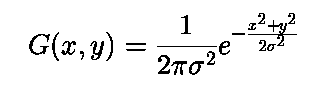
Complete the tasks using python and when submitting the answers include the code you wrote and word processed answers to the questions with relevant output images.

1. **Using the given equation for a 2D Gaussian filter, plot the output of a filter-convolved image with an appropriate sigma, σ, value [2]. What type of filter does a high sigma value produce [1]? Can you think of a way of extracting high frequency image components using only a low frequency filtered image [1]? Plot such an image and comment on it’s quality [1].**



*Hint: Use PIL.Image.open to import your image, and from scipy.signal use the convolve2d (with mode=’same’ ) for the convolution.*

1. **Create a Difference of Gaussian (DOG) filter by applying two different sigma valued Gaussian filters to the original image and then subtracting the two outputs from each other [2]. Try to find optimum sigma values for edge detection [1]. Comment on the difference between this filter and the first [2].**

*Hint: Larger sigma values require larger Gaussian kernels.*

1. **Oriented Difference of Gaussian (ODOG) filters can be created by using the below equation. Where [a, b] is a directional vector of x and y respectively for defining the direction of the filter. Plot a range of differently oriented difference of Gaussian-blurred images filters[3].**
2. **Take the derivative of a Gaussian filter with it's scaling and normalization constants set to zero [1], as below. Plot these filters and convolve these differentiated Gaussians with an input image[1]. The using two different sigma values created a difference of derivative Gaussian filter [1].**
3. **Multi-scale spatial filtering models have been applied to common visual illusion images to see if they could replicate differences in observed lightness e.g. White's illusion. Describe the model, mentioning what kind of filters they use [4]? Does this model indicate early or late stage visual processing as being responsible for whites illusion[1]?**

**Maximum marks 20/20**

Email your answers to marianne.maertens@tu-berlin.de by **DATE**