All the header files of cv2,numpy and matplot

In [110]:

```
import cv2
import numpy as np
from skimage.exposure import rescale_intensity
import matplotlib.pyplot as plt
import scipy.stats as st
%matplotlib inline
```

Load the images and change to grayscale

In [111]:

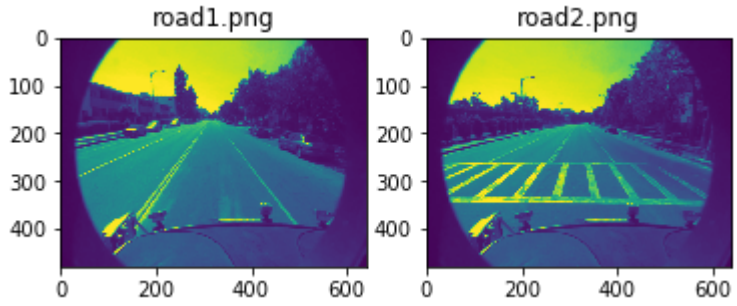
```
roadimage1 = cv2.imread("road1.png")
roadimage2 = cv2.imread("road2.png")
roadimage1 = cv2.cvtColor(roadimage1, cv2.COLOR_BGR2GRAY)
roadimage2 = cv2.cvtColor(roadimage2, cv2.COLOR_BGR2GRAY)
```

In [112]:

```
fig = plt.figure()
a=fig.add_subplot(1,2,1)
a.set_title("road1.png")
plt.imshow(roadimage1)
a=fig.add_subplot(1,2,2)
a.set_title("road2.png")
plt.imshow(roadimage2)
```

Out[112]:

```
<matplotlib.image.AxesImage at 0x13e9d278>
```



Function for 2D filtering, using same for all.

1. Pad the image with zeros.

2. Run the loop for each pixel inside kernel.

3. Multiply the region of image around pixel and kernel.

4.Rescale to 0 to 255.

5.Convert to int8 and return

In [113]:

```
def filtering(image, kernel):
    height,width= image.shape
    K,_K = kernel.shape
    pad = (K - 1) / 2
    image = cv2.copyMakeBorder(image, pad, pad, pad, pad, cv2.BORDER_REPLICATE)
    output = np.zeros((height, width), dtype="float32")
    for y in np.arange(pad, height + pad):
        for x in np.arange(pad, width + pad):
            mul_image = image[y-pad:y+pad+1, x-pad:x+pad+1]
            res = (mul_image*kernel).sum()
            output[y-pad,x-pad] = res
    output = rescale_intensity(output, in_range=(0, 255))
    output = (output * 255).astype("uint8")
    return output
```

Predefined function -

http://stackoverflow.com/questions/29731726/how-to-calculate-a-gaussian-kernel-matrix-efficiently-in-numpy (http://stackoverflow.com/questions/29731726/how-to-calculate-a-gaussian-kernel-matrix-efficiently-in-numpy)

In [114]:

```
def gkern(kernlen, nsig):
    """Returns a 2D Gaussian kernel array."""

    interval = (2*nsig+1.)/(kernlen)
    x = np.linspace(-nsig-interval/2., nsig+interval/2., kernlen+1)
    kern1d = np.diff(st.norm.cdf(x))
    kernel_raw = np.sqrt(np.outer(kern1d, kern1d))
    kernel = kernel_raw/kernel_raw.sum()
    return kernel
```

Now apply for image blurring, road1.png

In [115]:

```
#Changing the sigma values
k1 = gkern(11, 1)
k2 = gkern(11, 3)
k3 = gkern(11, 7)



blur1 = filtering(roadimage1, k1)
blur2 = filtering(roadimage1, k2)
blur3 = filtering(roadimage1, k3)


fig = plt.figure()
a=fig.add_subplot(1,3,1)
a.set_title("Sigma=1")
plt.imshow(blur1)
a=fig.add_subplot(1,3,2)
a.set_title("Sigma=3")
plt.imshow(blur2)
a=fig.add_subplot(1,3,3)
a.set_title("Sigma=7")
plt.imshow(blur3)
```

Out[115]:

```
<matplotlib.image.AxesImage at 0x14291898>
```

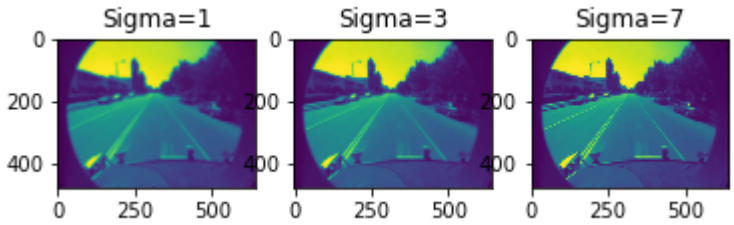


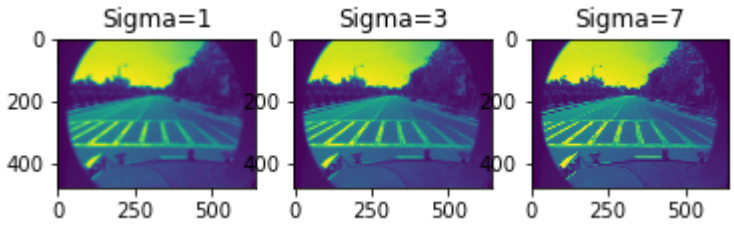
Image bluring, road2.png

In [116]:

```
#Changing the sigma values
k1 = gkern(11, 1)
k2 = gkern(11, 3)
k3 = gkern(11, 7)



blur1 = filtering(roadimage2, k1)
blur2 = filtering(roadimage2, k2)
blur3 = filtering(roadimage2, k3)


fig = plt.figure()
a=fig.add_subplot(1,3,1)
a.set_title("Sigma=1")
plt.imshow(blur1)
a=fig.add_subplot(1,3,2)
a.set_title("Sigma=3")
plt.imshow(blur2)
a=fig.add_subplot(1,3,3)
a.set_title("Sigma=7")
plt.imshow(blur3)
```

Out[116]:

```
<matplotlib.image.AxesImage at 0x14706668>
```



Sobel filter, hardcoded values

In [117]:

```
k1 = np.array(([[1  , 0 ,  -1],
      [2,   0,   -2],
      [1,   0,   -1]]),dtype="int");
k2 = np.array(([[2,   1,   0,   -1,  -2],
      [3,   2,   0,   -2,  -3],
      [4,   3,   0,   -3,  -4],
      [3,  2,  0,   -2,  -3],
      [2,   1,   0,   -1,  -2]]),dtype="int");
k3 = np.array(([[3,   2,   1,   0,   -1,  -2,  -3],
      [4,   3,   2,   0,   -2,  -3,  -4],
      [5,   4,   3,   0,   -3,  -4,  -5],
      [6,   5,   4,   0,   -4,  -5,  -6],
      [5,   4,   3,   0,   -3,  -4,  -5],
      [4,   3,   2,   0,   -2,  -3,  -4],
      [3,   2,   1,   0,   -1,  -2,  -3]]),dtype="int");
```

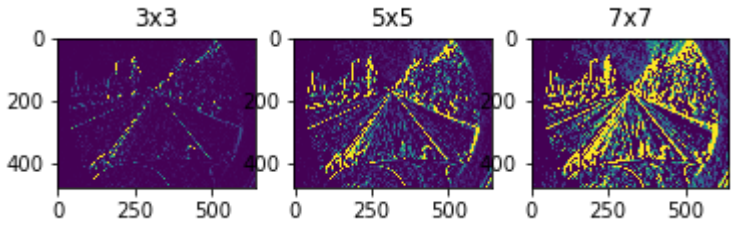
For road1.png

In [118]:

```
sobl1 = filtering(roadimage1, k1)
sobl2 = filtering(roadimage1, k2)
sobl3 = filtering(roadimage1, k3)


fig = plt.figure()
a=fig.add_subplot(1,3,1)
a.set_title("3x3")
plt.imshow(sobl1)
a=fig.add_subplot(1,3,2)
a.set_title("5x5")
plt.imshow(sobl2)
a=fig.add_subplot(1,3,3)
a.set_title("7x7")
plt.imshow(sobl3)
```

Out[118]:

```
<matplotlib.image.AxesImage at 0x14cb9470>
```

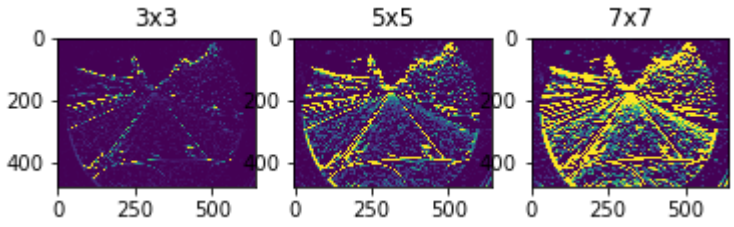


In [119]:

```
sobl1 = filtering(roadimage1, k1.T)
sobl2 = filtering(roadimage1, k2.T)
sobl3 = filtering(roadimage1, k3.T)


fig = plt.figure()
a=fig.add_subplot(1,3,1)
a.set_title("3x3")
plt.imshow(sobl1)
a=fig.add_subplot(1,3,2)
a.set_title("5x5")
plt.imshow(sobl2)
a=fig.add_subplot(1,3,3)
a.set_title("7x7")
plt.imshow(sobl3)
```

Out[119]:

```
<matplotlib.image.AxesImage at 0x151b56d8>
```



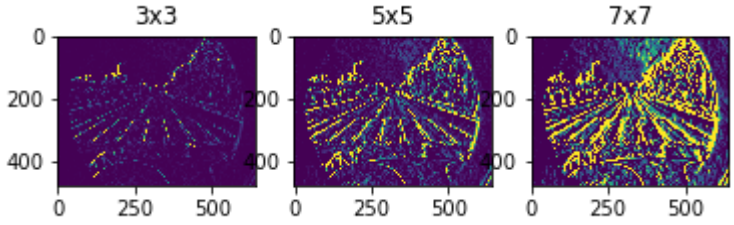
For road2.png

In [120]:

```
sobl1 = filtering(roadimage2, k1)
sobl2 = filtering(roadimage2, k2)
sobl3 = filtering(roadimage2, k3)


fig = plt.figure()
a=fig.add_subplot(1,3,1)
a.set_title("3x3")
plt.imshow(sobl1)
a=fig.add_subplot(1,3,2)
a.set_title("5x5")
plt.imshow(sobl2)
a=fig.add_subplot(1,3,3)
a.set_title("7x7")
plt.imshow(sobl3)
```

Out[120]:

```
<matplotlib.image.AxesImage at 0x1560f828>
```



In [121]:

```
sobl1 = filtering(roadimage2, k1.T)
sobl2 = filtering(roadimage2, k2.T)
sobl3 = filtering(roadimage2, k3.T)


fig = plt.figure()
a=fig.add_subplot(1,3,1)
a.set_title("3x3")
plt.imshow(sobl1)
a=fig.add_subplot(1,3,2)
a.set_title("5x5")
plt.imshow(sobl2)
a=fig.add_subplot(1,3,3)
a.set_title("7x7")
plt.imshow(sobl3)
```

Out[121]:

```
<matplotlib.image.AxesImage at 0x15af2ac8>
```

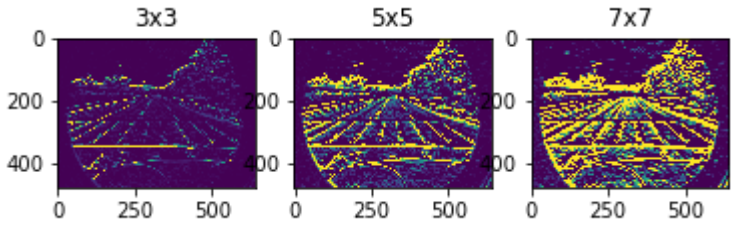


Image sharpening

1. Used k1, enhance the central pixel

2. Used k2, degrade central pixel

http://www.sfu.ca/geog/geog452spring01/group2/edge_enh_filter.html
(http://www.sfu.ca/geog/geog452spring01/group2/edge_enh_filter.html)

In [122]:

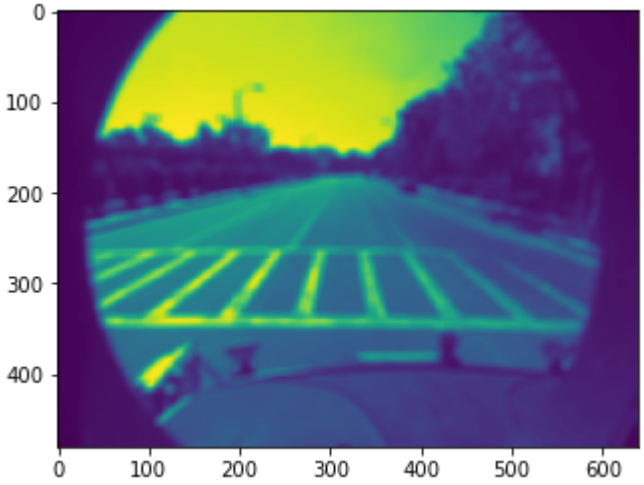
```
k1 = np.array([[-1,-1,-1], [-1,9,-1], [-1,-1,-1]]);
k2 = np.array([[1,1,1], [1,-7,1], [1,1,1]]);
```

In [124]:

```
plt.imshow(blur1)
#Blured image road1.png
```

Out[124]:

<matplotlib.image.AxesImage at 0x15e15f98>



In [125]:

```
blur1 = filtering(blur1, k1)
plt.imshow(blur1)
```

Out[125]:

<matplotlib.image.AxesImage at 0x1448ccc0>