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In [ ]:
```python
import matplotlib.pyplot as plt
import numpy as np
import cv2 as cv
from mpl_toolkits.mplot3d import Axes3D
from matplotlib import cm
from matplotlib.ticker import LinearLocator, FormatStrFormatter

fig,ax=plt.subplots(1,2,figsize=(16,8))
ax1=fig.add_subplot(121,projection="3d")
ax2=fig.add_subplot(122,projection="3d")
sigma =1
delta=0.1
xx,yy=np.meshgrid(np.arange(-5,5+delta,delta),np.arange(-5,5+delta,delta))
g=np.exp(-(xx**2+yy**2)/2*sigma**2)
g/=np.sum(g)
sobel_v=np.array([[-1,-2,-1],[0,0,0],[1,2,1]],dtype=np.float32)
g_x=cv.filter2D(g,-1,sobel_v)
sobel_h=np.array([[-1,0,1],[-2,0,2],[-1,0,1]],dtype=np.float32)
g_y=cv.filter2D(g,-1,sobel_h)
surf1=ax1.plot_surface(xx,yy,g_x,cmap=cm.jet,linewidth=0,antialiased=True)
surf2=ax2.plot_surface(xx,yy,g_y,cmap=cm.jet,linewidth=0,antialiased=True)
ax1.axis('off')
ax2.axis("off")
plt.show()
```
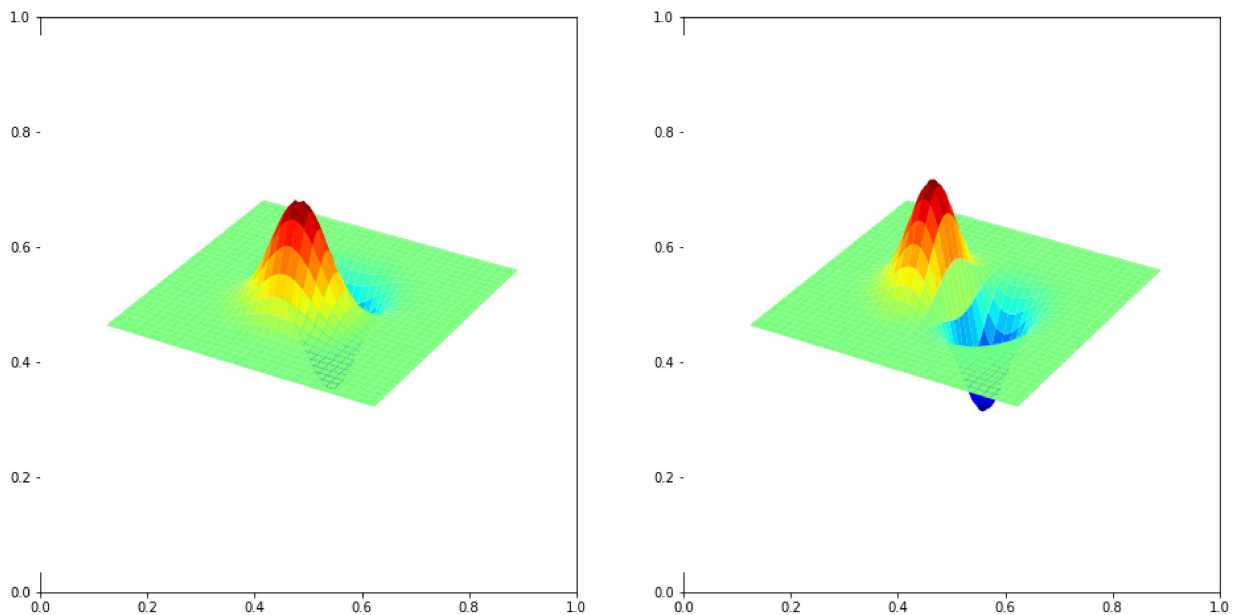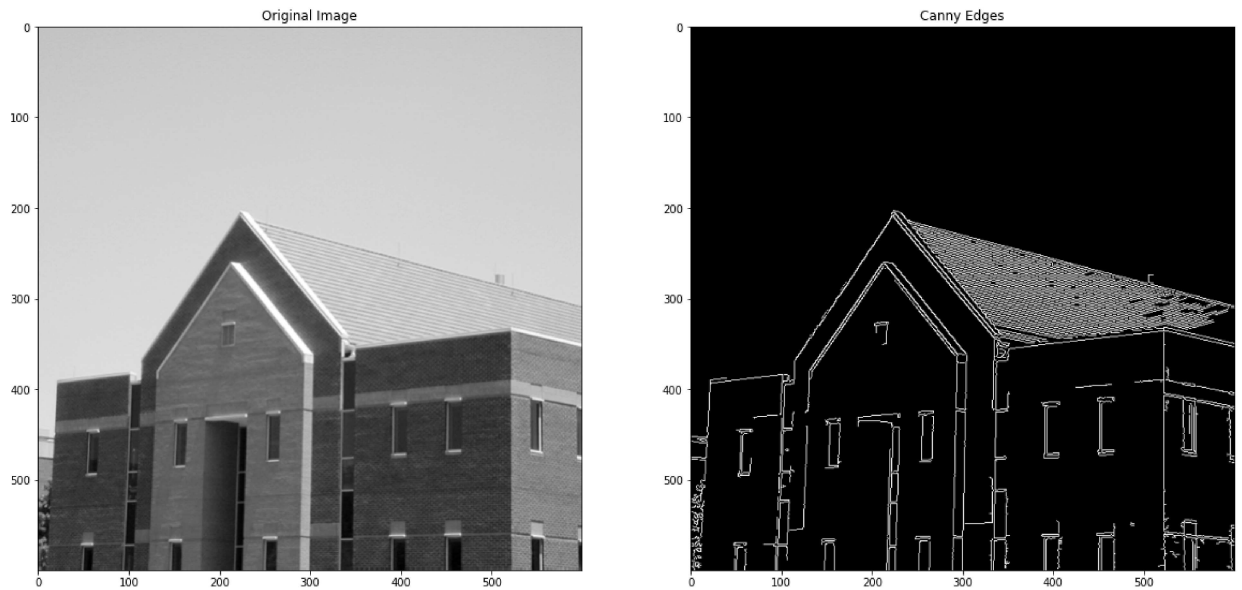

In [ ]:
```python
import cv2 as cv
import matplotlib.pyplot as plt

img=cv.imread(r"Images/building.tif",cv.IMREAD_GRAYSCALE)

edges=cv.Canny(img,100,200) #image,low threshold,high threshold

fig,ax=plt.subplots(1,2,figsize=(20,20))
ax[0].imshow(img,cmap="gray")
```

```python
ax[0].set_title('Original Image')
ax[1].imshow(edges,cmap="gray")
ax[1].set_title('Canny Edges')
plt.show()
```



```python
import cv2 as cv
import matplotlib.pyplot as plt
import numpy as np

img=cv.imread(r"Images/building.tif",cv.IMREAD_COLOR)
assert img is not None
fig,ax=plt.subplots(1,2,sharex='all',sharey='all',figsize=(16,16))
ax[0].imshow(img,cmap='gray')
ax[0].set_title("Original Image")
gray=cv.cvtColor(img,cv.COLOR_BGR2GRAY)
gray=np.float32(gray)
dst=cv.cornerHarris(gray,2,3,0.04)

dst=cv.dilate(dst,None)
img[dst>0.01*dst.max()] = [0,0,255]
cv.imshow('dst',img)
cv.waitKey(0)
cv.destroyAllWindows()
ax[1].imshow(img,cmap="gray")
ax[1].set_title("Harris Corner Image")
plt.show()
```

Original Image — Harris Corner Image
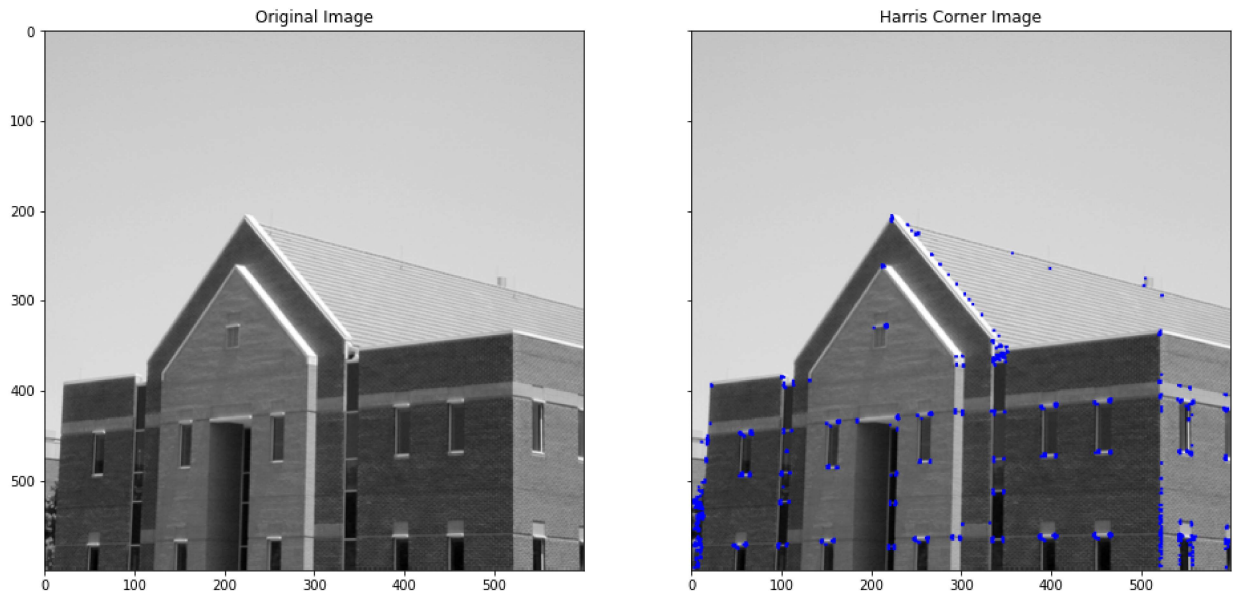
```python
import cv2 as cv
import matplotlib.pyplot as plt
import numpy as np
from skimage.feature import peak_local_max

img=cv.imread(r"Images/building.tif",cv.IMREAD_COLOR)
assert img is not None

I= cv.cvtColor(img,cv.COLOR_BGR2GRAY)
I=np.float32(I)
sobel_v=np.array([[-1,-2,-1],[0,0,0],[1,2,1]],dtype=np.float32)
sobel_h=np.array([[-1,0,1],[-2,0,2],[-1,0,1]],dtype=np.float32)

Ix=cv.filter2D(I,-1,sobel_v)
Iy=cv.filter2D(I,-1,sobel_h)

sigma=3
ksize=7

m11=cv.GaussianBlur(Ix*Iy,(ksize,ksize),sigma)
m12=cv.GaussianBlur(Ix*Iy,(ksize,ksize),sigma)
m21=m12
m22=cv.GaussianBlur(Iy*Iy,(ksize,ksize),sigma)

det=m11*m22-m12*m21
trace=m11+m22
alpha=0.04
R=det-alpha*trace**2
R[R<1e6]=0
coordinates=peak_local_max(R,min_distance=2)

fig,ax=plt.subplots(2,2,sharex='all',sharey='all',figsize=(16,16))
ax[0,0].imshow(img,cmap='gray')
ax[0,0].plot(coordinates[:,1],coordinates[:,0],"r.")
ax[0,1].imshow(Ix+127,cmap="gray")
ax[1,0].imshow(Iy+127,cmap="gray")
ax[1,1].imshow(R+127,cmap=cm.jet)
plt.show()
```