EE5175 -Image Signal Processing

Lab-4

Space-invariant Blurring

importing libraries

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
from skimage.io import imread
import os
import math as m
```

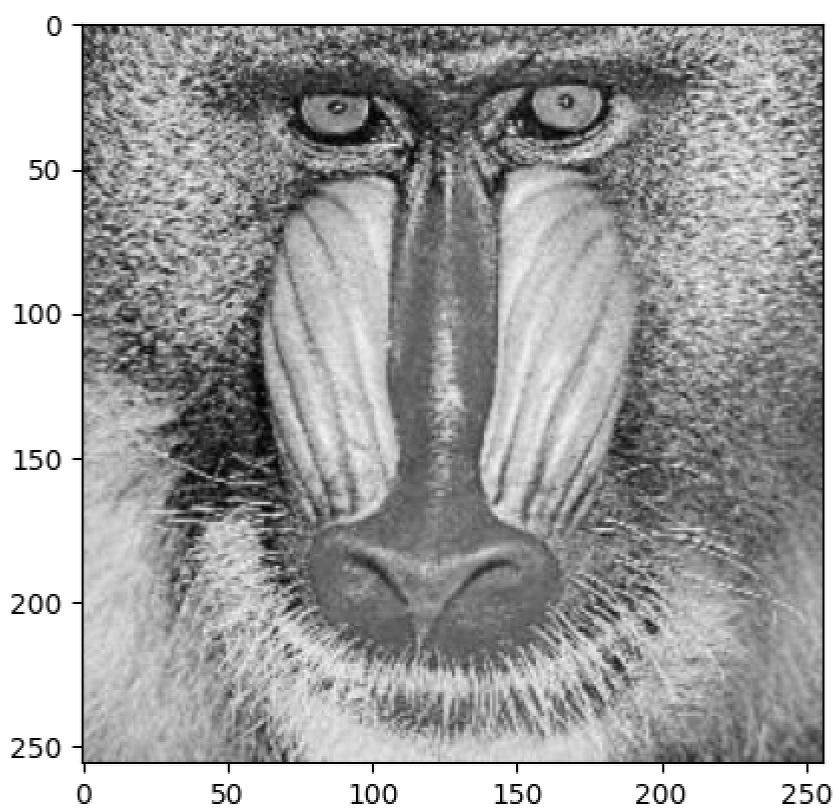
given image

In [2]:
```
img = imread('./Mandrill.png')
```

plot the given image

In [3]:
```
plt.imshow(img,'gray')
```

Out[3]: <matplotlib.image.AxesImage at 0x203195b1750>



Gaussian Kernel

- input args - sigma value (σ)
- return kernel

$$G(i,j) = \frac{1}{2\pi\sigma^2} e^{\frac{-i^2-j^2}{2\sigma^2}}$$

- normalize it by taking the sum of the kernel

In [4]:
```
def gaussian_kernel(sigma):

    w = np.ceil(6 * sigma + 1)  #window size for a given sigma

    d = int(w//2)   # d = integer value of the window size / 2
    w = int(w)     #float 64 to integer
    kernel_cal = np.zeros((w,w)) #create the zeros of the size of the window

    if w == 1 :
        return np.ones((w,w))

    for i in range(w):
        for j in range(w):
            kernel_cal[i, j] = np.exp((-(i-d)**2-(j-d)**2)/(2*(sigma**2)))

    kernel_cal_normalised = kernel_cal / kernel_cal.sum()
#     plt.imshow(kernel_cal_normalised)
    return kernel_cal_normalised
```

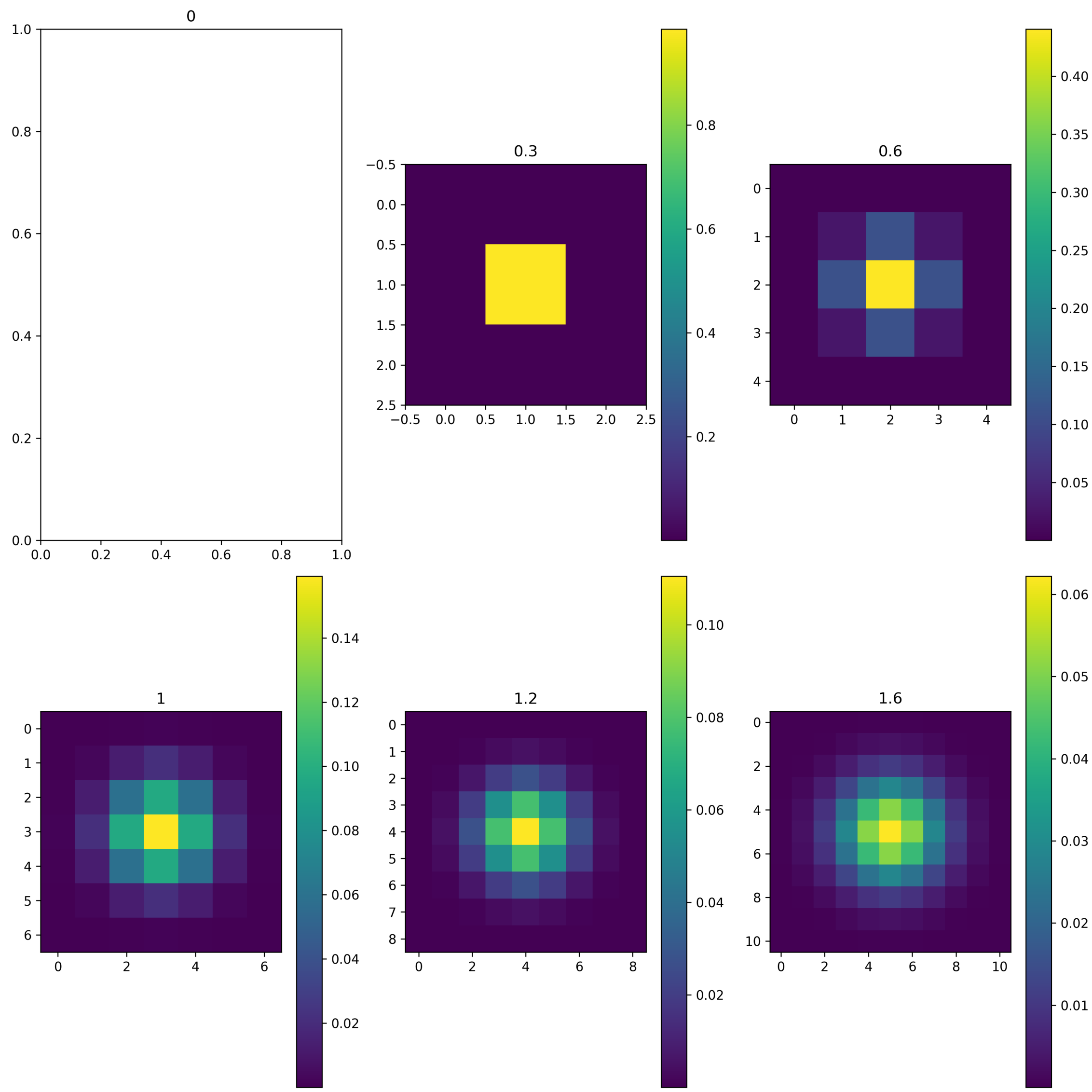
2D Convolution

In [5]:
```
def conv_2d(img , sigma ,plot_kernel = True ):
    x,y = img.shape
    w = np.ceil(6 * sigma + 1)  #get the window size
#     print(w)
    d = int(w//2)
#     print(d)

    if d == 0 :
        return img   ## had to make this case , caused an error , bcoz window of si

    #making of zeros padded image
    zero_padded_image = np.zeros((x+2*d, y+2*d))  #making a zeros of size (x+2*d)
    zero_padded_image[d:-d, d:-d] = img   #making the image go to the centre

    if plot_kernel:   #jst plotting the kernels in case to see how it comes out
        blur_kernel = gaussian_kernel_plot(sigma)
    else:
        blur_kernel = gaussian_kernel(sigma)

    final_image = np.zeros((x, y))

    for i in range(d, x+d):
        for j in range(d, y+d):
            # Extract the required image patch, multiply it with the kernel,
            # sum up the values and store it in the filtered_image array
```

```
            result = zero_padded_image[i-d:i+d+1, j-d:j+d+1]
            final_image[i-d, j-d] = np.sum(blur_kernel*result)

    return final_image
```

In [6]:
```
sigma_list = [0,0.3,0.6,1,1.2,1.6]
```

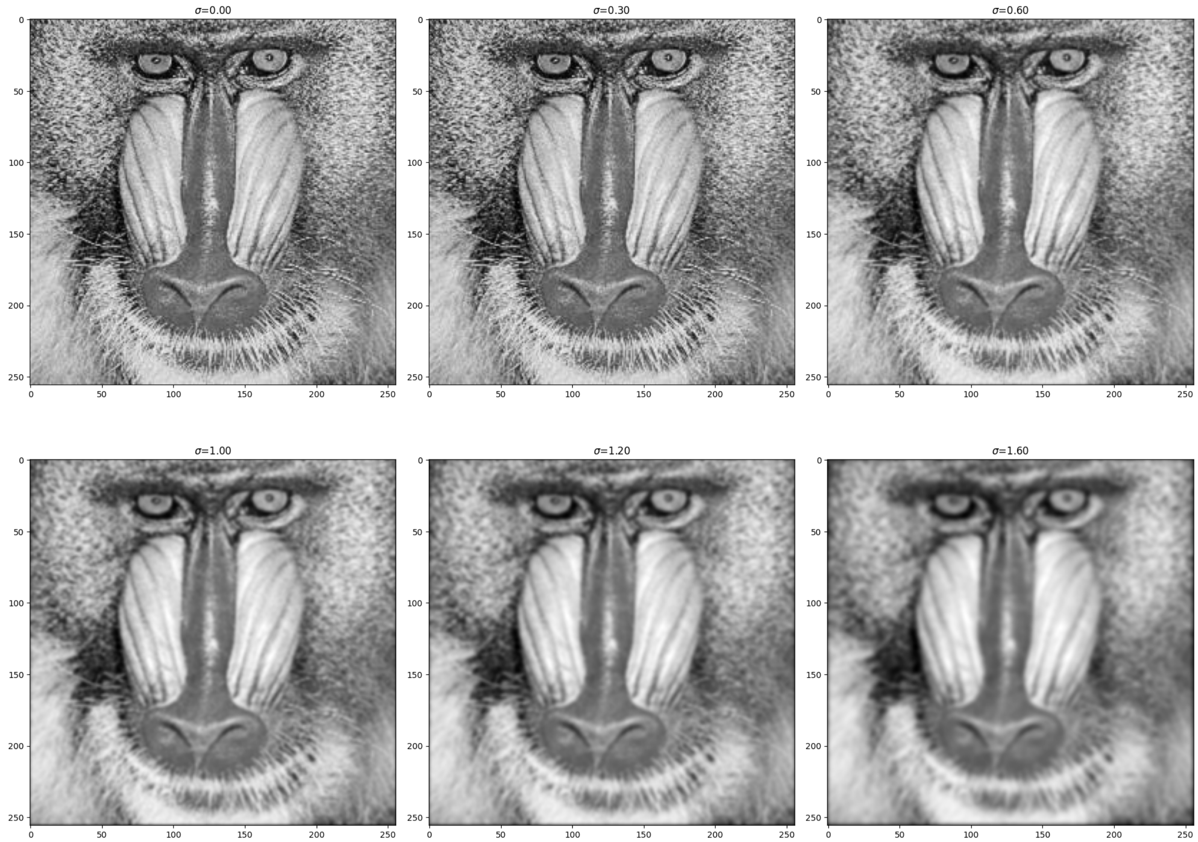
Plot of the gaussian kernels



Plot of the Gaussian blurring on Mandrill

In [9]:
```
plt.figure(figsize=(20,15))
rows = int(2)
for i in range(len(sigma_list)):
    plt.subplot(rows,3,i+1)
    op = conv_2d(img,sigma_list[i],False)
    plt.title(r'$\sigma$=%0.2f'%(sigma_list[i]))
```

```
    plt.imshow(op , cmap = 'gray')
plt.tight_layout()
```



Conclusions

- Higher the value of the σ higher is the blur
- since it is a space invariant blur we can use the convolution
- convolution and correlation for gaussian kernel gives the same result
- no blur at σ = 0
- gaussian filtering looks like a low pass filterng , where the edges are faded