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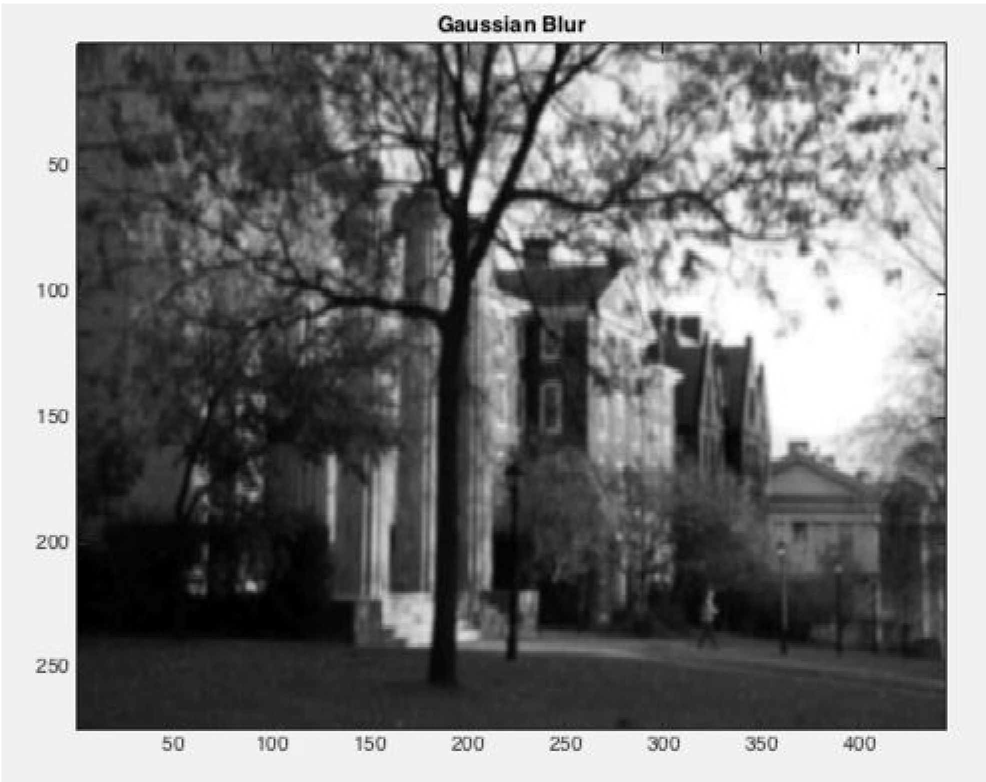
Box Filter

box - The box filter creation is pretty simple, just take the number of elements and make an m*n matrix with 1/sqrt(height*width) as its entries

conv2 - The conv2 function is, in this case, going sequentially through all 4x4 (as specified in the box creation below) "mini matrices" within the brown photo, multiplying each of those with their respective elements in the filter, and setting the center value to the sum of that product. This is in a way "blurring" the image, to the point that a box filter of 25x25 would leave almost an entirely white screen.

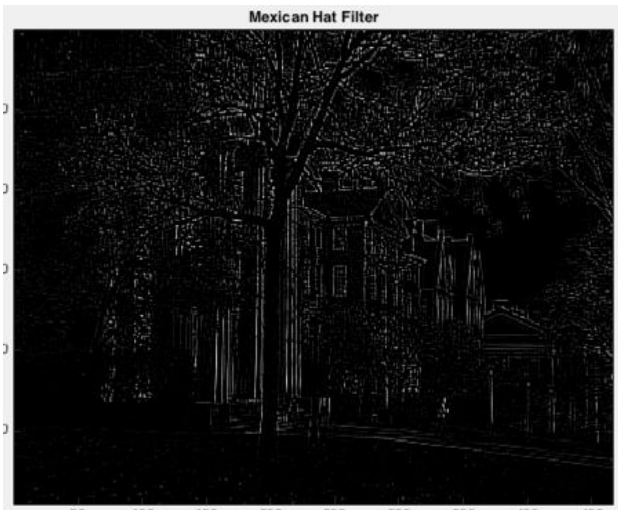
valid - This creates some difficulties with the edges of the photo simply by how choosing the "mini grids" works, so it seems the 'valid' keyword remedies that issue by filling in values for the edges of the photo

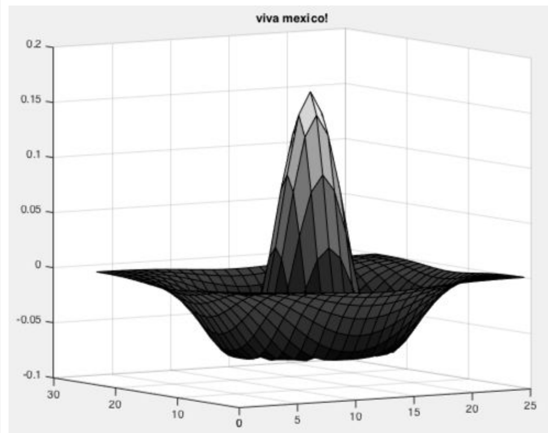
<u>**Gaussian Blur**</u>



This is blurring based on a gaussian distribution function. The larger the dimensions of the gaussian blur the larger the blur will be. A higher standard deviation will contribute to a more overall blur, a larger height of the gaussian will lead to more of a vertical blur, etc.

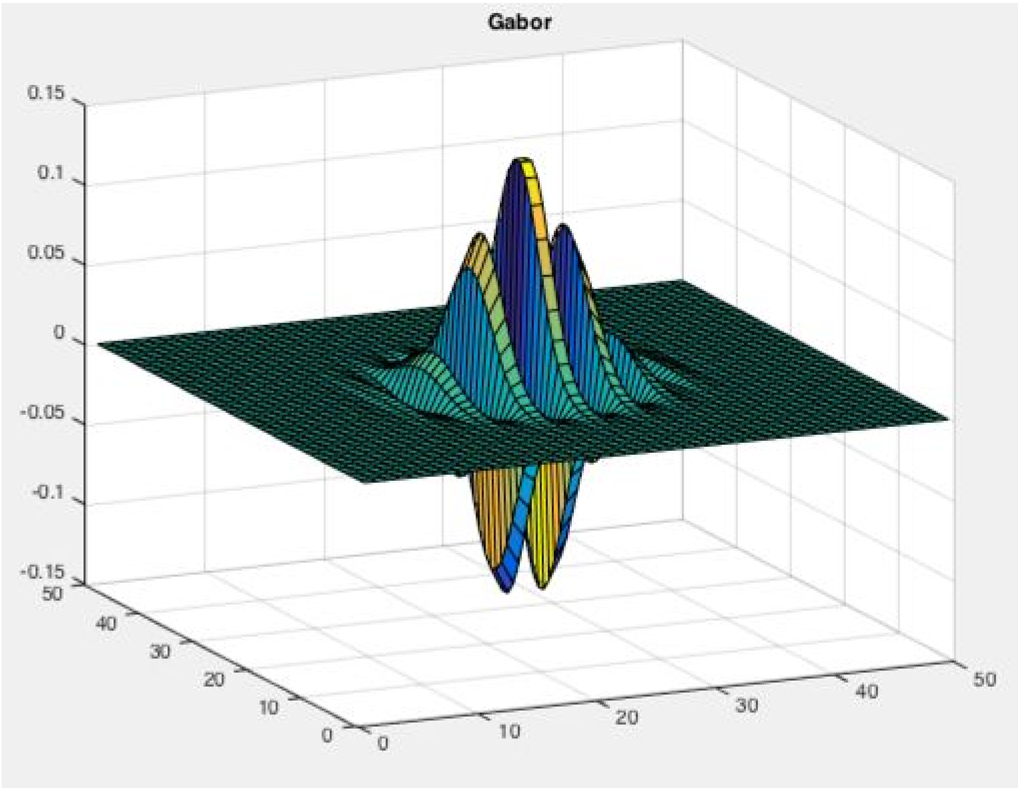
Mexican Hat Filter





Here I've computed the difference between two gaussians of differing sigmas for the purpose of creating a center-surround blur. This is effectively focusing the pixels in the image towards the areas with the highest gradients, which results in what appears above: highlighted edges.

Gabor Filter



Params

gabor_size - size of the filter we are creating (width and height)

lambda - defines wavelength > lambda = > wavelength

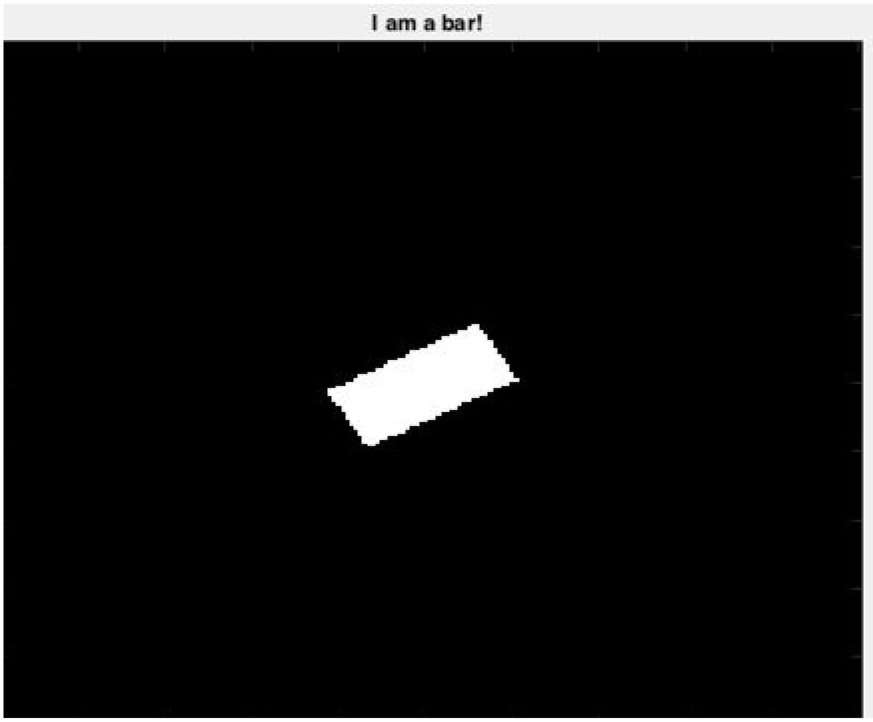
theta - rotates the gabor filter when changed

sigma - standard deviation of gaussian portion (changes concentration of the function)

gamma - controls how circulur the elipse portion of the gaussian is

psi - performs a phase shift on the cosine portion of the function, essentially "moving" the sinusoidal part

Sample Bar



Params

h - height of the bar

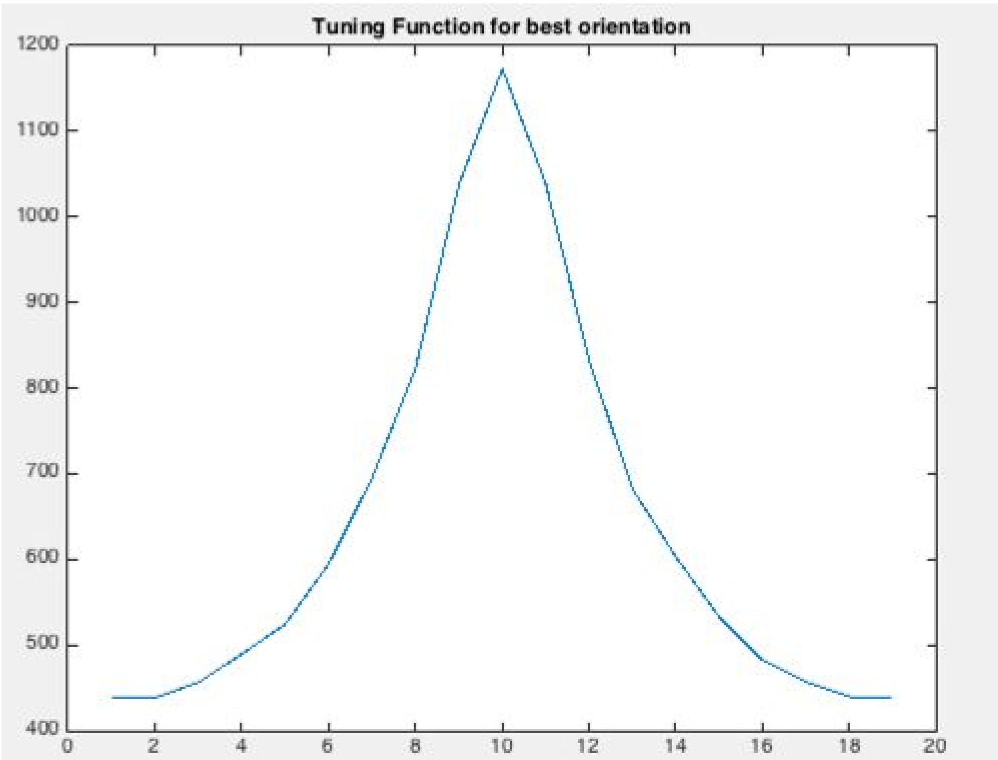
w - width of the bar

theta - angle of rotating the bar

s - translates the bar

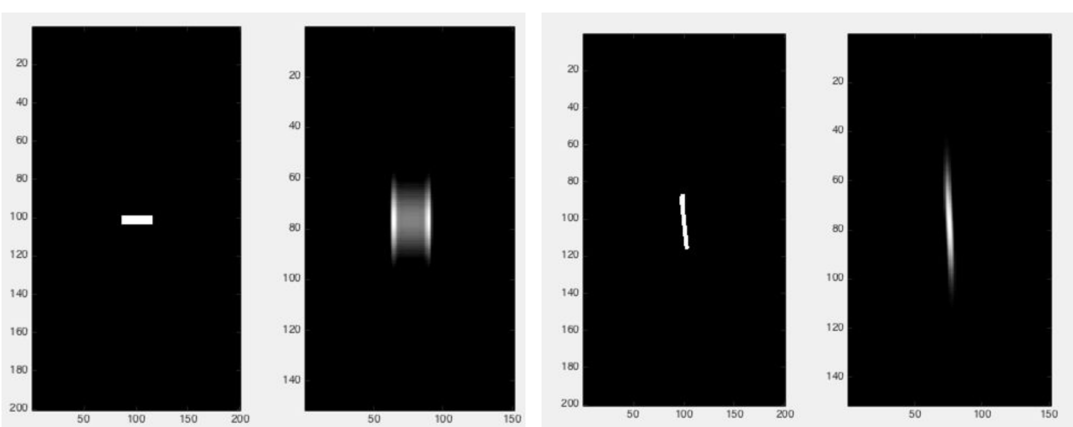
image_size - size of image to put bar on

Bar and Gabor



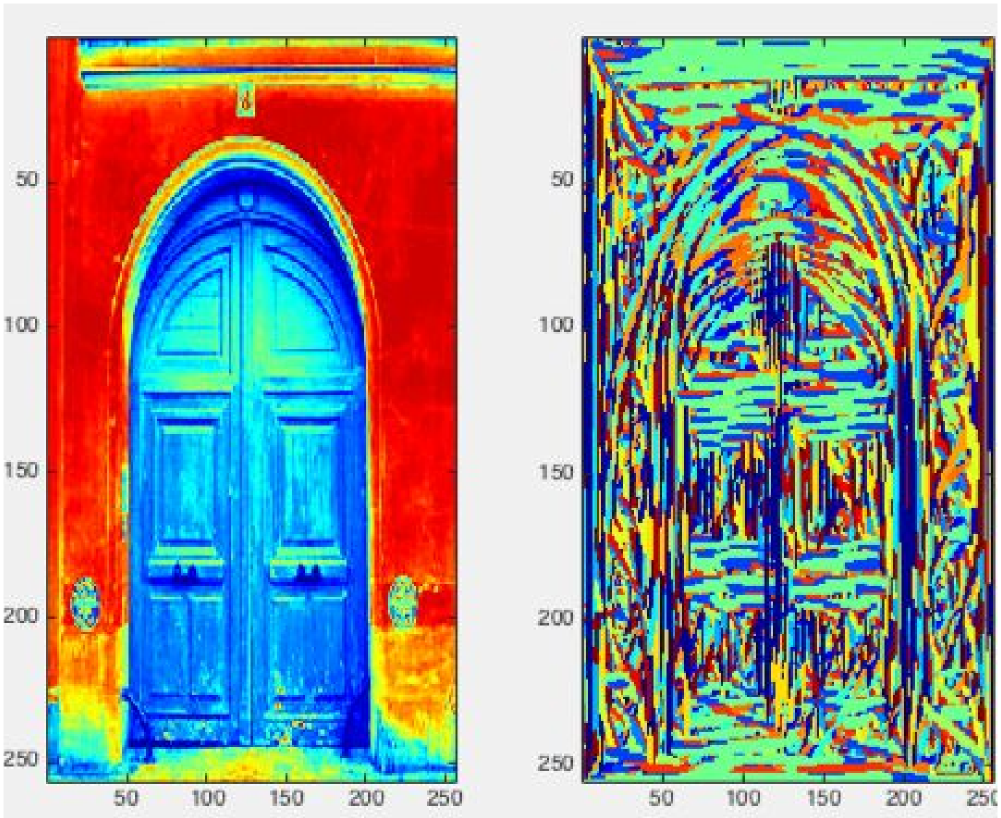
Tuning function for the best orientation that the Gabor function will help with discovering edges of

Gabor Function and Bar, Horizontal and Vertical



Gabor functions at their best and at their worst for recognizing a bar as an edge

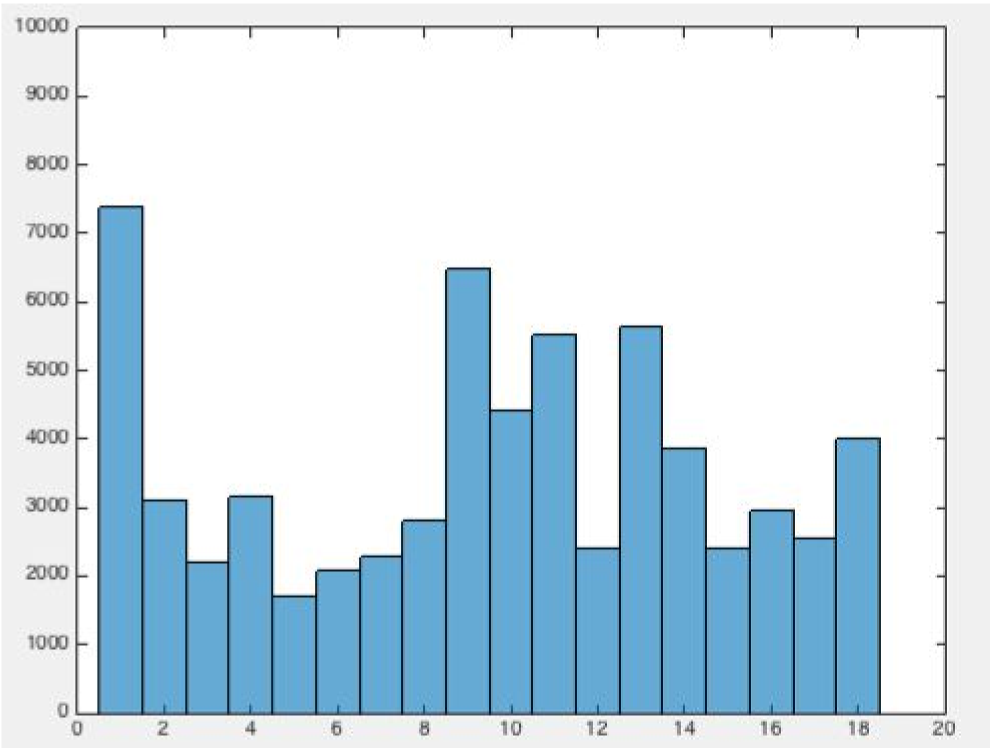
Tuning and Arg Max



An image and its estimated edges at various orientations based on application of a series of gabor filters

I observe that through this method we can categorize orientations of edges by the gabor filters that are best for their respective angles. They can show how similar/dissimilar an image is based on what kinds of angles can be found in the image. Two images of forests with similar trees, for example, would probably be represented more similarly in this way because of the common vertical orientations they would have.

Histograms

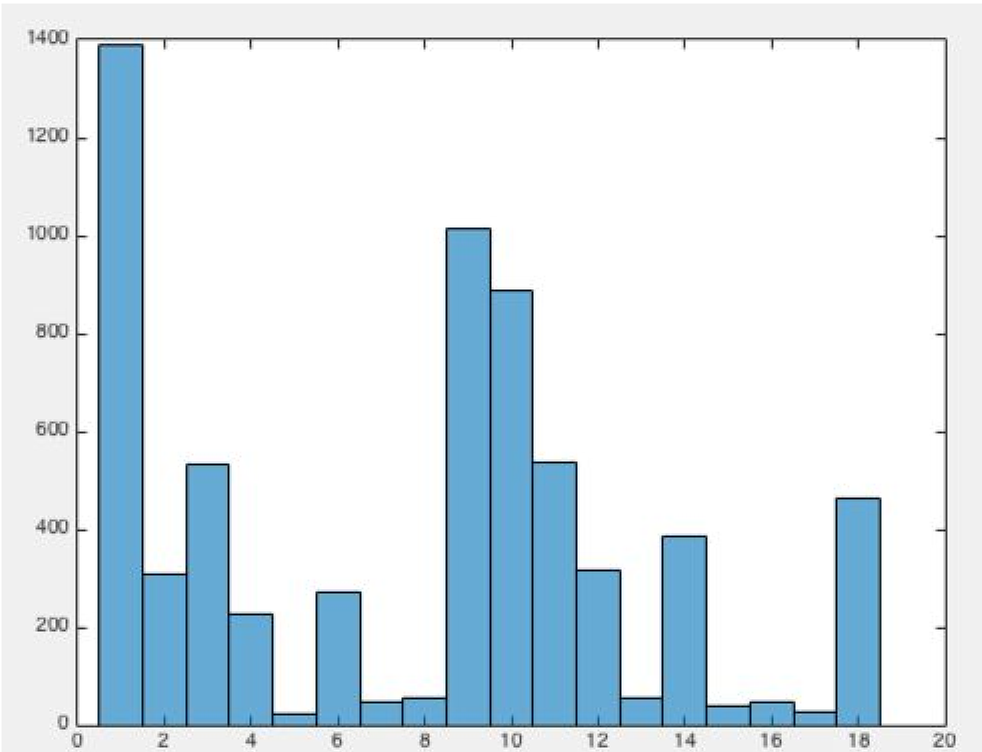


Example image’s histogram over 18 orientations for each pixel

Well in the case of the two pictures with multiple trees (#6 and #8), we can see that both images have more verical edge pixels than horizontal edge pixels. Picture #8 has many tall barren trees, however, which explains why such a high percentage of it's edge pixels are vertical. Contrast this to picture #6 which has many leaves and a hilly region and other edges of various angles.

A smoother image seems to have a more spread out histogram, whereas one with many jagged edges of similar orientation would have a much more concentrated histogram around the jagged edge orientations.

Surface Slices



Example histogram of pixel orientations found in the first surface

By comparing the histograms across slices of each of these 3 surfaces, we can infer a 3-D perspective from the 2-D images. If we take for granted that the above histogram is the distribution for a slice of the circles at a “normal” angle, we can use the distributions and *change* in distributions of other images we know to contain the same objects (in this case circles) to gain insight into what perspective or angle we’re looking at.