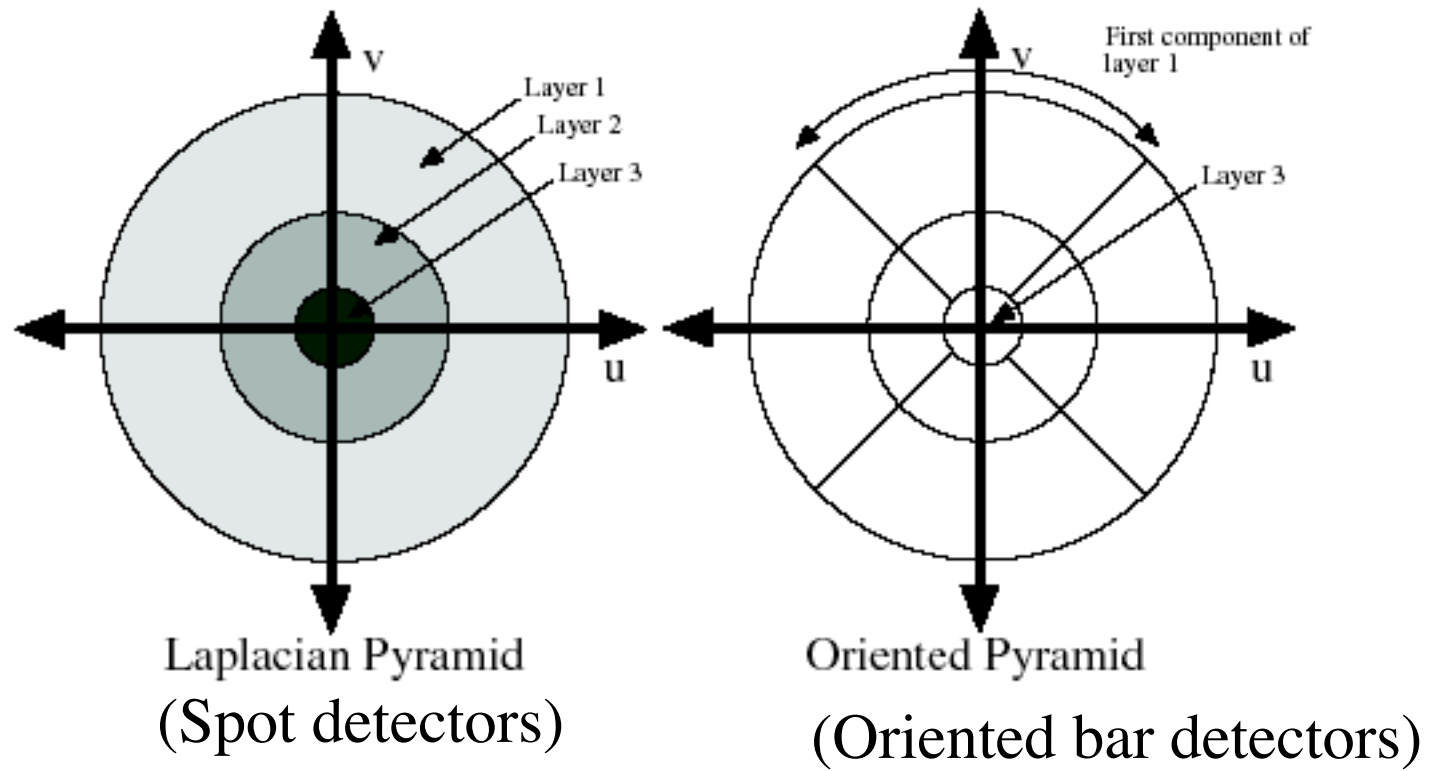
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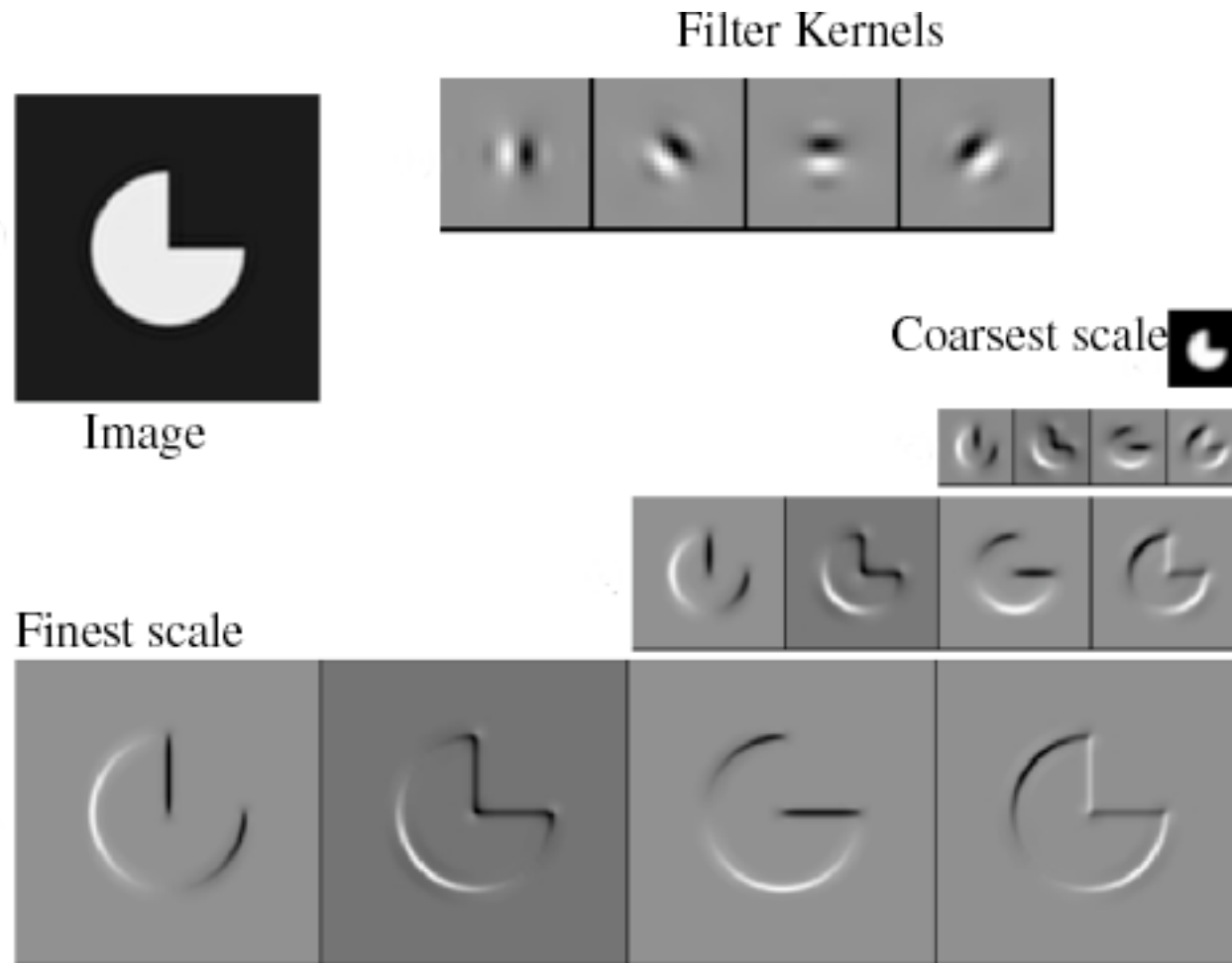




(Note that plots are in the frequency domain)

Oriented pyramids

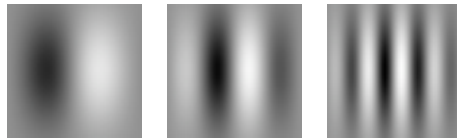
- Laplacian pyramid is orientation independent
- Apply an oriented filter to determine orientations at each layer
 - by clever filter design, we can simplify synthesis
 - this represents image information at a particular scale and orientation



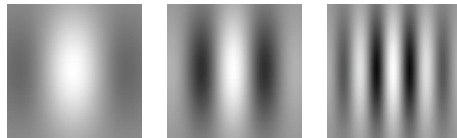
Reprinted from "Shiftable MultiScale Transforms," by Simoncelli et al., IEEE Transactions on Information Theory, 1992, copyright 1992, IEEE

Yet another way to create filters

Anti-symmetric



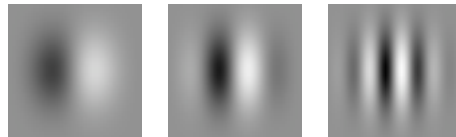
Symmetric



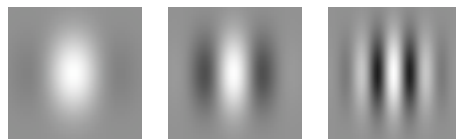
Gabor filters at different scales and spatial frequencies

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

Anti-symmetric



Symmetric



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

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Figure from Texture Synthesis by Non-parametric Sampling, A. Efros and T.K. Leung, Proc. Int. Conf. Computer Vision, 1999 copyright 1999, IEEE