Code

The goal of this assignment is three-fold:

a) Roberts cross operator (Please read Roberts cross operator from the book)

b) Sobel's operator

c) Apply Laplacian operator in 3x3 window and show the results.

In [1]:
```
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
def padpix(x):
    m,n = x.shape
    x1 = np.zeros((m,n+2),dtype = 'uint8')
    x2 = np.zeros((m+2,n+2),dtype = 'uint8')
    x1[:,1:n+1] = x
    x1[:,0] = x[:,1]
    x1[:,n+1] = x[:,n-2]
    x2[1:m+1,:] = x1
    x2[0,:] = x1[1,:]
    x2[m+1,:] = x1[m-2,:]
    return x2
```

In [3]:
```
def convol0(x,h):
    m,n = x.shape
    x1 = np.zeros(x.shape, dtype = 'float')
    for i in range(1,m-1):
        for j in range(1,n-1):
            for ii in range(-1,2):
                for jj in range(-1,2):
                    x1[i,j] += x[i+ii,j+jj]*h[ii+1,jj+1]
    return x1[1:m+1,1:n+1]
```

In [4]:
```
def thresh(x,thr):
    xout = np.zeros(x.shape, dtype = 'uint8')
    xout[x>thr] = 255
    return xout
```

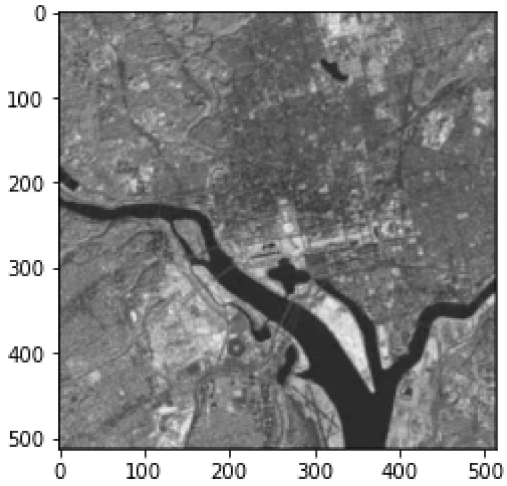
In [5]:
```
def Gfilter(filter_sz,sig):
    w = np.zeros((filter_sz,filter_sz), dtype = 'float')
    fs = filter_sz//2
    for i in range(-fs,fs):
```

```
        for j in range(-fs,fs):
            w[i,j] = 1.0*np.exp(-0.5*(i*i+j*j))/np.sqrt(2*np.pi)/sig
    return w/np.sum(w)
```

Filtered Image

In [6]:
```
x = plt.imread('washdc512.jpg')
h = Gfilter(15,1.0)
x = convol0(padpix(x),h)
plt.imshow(x,cmap = 'gray')
print(np.max(x),np.min(x))
print(x.shape)
```

```
43.10907221378113 0.0
(513, 513)
```



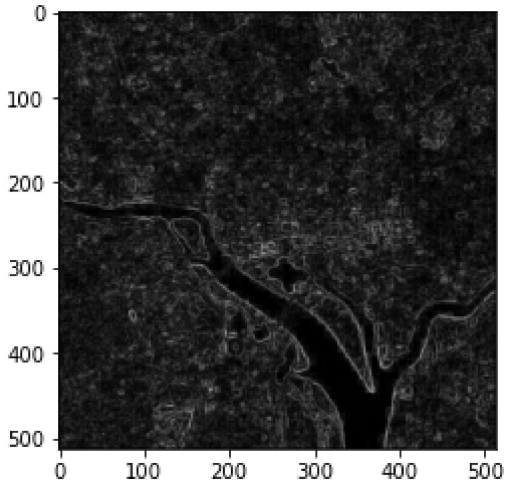
a) Robert's Operator

In [7]:
```
def hpfRoberts():
    hv = np.asarray([[0,0,0],
                     [0,1,0],
                     [0,0,-1]])

    hh = np.asarray([[0,0,0],
                     [0,0,1],
                     [0,-1,0]])
    return hh,hv
```

In [8]:
```
x = plt.imread('washdc512.jpg')
hh,hv = hpfRoberts()
yh = convol0(padpix(x),hh)
yv = convol0(padpix(x),hv)
y = np.abs(yh) + np.abs(yv)
plt.imshow(y, cmap = 'gray')
print(y.shape)
```

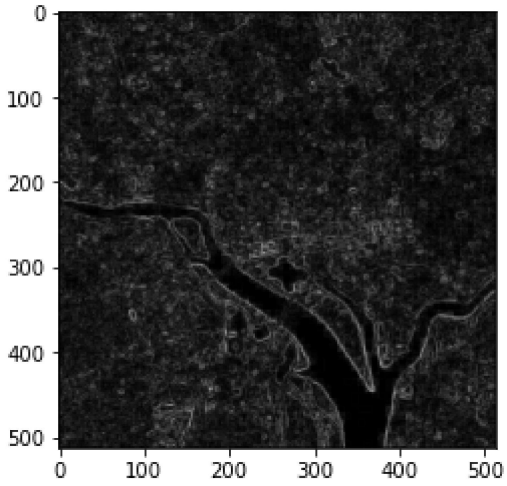
```
(513, 513)
```



In [9]:
```
y = y + np.min(y)
print(np.max(y))
y = np.uint8(y*255/np.max(y))
print(np.min(y),np.max(y),np.mean(y))
plt.imshow(y, cmap = 'gray')
```

```
76.0
0 255 28.121070490825286
```

Out[9]: <matplotlib.image.AxesImage at 0x1e55c0bfb50>

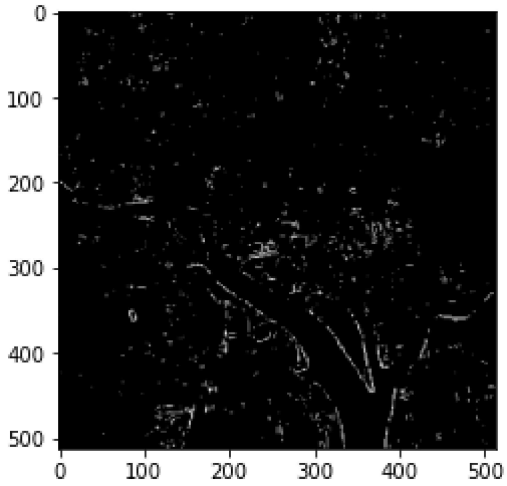


Implementing Threshold

In [10]:
```
print(np.mean(y),np.max(y),np.min(y))
xx = thresh(y,100)
plt.imshow(xx, cmap = 'gray')
```

```
28.121070490825286 255 0
```

Out[10]: <matplotlib.image.AxesImage at 0x1e55c113e80>



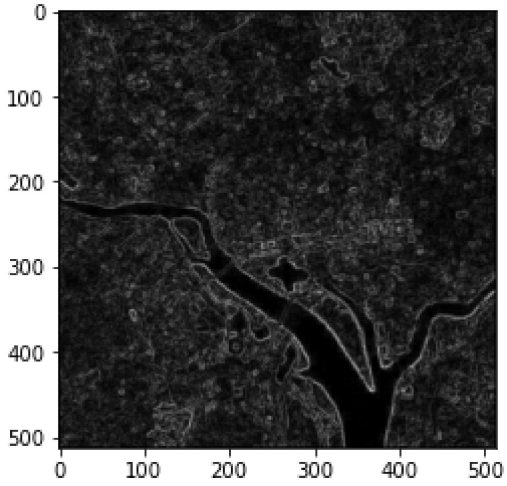
b) Sobel's Operator

In [11]:
```
def hpfSobels():
    hv = np.asarray([[1,2,1],
                     [0,0,0],
                     [-1,-2,-1]])

    hh = np.asarray([[1,0,-1],
                     [2,0,-2],
                     [1,0,-1]])
    return hh,hv
```

In [12]:
```
x = plt.imread('washdc512.jpg')
hh,hv = hpfSobels()
yh = convol0(padpix(x),hh)
yv = convol0(padpix(x),hv)
y = np.abs(yh) + np.abs(yv)
plt.imshow(y, cmap = 'gray')
print(y.shape)
```

```
(513, 513)
```

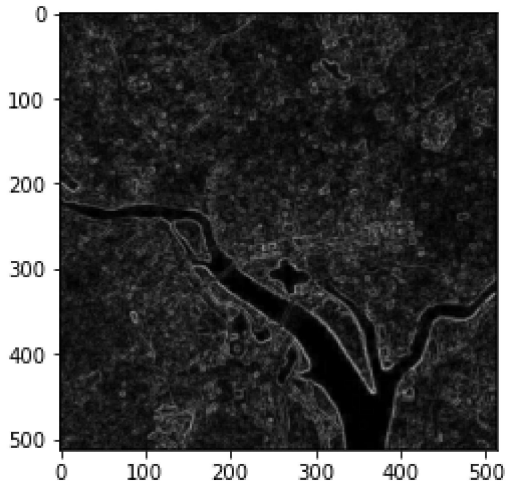


In [13]:
```
y = y + np.min(y)
print(np.max(y))
```

```
y = np.uint8(y*255/np.max(y))
print(np.min(y),np.max(y),np.mean(y))
plt.imshow(y, cmap = 'gray')
```

```
318.0
0 255 30.043470165559015
```

Out[13]: <matplotlib.image.AxesImage at 0x1e55b12e5b0>



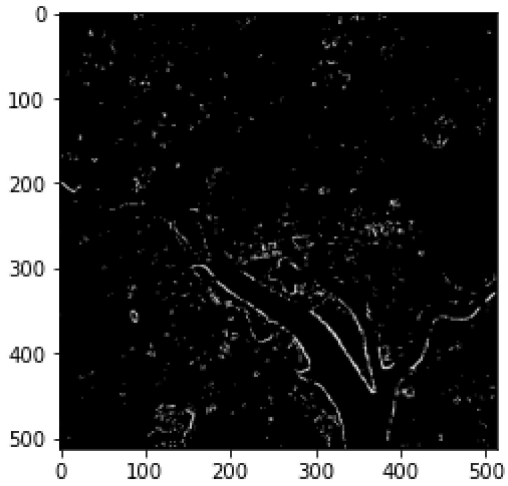
Implementing Threshold

In [14]:

```
print(np.mean(y),np.max(y),np.min(y))
xx = thresh(y,100)
plt.imshow(xx, cmap = 'gray')
```

```
30.043470165559015 255 0
```

Out[14]: <matplotlib.image.AxesImage at 0x1e55b180910>



c) Apply Laplacian operator in 3x3 window and show the results.

In [15]:

```
def hpfLaplacian():
    hv = np.asarray([[0,1,0],
```

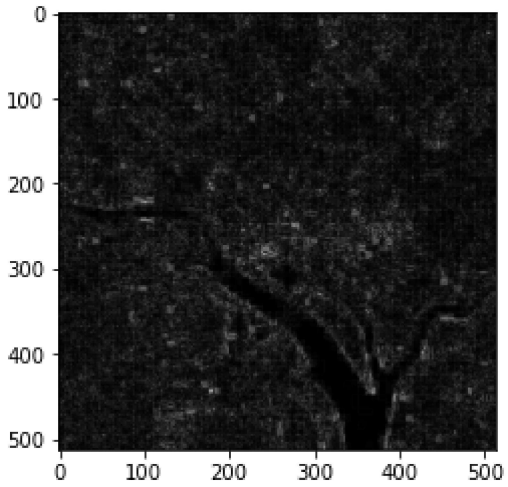
```
                    [1,-4,1],
                    [0,1,0]])

    hh = np.asarray([[-1,-1,-1],
                    [-1,8,-1],
                    [-1,-1,-1]])
    return hh,hv
```

In [16]:

```
x = plt.imread('washdc512.jpg')
hh,hv = hpfLaplacian()
yh = convol0(padpix(x),hh)
yv = convol0(padpix(x),hv)
y = np.abs(yh) + np.abs(yv)
plt.imshow(y, cmap = 'gray')
print(y.shape)
```

```
(513, 513)
```

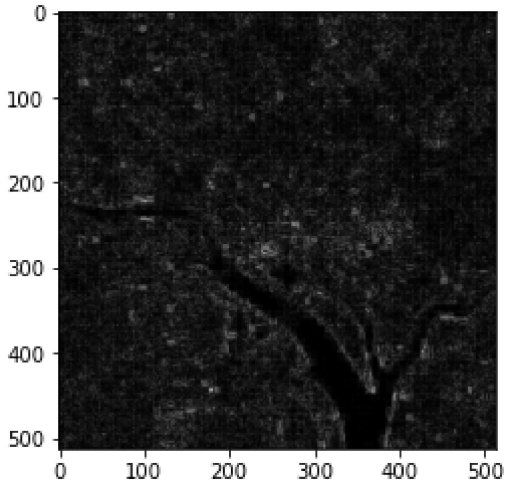


In [17]:

```
y = y + np.min(y)
print(np.max(y))
y = np.uint8(y*255/np.max(y))
print(np.min(y),np.max(y),np.mean(y))
plt.imshow(y, cmap = 'gray')
```

```
252.0
0 255 21.310754686152244
```

Out[17]: <matplotlib.image.AxesImage at 0x1e55b23c100>



Implementing Threshold

In [20]:
```
print(np.mean(y),np.max(y),np.min(y))
xx = thresh(y,100)
plt.imshow(xx, cmap = 'gray')
```

```
21.310754686152244 255 0
```

Out[20]:
```
<matplotlib.image.AxesImage at 0x1e55b265c40>
```