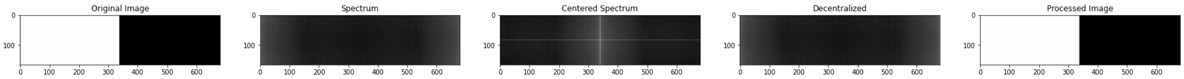
In [5]:

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
from math import sqrt,exp
```

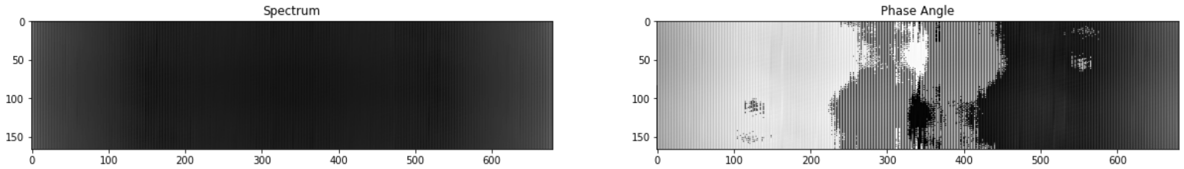
In [6]:

```
#hasil dari fungsi yang diatas
plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

img = cv2.imread("./img.png", 0)
plt.subplot(151), plt.imshow(img, "gray"), plt.title("Original Image")

original = np.fft.fft2(img)
plt.subplot(152), plt.imshow(np.log(1+np.abs(original)), "gray"), plt.title("Spectrum")

center = np.fft.fftshift(original)
plt.subplot(153), plt.imshow(np.log(1+np.abs(center)), "gray"), plt.title("Centered Spectru

inv_center = np.fft.ifftshift(center)
plt.subplot(154), plt.imshow(np.log(1+np.abs(inv_center)), "gray"), plt.title("Decentralize

processed_img = np.fft.ifft2(inv_center)
plt.subplot(155), plt.imshow(np.abs(processed_img), "gray"), plt.title("Processed Image")

plt.show()
```



In [7]:

```
#print spectrum dan phase angle
plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

img = cv2.imread("./img.png", 0)

original = np.fft.fft2(img)
plt.subplot(131), plt.imshow(np.log(np.abs(original)), "gray"), plt.title("Spectrum")

plt.subplot(132), plt.imshow(np.angle(original), "gray"), plt.title("Phase Angle")
plt.show()
```

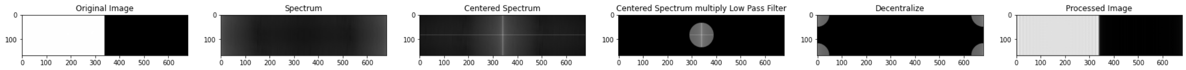


In [8]:

```
def distance(point1,point2):
    return sqrt((point1[0]-point2[0])**2 + (point1[1]-point2[1])**2)

#https://gist.github.com/HiCraigChen/255cd53ca08b2b56a0fff60f4ce1da60
def idealFilterLP(D0,imgShape):
    base = np.zeros(imgShape[:2])
    rows, cols = imgShape[:2]
    center = (rows/2,cols/2)
    for x in range(cols):
        for y in range(rows):
            if distance((y,x),center) < D0:
                base[y,x] = 1
    return base

def idealFilterHP(D0,imgShape):
    base = np.ones(imgShape[:2])
    rows, cols = imgShape[:2]
    center = (rows/2,cols/2)
    for x in range(cols):
        for y in range(rows):
            if distance((y,x),center) < D0:
                base[y,x] = 0
    return base
# referensi https://gist.github.com/HiCraigChen/aea8765162db5c61da30df1f0d19d16a
def butterworthLP(D0,imgShape,n):
    base = np.zeros(imgShape[:2])
    rows, cols = imgShape[:2]
    center = (rows/2,cols/2)
    for x in range(cols):
        for y in range(rows):
            base[y,x] = 1/(1+(distance((y,x),center)/D0)**(2*n))
    return base

def butterworthHP(D0,imgShape,n):
    base = np.zeros(imgShape[:2])
    rows, cols = imgShape[:2]
    center = (rows/2,cols/2)
    for x in range(cols):
        for y in range(rows):
            base[y,x] = 1-1/(1+(distance((y,x),center)/D0)**(2*n))
    return base
# sumber https://gist.github.com/HiCraigChen/2ef0cbb005ddbb84a65a3ab25f46daab#file-gaussian
def gaussianLP(D0,imgShape):
    base = np.zeros(imgShape[:2])
    rows, cols = imgShape[:2]
    center = (rows/2,cols/2)
    for x in range(cols):
        for y in range(rows):
            base[y,x] = exp(((-distance((y,x),center)**2)/(2*(D0**2))))
    return base

def gaussianHP(D0,imgShape):
    base = np.zeros(imgShape[:2])
    rows, cols = imgShape[:2]
    center = (rows/2,cols/2)
    for x in range(cols):
        for y in range(rows):
            base[y,x] = 1 - exp(((-distance((y,x),center)**2)/(2*(D0**2))))
    return base
```

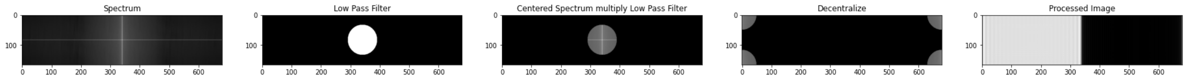
In [9]:

```
#hasil dari fungsi yang dibuat diatas
plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

img = cv2.imread("./img.png", 0)
plt.subplot(161), plt.imshow(img, "gray"), plt.title("Original Image")

original = np.fft.fft2(img)
plt.subplot(162), plt.imshow(np.log(1+np.abs(original)), "gray"), plt.title("Spectrum")

center = np.fft.fftshift(original)
plt.subplot(163), plt.imshow(np.log(1+np.abs(center)), "gray"), plt.title("Centered Spectru

LowPassCenter = center * idealFilterLP(50,img.shape)
plt.subplot(164), plt.imshow(np.log(1+np.abs(LowPassCenter)), "gray"), plt.title("Centered 

LowPass = np.fft.ifftshift(LowPassCenter)
plt.subplot(165), plt.imshow(np.log(1+np.abs(LowPass)), "gray"), plt.title("Decentralize")

inverse_LowPass = np.fft.ifft2(LowPass)
plt.subplot(166), plt.imshow(np.abs(inverse_LowPass), "gray"), plt.title("Processed Image")

plt.show()
```



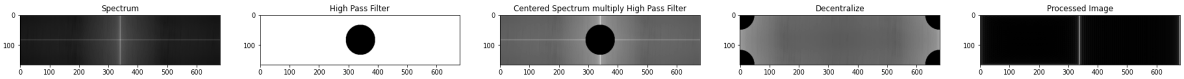
In [10]:

```
#visualisasi low pass filter
img = cv2.imread("./img.png", 0)
original = np.fft.fft2(img)
center = np.fft.fftshift(original)

plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

plt.subplot(151), plt.imshow(np.log(1+np.abs(center)), "gray"), plt.title("Spectrum")

LowPass = idealFilterLP(50,img.shape)
plt.subplot(152), plt.imshow(np.abs(LowPass), "gray"), plt.title("Low Pass Filter")

LowPassCenter = center * idealFilterLP(50,img.shape)
plt.subplot(153), plt.imshow(np.log(1+np.abs(LowPassCenter)), "gray"), plt.title("Centered 

LowPass = np.fft.ifftshift(LowPassCenter)
plt.subplot(154), plt.imshow(np.log(1+np.abs(LowPass)), "gray"), plt.title("Decentralize")

inverse_LowPass = np.fft.ifft2(LowPass)
plt.subplot(155), plt.imshow(np.abs(inverse_LowPass), "gray"), plt.title("Processed Image")

plt.show()
```



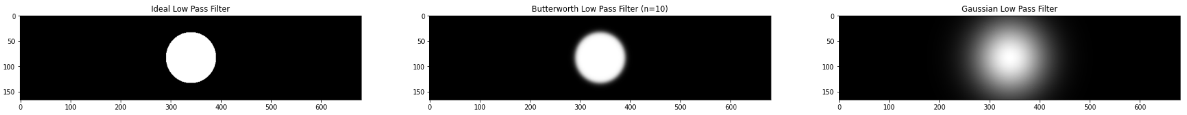
In [11]:

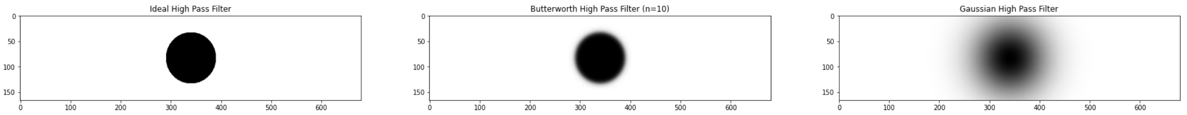
```
#visualisasi high pass filter
img = cv2.imread("./img.png", 0)
original = np.fft.fft2(img)
center = np.fft.fftshift(original)

plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

plt.subplot(151), plt.imshow(np.log(1+np.abs(center)), "gray"), plt.title("Spectrum")

HighPass = idealFilterHP(50,img.shape)
plt.subplot(152), plt.imshow(np.abs(HighPass), "gray"), plt.title("High Pass Filter")

HighPassCenter = center * idealFilterHP(50,img.shape)
plt.subplot(153), plt.imshow(np.log(1+np.abs(HighPassCenter)), "gray"), plt.title("Centered

HighPass = np.fft.ifftshift(HighPassCenter)
plt.subplot(154), plt.imshow(np.log(1+np.abs(HighPass)), "gray"), plt.title("Decentralize")

inverse_HighPass = np.fft.ifft2(HighPass)
plt.subplot(155), plt.imshow(np.abs(inverse_HighPass), "gray"), plt.title("Processed Image"

plt.show()
```



In [16]:

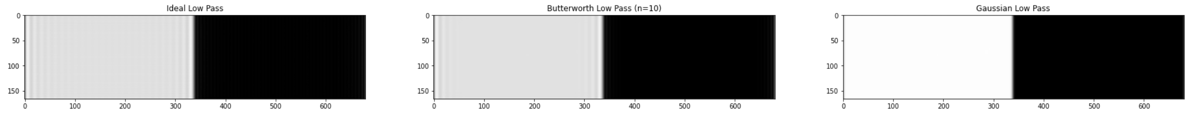
```
plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

IdealLP = idealFilterLP(50,img.shape)
plt.subplot(131), plt.imshow(IdealLP, "gray"), plt.title("Ideal Low Pass Filter")

ButterLP = butterworthLP(50,img.shape,10)
plt.subplot(132), plt.imshow(ButterLP, "gray"), plt.title("Butterworth Low Pass Filter (n=1

GaussianLP = gaussianLP(50,img.shape)
plt.subplot(133), plt.imshow(GaussianLP, "gray"), plt.title("Gaussian Low Pass Filter")

plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)
IdealHP = idealFilterHP(50,img.shape)
plt.subplot(231), plt.imshow(IdealHP, "gray"), plt.title("Ideal High Pass Filter")

ButterHP = butterworthHP(50,img.shape,10)
plt.subplot(232), plt.imshow(ButterHP, "gray"), plt.title("Butterworth High Pass Filter (n=

GaussianHP = gaussianHP(50,img.shape)
plt.subplot(233), plt.imshow(GaussianHP, "gray"), plt.title("Gaussian High Pass Filter")

plt.show()
```





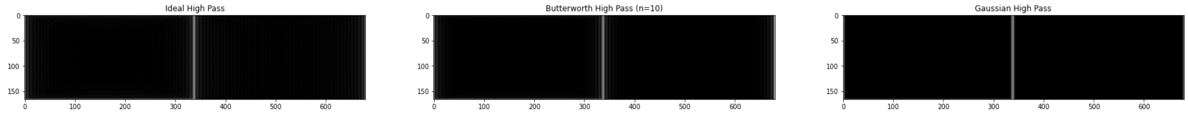
In [17]:

```
img = cv2.imread("./img.png", 0)
original = np.fft.fft2(img)
center = np.fft.fftshift(original)

plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

LowPassCenter = center * idealFilterLP(50,img.shape)
LowPass = np.fft.ifftshift(LowPassCenter)
inverse_LowPass = np.fft.ifft2(LowPass)
plt.subplot(131), plt.imshow(np.abs(inverse_LowPass), "gray"), plt.title("Ideal Low Pass")

LowPassCenter = center * butterworthLP(50,img.shape,10)
LowPass = np.fft.ifftshift(LowPassCenter)
inverse_LowPass = np.fft.ifft2(LowPass)
plt.subplot(132), plt.imshow(np.abs(inverse_LowPass), "gray"), plt.title("Butterworth Low P

LowPassCenter = center * gaussianLP(50,img.shape)
LowPass = np.fft.ifftshift(LowPassCenter)
inverse_LowPass = np.fft.ifft2(LowPass)
plt.subplot(133), plt.imshow(np.abs(inverse_LowPass), "gray"), plt.title("Gaussian Low Pass

plt.show()
```



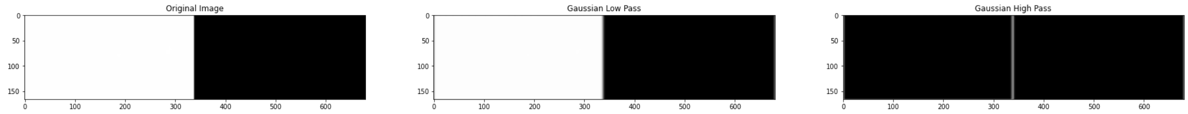
In [18]:

```
img = cv2.imread("./img.png", 0)
original = np.fft.fft2(img)
center = np.fft.fftshift(original)

plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

HighPassCenter = center * idealFilterHP(50,img.shape)
HighPass = np.fft.ifftshift(HighPassCenter)
inverse_HighPass = np.fft.ifft2(HighPass)
plt.subplot(131), plt.imshow(np.abs(inverse_HighPass), "gray"), plt.title("Ideal High Pass"

HighPassCenter = center * butterworthHP(50,img.shape,10)
HighPass = np.fft.ifftshift(HighPassCenter)
inverse_HighPass = np.fft.ifft2(HighPass)
plt.subplot(132), plt.imshow(np.abs(inverse_HighPass), "gray"), plt.title("Butterworth High

HighPassCenter = center * gaussianHP(50,img.shape)
HighPass = np.fft.ifftshift(HighPassCenter)
inverse_HighPass = np.fft.ifft2(HighPass)
plt.subplot(133), plt.imshow(np.abs(inverse_HighPass), "gray"), plt.title("Gaussian High Pa

plt.show()
```



In [19]:

```
img = cv2.imread("./img.png", 0)
original = np.fft.fft2(img)
center = np.fft.fftshift(original)

plt.figure(figsize=(6.4*5, 4.8*5), constrained_layout=False)

plt.subplot(131), plt.imshow(img, "gray"), plt.title("Original Image")

LowPassCenter = center * gaussianLP(50,img.shape)
LowPass = np.fft.ifftshift(LowPassCenter)
inverse_LowPass = np.fft.ifft2(LowPass)
plt.subplot(132), plt.imshow(np.abs(inverse_LowPass), "gray"), plt.title("Gaussian Low Pass

HighPassCenter = center * gaussianHP(50,img.shape)
HighPass = np.fft.ifftshift(HighPassCenter)
inverse_HighPass = np.fft.ifft2(HighPass)
plt.subplot(133), plt.imshow(np.abs(inverse_HighPass), "gray"), plt.title("Gaussian High Pa

plt.show()
```


Original Image
Gaussian Low Pass
Gaussian High Pass