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Computer Vision Homework

BIOENG 1586

Spring 2017

Problem 1

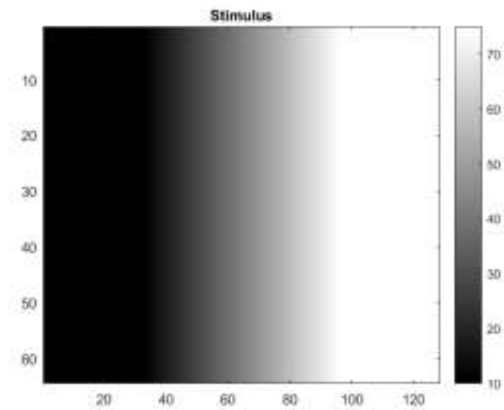


Figure 1a. Mach Band Stimulus (126x126)

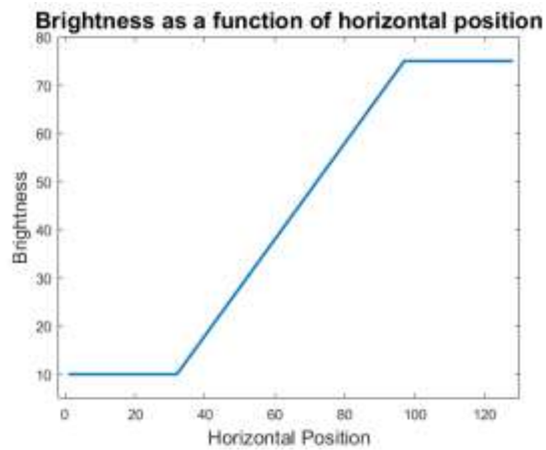


Figure 1b.

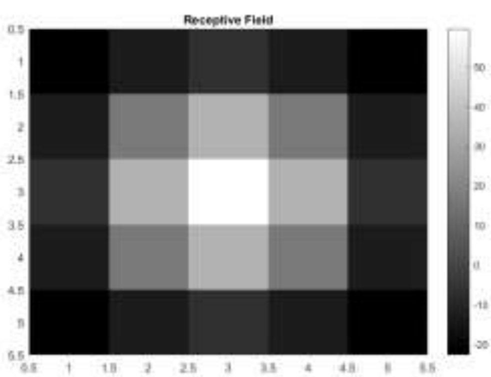


Figure 1c. Excitatory center, inhibitory surround characteristic of receptive field.

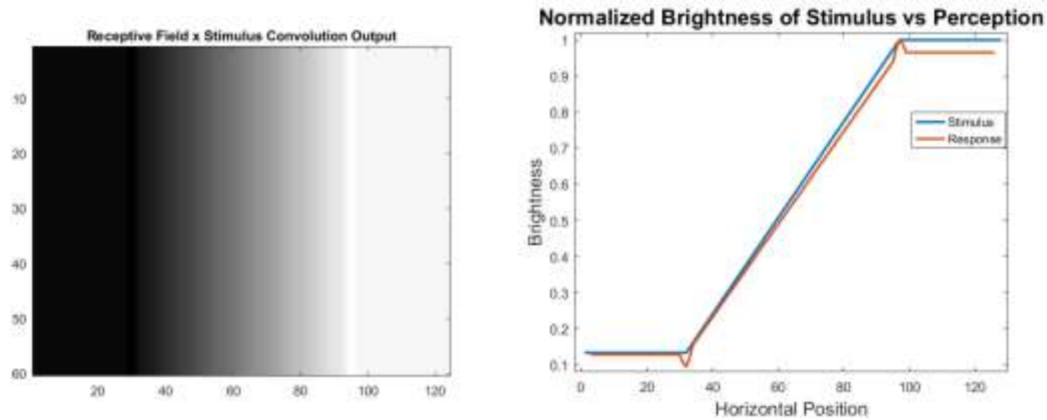
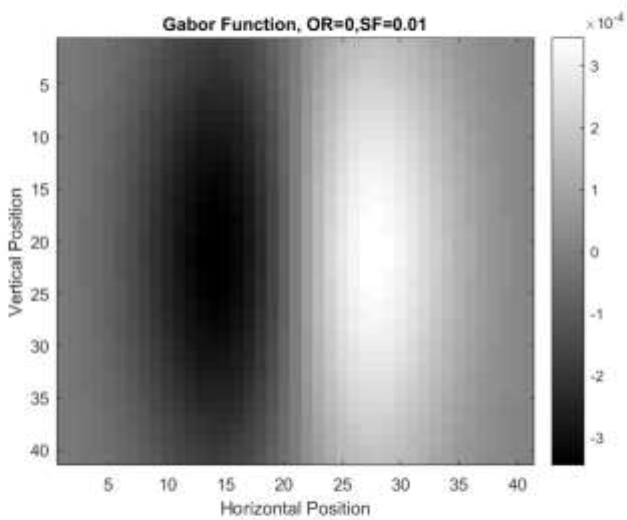


Figure 1d. Convolving the Mach Band stimulus with the E/I receptive field produces the effect of the Mach Band Illusion. At the edges of the gradient, the luminance is exaggerated relative to the flat luminance. This emphasizes the edge of the gradient. Therefore, the Mach Band Illusion arises at the level of the receptive field properties of retinal ganglion neurons. It is an essential requirement for edge detection. NOTE: The values in the plot to the right is NORMALIZED by the maximum brightness, the plateau levels are the same brightness values. Therefore, the peak in red to the right is actually a higher value than the plateau brightness in blue.

Problem 2



(No Figure 2a-c)

Figure 2d. Gabor function developed per instructions 2a-c. A sinusoid windowed by a 2-d Gaussian.

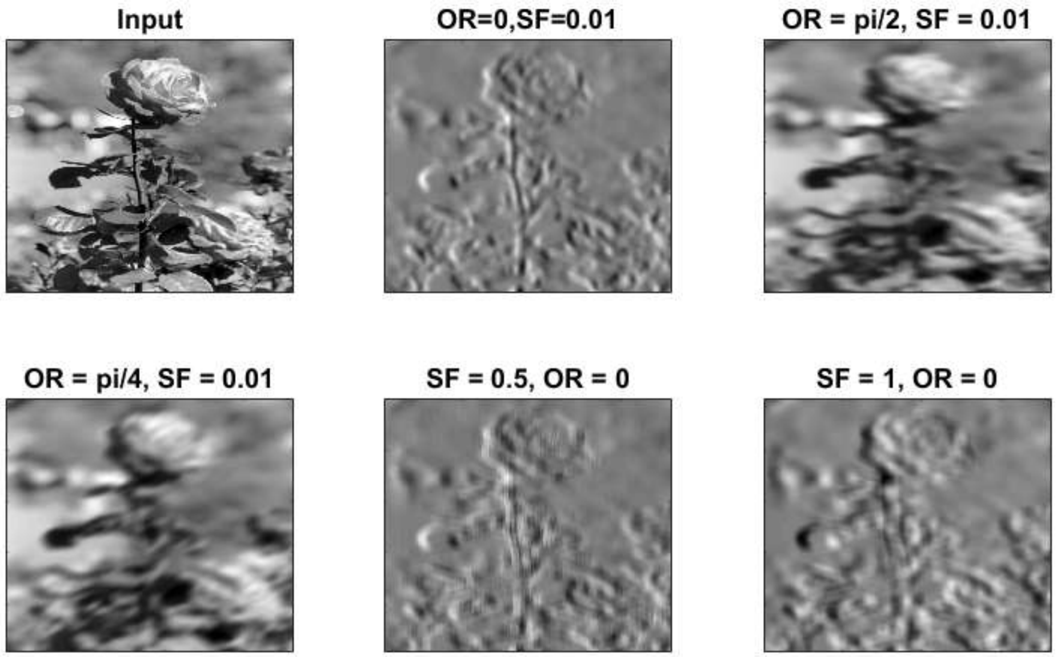
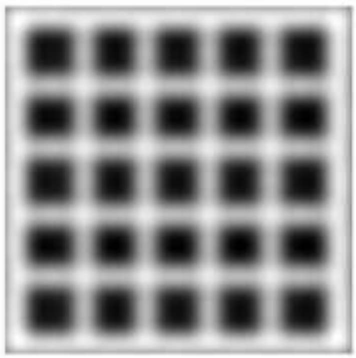


Figure 2e/f. A rose image convolved with Gabor functions of different orientation (OR) and spatial frequency (SF). Changing OR causes the Gabor function to shift relative to the norm. Convolving different OR values with the image shows that it allows resolution of features (lines, edges) that occur in different directions. Changing SF allows for resolution of details at different levels of spatial scale. For example, low SF (0.01) catches the bulk of the rose stem, whereas higher SF (1) catches the transition from the edge of the stem to the surrounding, but not the actual center. If this process is analogous to early stages of visual processing, it suggests that V1 simple cells filter information from different spatial locations by combinations of spatial frequency and orientation. These three features in addition to sparse coding (one cell has a combination of all 3) are identified by Olshausen and Field (1996).

Problem 3

With large receptive field coverage, the boxes are resolved normally (if a bit blurry, pct > 0.15 bottom left). However, at low spatial coverage (pct < 0.1) you see that gray circles/boxes/x's begin appearing in the junctions between four boxes. The receptive field size corresponds to 1/pct(image), so low pct -> many, small receptive fields. When you have these many receptive fields, they convolve, and average the intensity of the surrounding spaces. Having many, small receptive fields is essential for high acuity. When the filters are the right size (medium-large), the black surrounds encompassing the corners of the boxes cause the central points (white at the junction) to appear closer to gray than white (in the on cells) by “averaging” the brightness of the receptive field. This is a distinct result of surround inhibition and receptor field size.

pct = 0.25



pct = 0.075