

```
In [1]: from PIL import Image
import pywt
```

```
In [3]: img = Image.open("img.jpg")
img
```

```
Out[3]:
```



```
In [4]: import pywt
import numpy as np
import cv2
import matplotlib.pyplot as plt
```

```
In [5]: image = cv2.imread('img.jpg', cv2.IMREAD_GRAYSCALE)
```

```
In [6]: image
```

```
Out[6]: array([[ 74,  71,  70, ...,  86,  86,  86],
   [ 72,  72,  74, ...,  92,  91,  89],
   [ 73,  74,  75, ...,  94,  89,  89],
   ...,
   [ 80,  76,  82, ...,  89,  84,  90],
   [ 85,  81,  81, ..., 122, 110,  68],
   [ 34,  43,  50, ..., 134, 140, 128]], dtype=uint8)
```

```
In [7]: coeffs_haar = pywt.dwt2(image, 'haar')
```

In [9]: coeffs_haar

```
Out[9]: (array([[144.5, 144.5, 145.5, ..., 191., 180., 176.],
   [149., 151.5, 148., ..., 214.5, 195., 178.5],
   [152., 156.5, 155., ..., 189., 193., 200.],
   ...,
   [137.5, 147., 152., ..., 66., 136.5, 184.],
   [161., 157.5, 142.5, ..., 153.5, 211.5, 176.],
   [ 77., 107., 139., ..., 235., 250., 268.]]),
 (array([[ 0.5, -4.5, -2.5, ..., -15., -5., -4.],
   [-2., -0.5, 0., ..., 3.5, 1., -0.5],
   [ 0., 0.5, -1., ..., 0., -4., -3.],
   ...,
   [-4.5, -8., -2., ..., 15., 14.5, -23.],
   [-5., -0.5, -1.5, ..., -56.5, -38.5, -2.],
   [ 0., 0., 0., ..., 0., 0., 0.]]),
 array([[ 1.5, -0.5, -0.5, ..., 1., 2., 1.],
   [ 0., -0.5, 0., ..., 7.5, 7., -0.5],
   [ 0., -1.5, 0., ..., -3., -7., 3.],
   ...,
   [-4.5, -11., 2., ..., -14., -9.5, -19.],
   [ 4., 5.5, 3.5, ..., -11.5, 0.5, 18.],
   [-9., -7., 1., ..., -3., -18., 12.]]),
 array([[ 1.50000000e+00, 5.00000000e-01, -5.00000000e-01, ...,
   -1.00000000e+00, 1.00000000e+00, -1.00000000e+00],
   [-1.00000000e+00, -5.00000000e-01, 0.00000000e+00, ...,
   5.00000000e-01, 1.00000000e+00, 5.00000000e-01],
   [ 0.00000000e+00, 5.00000000e-01, 0.00000000e+00, ...,
   0.00000000e+00, 0.00000000e+00, 0.00000000e+00],
   ...,
   [ 1.50000000e+00, -2.00000000e+00, -1.00000000e+01, ...,
   -7.00000000e+00, 5.00000000e-01, -5.32907052e-15],
   [ 0.00000000e+00, 1.50000000e+00, 5.50000000e+00, ...,
   -3.50000000e+00, -5.50000000e+00, -2.40000000e+01],
   [ 0.00000000e+00, 0.00000000e+00, 0.00000000e+00, ...,
   0.00000000e+00, 0.00000000e+00, 0.00000000e+00]])))
```

In [10]: LL_H, (LH_H, HL_H, HH_H) = coeffs_haar

```
In [11]: plt.figure(figsize=(12,8))

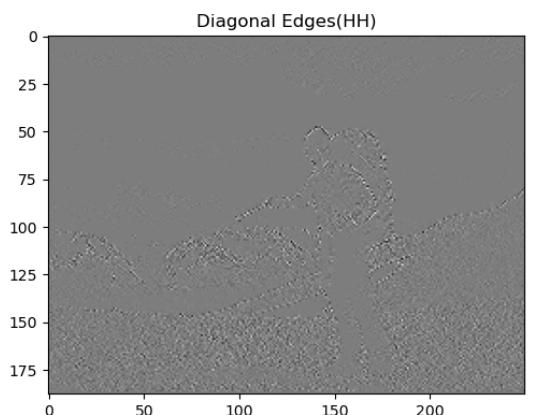
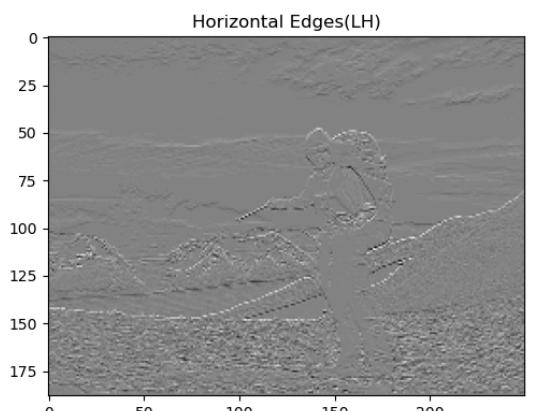
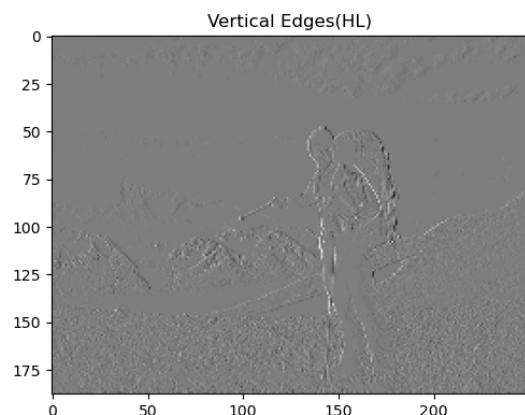
plt.subplot(2,2,1)
plt.imshow(image,cmap='gray')
plt.title('Original Image')

plt.subplot(2,2,2)
plt.imshow(LH_H,cmap='gray')
plt.title('Horizontal Edges(LH)')

plt.subplot(2,2,3)
plt.imshow(HL_H,cmap='gray')
plt.title('Vertical Edges(HL)')

plt.subplot(2,2,4)
plt.imshow(HH_H,cmap='gray')
plt.title('Diagonal Edges(HH)')

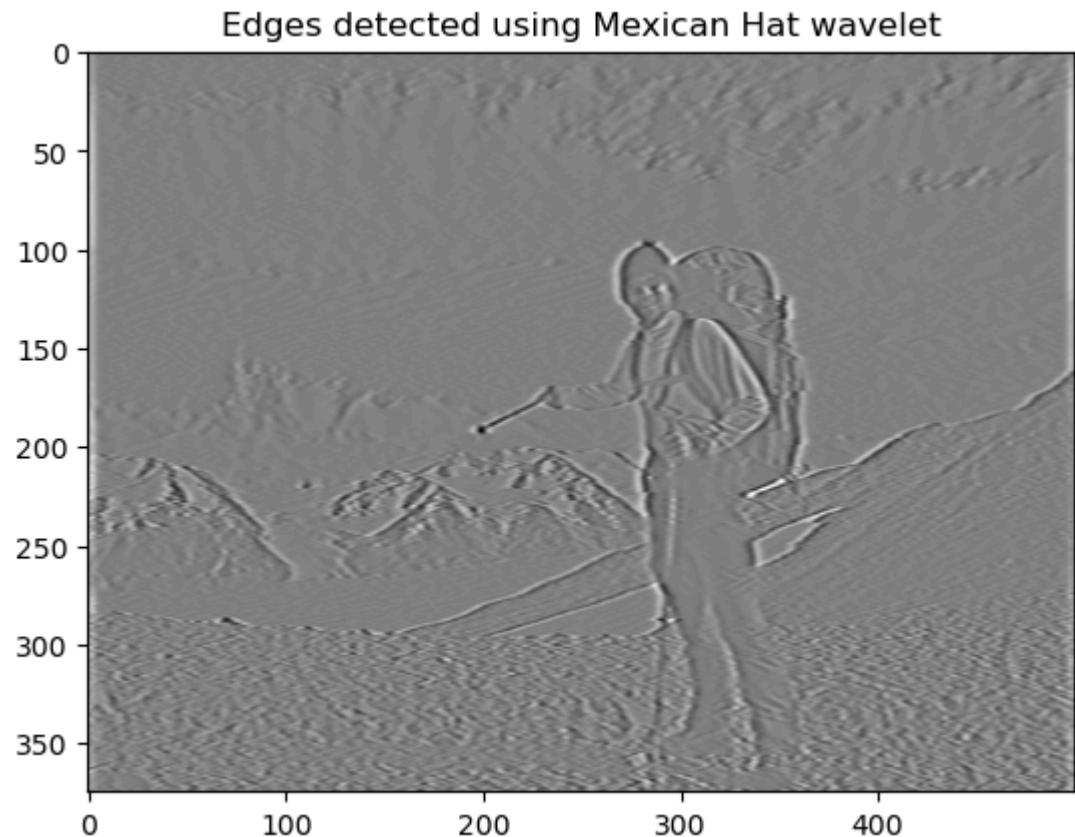
plt.tight_layout()
```



```
In [13]: widths = np.arange(1,31)
cwt_matr, freqs = pywt.cwt(image,widths,'mexh')
print(cwt_matr.shape)

plt.imshow(cwt_matr[1], cmap='gray')
plt.title('Edges detected using Mexican Hat wavelet')
plt.show()

(30, 375, 500)
```



```
In [14]: plt.figure(figsize=(12,8))

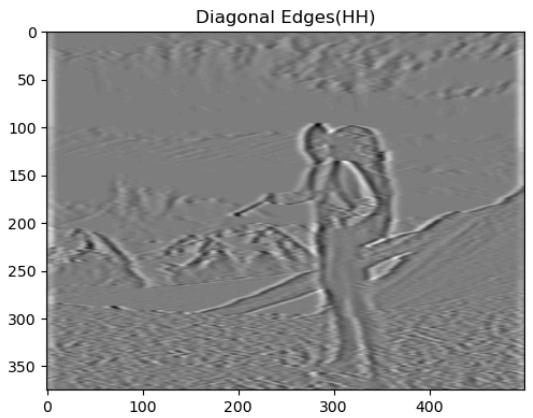
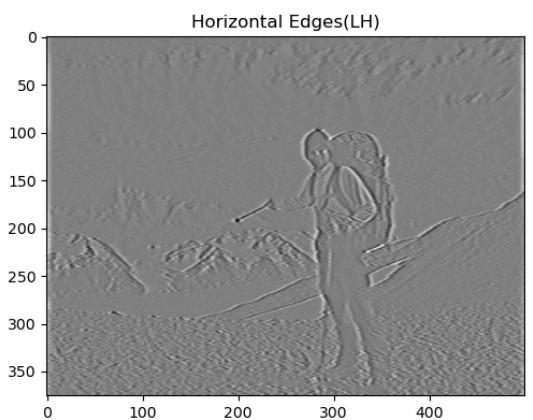
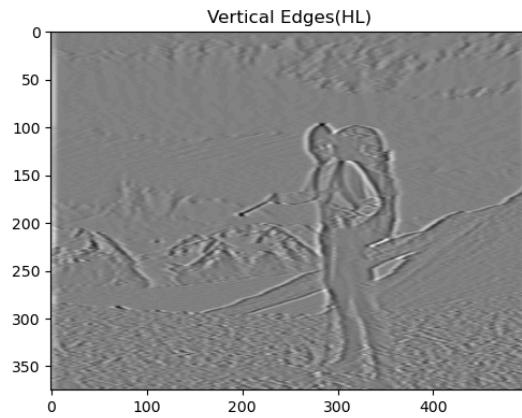
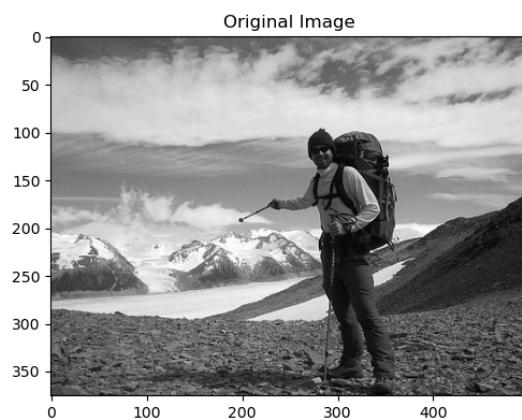
plt.subplot(2,2,1)
plt.imshow(image,cmap='gray')
plt.title('Original Image')

plt.subplot(2,2,2)
plt.imshow(cwt_matr[1],cmap='gray')
plt.title('Horizontal Edges(LH)')

plt.subplot(2,2,3)
plt.imshow(cwt_matr[2],cmap='gray')
plt.title('Vertical Edges(HL)')

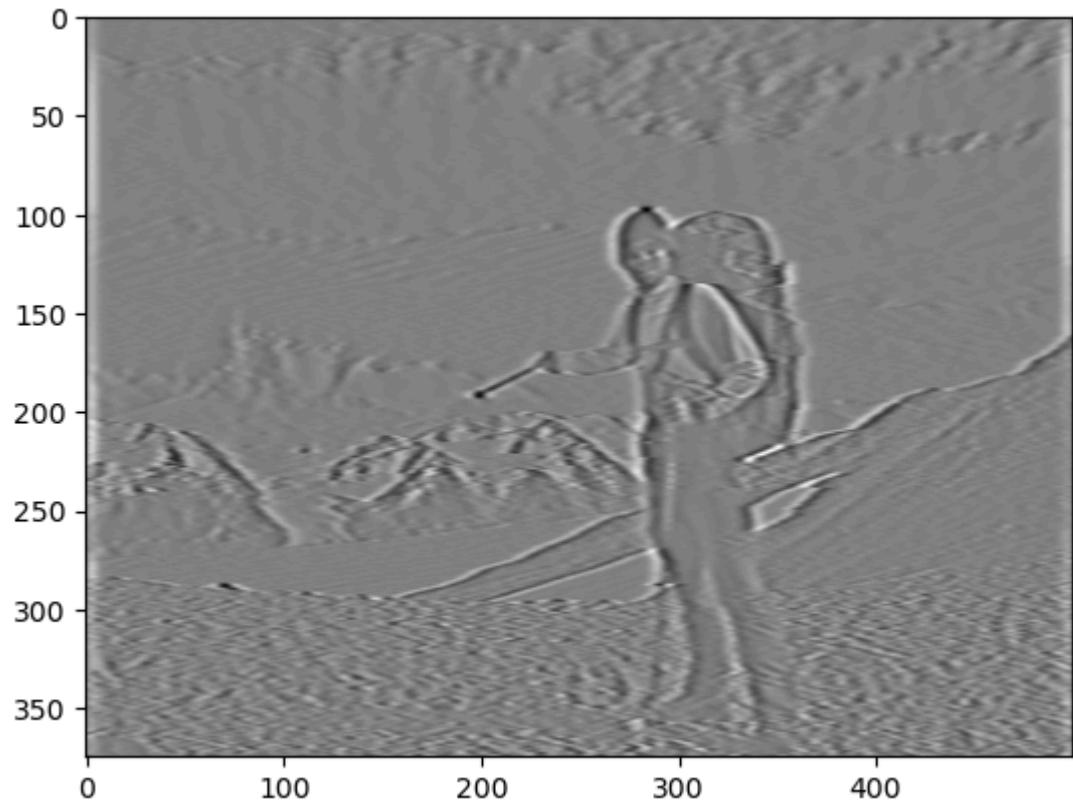
plt.subplot(2,2,4)
plt.imshow(cwt_matr[3],cmap='gray')
plt.title('Diagonal Edges(HH)')

plt.tight_layout()
```



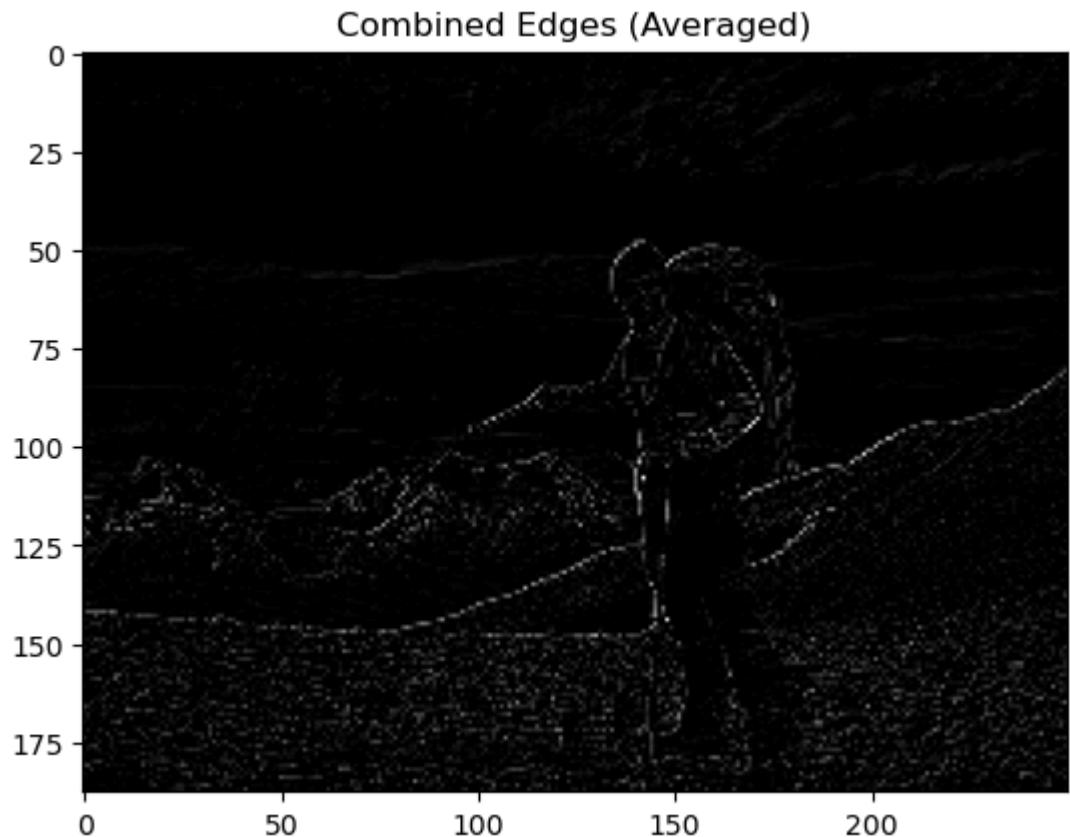
```
In [15]: plt.imshow(cwt_matr[2],cmap='gray')
```

```
Out[15]: <matplotlib.image.AxesImage at 0x7feb50399be0>
```



```
In [18]: combined_edges_avg_H = (LH_H + HL_H + HH_H) / 3  
  
combined_edges_avg_H = np.clip(combined_edges_avg_H, 0, 255)  
plt.imshow(combined_edges_avg_H, cmap ='gray')  
plt.title('Combined Edges (Averaged)')
```

Out[18]: Text(0.5, 1.0, 'Combined Edges (Averaged)')

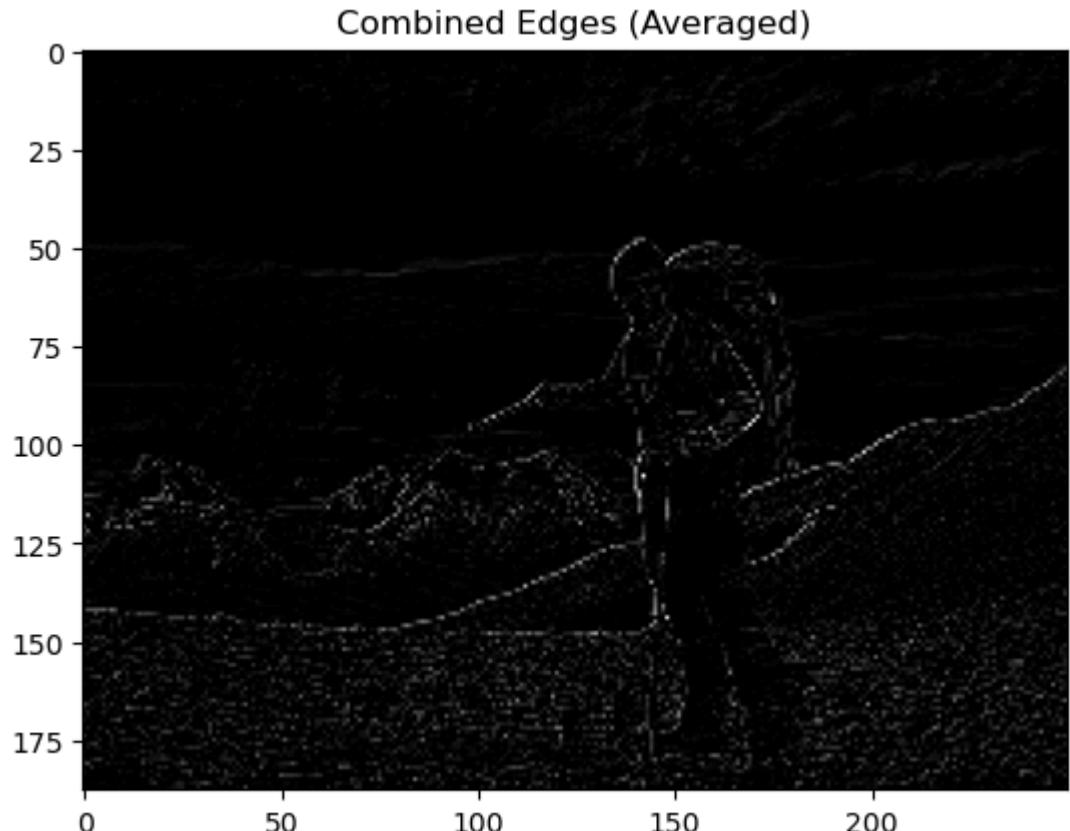


```
In [24]: coeffs2 = pywt.dwt2(image, 'haar')
LL_D, (LH_D, HL_D, HH_D) = coeffs2

combined_edges_avg_D = (LH_D + HL_D + HH_D) / 3

combined_edges_avg_D = np.clip(combined_edges_avg_D, 0, 255)

plt.imshow(combined_edges_avg_D, cmap='gray')
plt.title('Combined Edges (Averaged)')
plt.show()
```



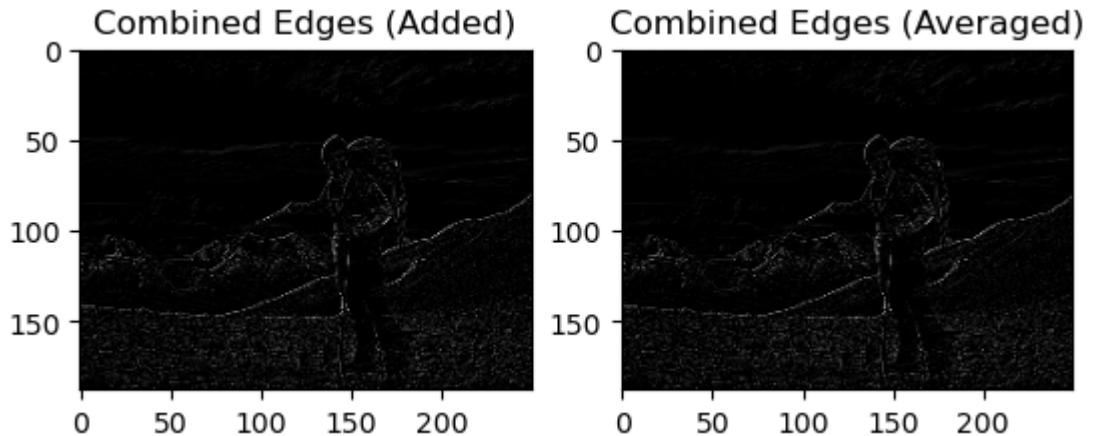
```
In [22]: combined_edges_avg_H_add = (LH_H + HL_H + HH_H)

combined_edges_avg_H_add = np.clip(combined_edges_avg_H, 0, 255)

plt.subplot(1,2,1)
plt.imshow(combined_edges_avg_H_add, cmap='gray')
plt.title('Combined Edges (Added)')

plt.subplot(1,2,2)
plt.imshow(combined_edges_avg_H, cmap ='gray')
plt.title('Combined Edges (Averaged)')
```

Out [22]: Text(0.5, 1.0, 'Combined Edges (Averaged)')



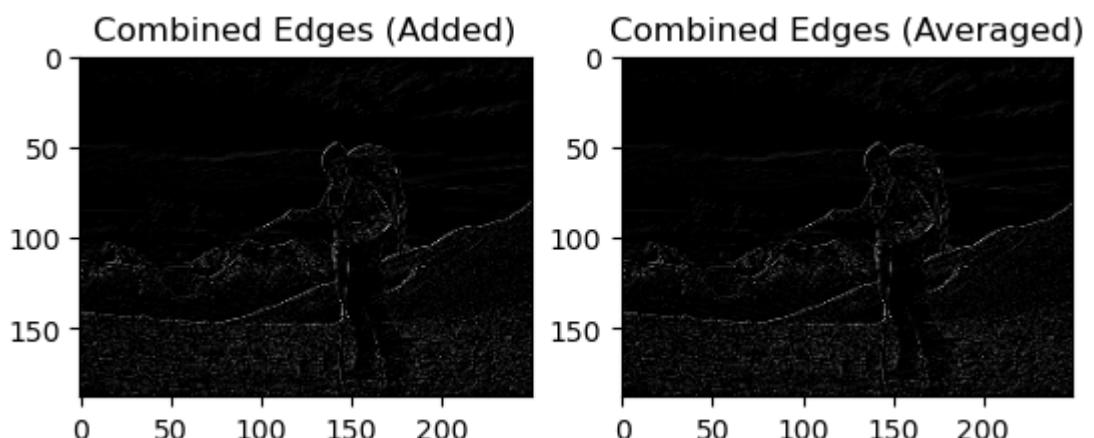
```
In [25]: combined_edges_avg_D_add = (LH_D + HL_D + HH_D)

combined_edges_avg_D_add = np.clip(combined_edges_avg_D, 0, 255)

plt.subplot(1,2,1)
plt.imshow(combined_edges_avg_D_add, cmap='gray')
plt.title('Combined Edges (Added)')

plt.subplot(1,2,2)
plt.imshow(combined_edges_avg_D, cmap ='gray')
plt.title('Combined Edges (Averaged)')
```

Out [25]: Text(0.5, 1.0, 'Combined Edges (Averaged)')

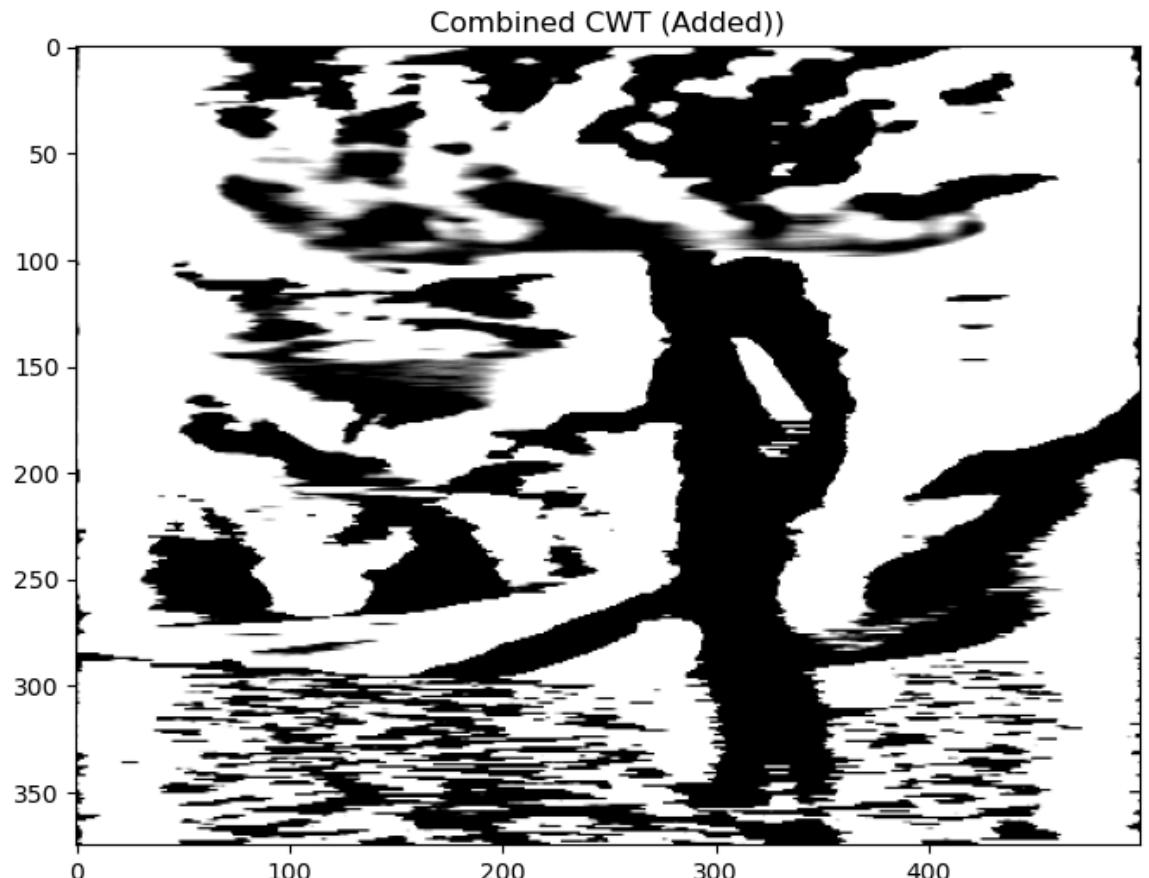


```
In [26]: combined_cwt_add = np.zeros_like(cwt_matr[0])

for i in range(len(cwt_matr)):
    combined_cwt_add += cwt_matr[i]

combined_cwt_add = np.clip(combined_cwt_add, 0, 255)

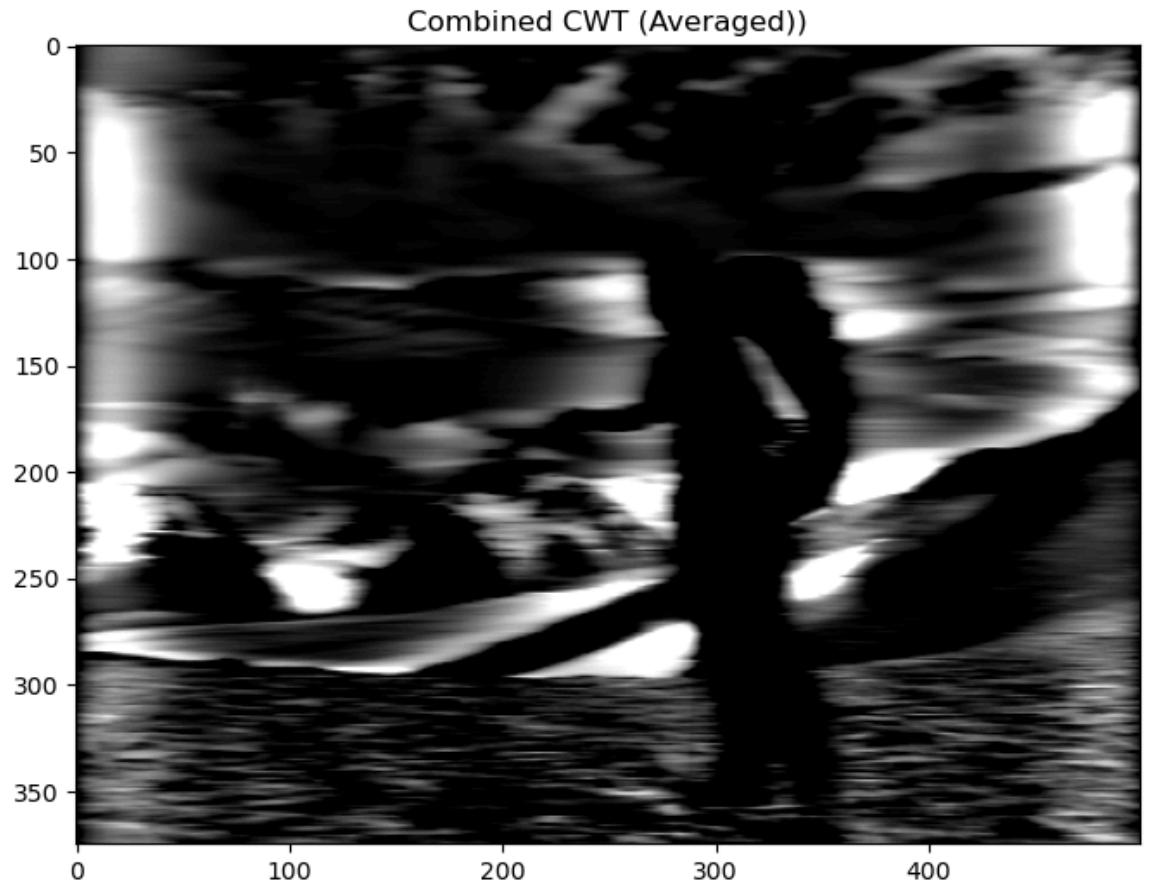
plt.figure(figsize=(8,6))
plt.imshow(combined_cwt_add,cmap='gray')
plt.title('Combined CWT (Added)')
plt.show()
```



```
In [27]: combined_cwt_avg = np.mean(cwt_matr, axis=0)

combined_cwt_avg = np.clip(combined_cwt_avg, 0, 255)

plt.figure(figsize=(8,6))
plt.imshow(combined_cwt_avg,cmap='gray')
plt.title('Combined CWT (Averaged))')
plt.show()
```



```
In [29]: combined_cwt_add_first_15 = np.zeros_like(cwt_matr[0])
combined_cwt_add_last_15 = np.zeros_like(cwt_matr[0])

for i in range(15):
    combined_cwt_add_first_15 += cwt_matr[i]

for i in range(15,30):
    combined_cwt_add_first_15 += cwt_matr[i]

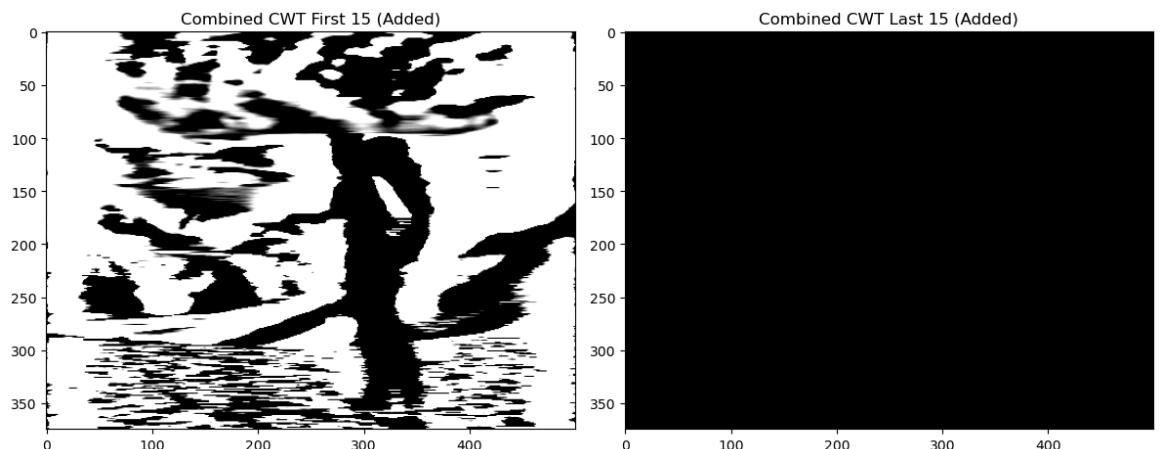
combined_cwt_add_first_15 = np.clip(combined_cwt_add_first_15, 0, 255)
combined_cwt_add_last_15 = np.clip(combined_cwt_add_last_15, 0, 255)

plt.figure(figsize=(12,6))

plt.subplot(1,2,1)
plt.imshow(combined_cwt_add_first_15, cmap='gray')
plt.title('Combined CWT First 15 (Added)')

plt.subplot(1,2,2)
plt.imshow(combined_cwt_add_last_15, cmap='gray')
plt.title('Combined CWT Last 15 (Added)')

plt.tight_layout()
plt.show()
```



```
In [31]: combined_cwt_avg_first_15 = np.mean(cwt_matr[:15], axis=0)
combined_cwt_avg_last_15 = np.mean(cwt_matr[15:], axis=0)

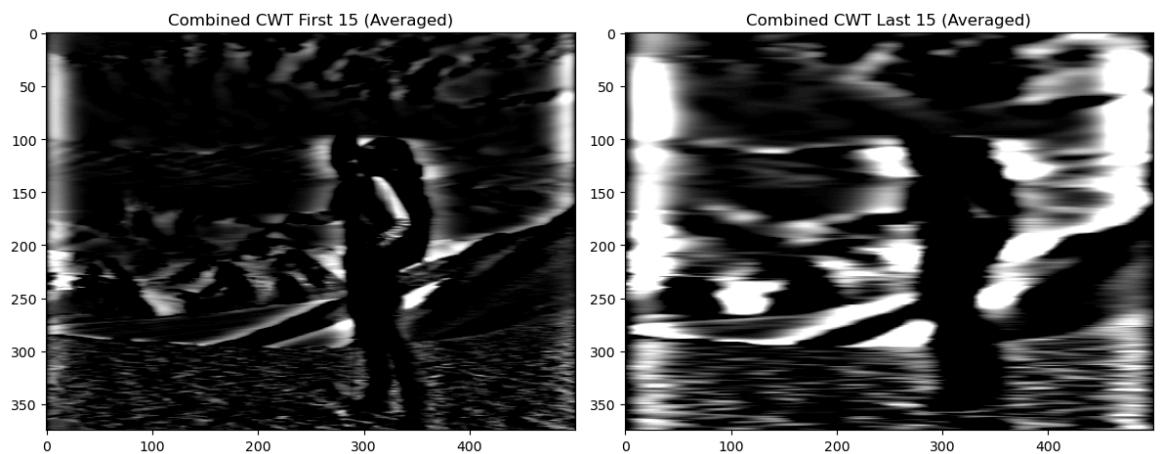
combined_cwt_avg_first_15 = np.clip(combined_cwt_avg_first_15, 0, 255)
combined_cwt_avg_last_15 = np.clip(combined_cwt_avg_last_15, 0, 255)

plt.figure(figsize=(12,6))

plt.subplot(1,2,1)
plt.imshow(combined_cwt_avg_first_15, cmap='gray')
plt.title('Combined CWT First 15 (Averaged)')

plt.subplot(1,2,2)
plt.imshow(combined_cwt_avg_last_15, cmap='gray')
plt.title('Combined CWT Last 15 (Averaged)')

plt.tight_layout()
plt.show()
```



```
In [34]: combined_cwt_add_first_10 = np.zeros_like(cwt_matr[0])
combined_cwt_add_last_10 = np.zeros_like(cwt_matr[0])

for i in range(10):
    combined_cwt_add_first_10 += cwt_matr[i]

for i in range(20,30):
    combined_cwt_add_first_10 += cwt_matr[i]

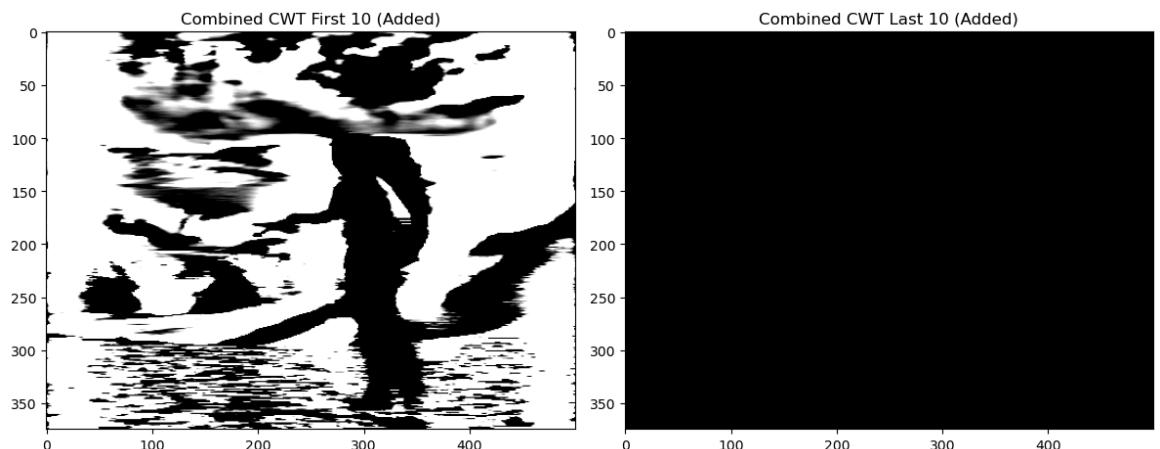
combined_cwt_add_first_10 = np.clip(combined_cwt_add_first_10, 0, 255)
combined_cwt_add_last_10 = np.clip(combined_cwt_add_last_10, 0, 255)

plt.figure(figsize=(12,6))

plt.subplot(1,2,1)
plt.imshow(combined_cwt_add_first_10, cmap='gray')
plt.title('Combined CWT First 10 (Added)')

plt.subplot(1,2,2)
plt.imshow(combined_cwt_add_last_10, cmap='gray')
plt.title('Combined CWT Last 10 (Added)')

plt.tight_layout()
plt.show()
```



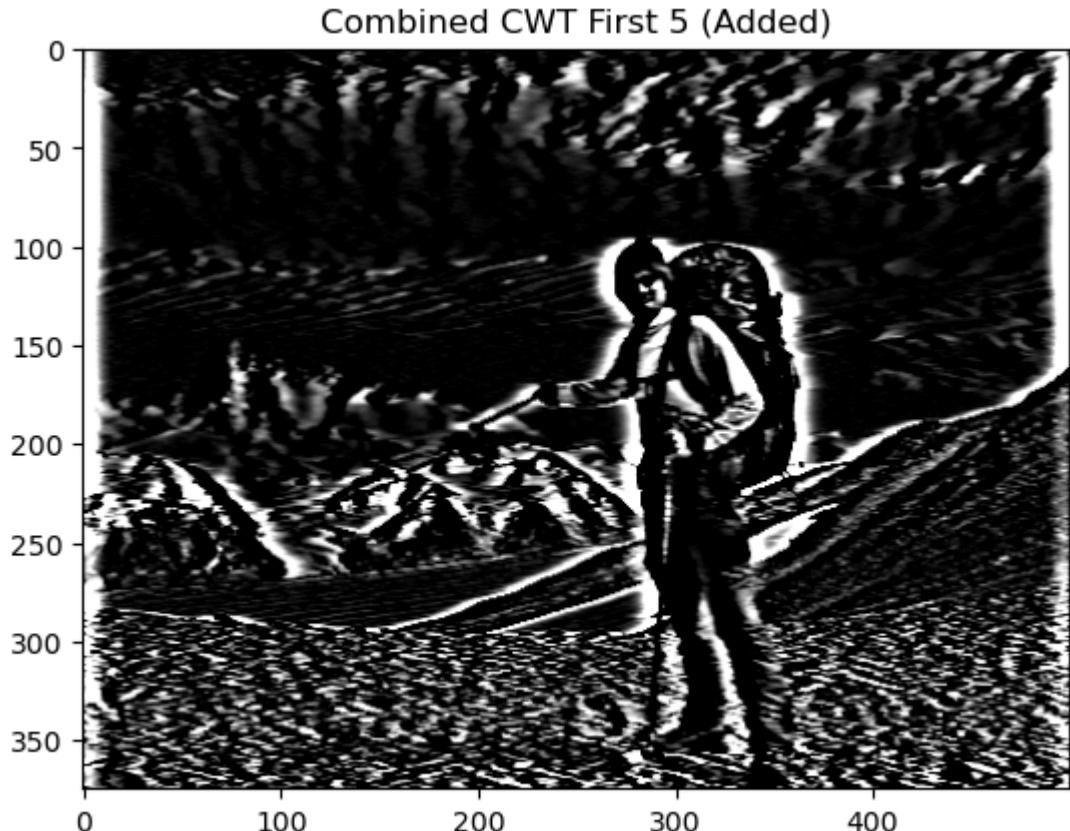
```
In [35]: combined_cwt_add_first_5 = np.zeros_like(cwt_matr[0])

for i in range(5):
    combined_cwt_add_first_5 += cwt_matr[i]

combined_cwt_add_first_5 = np.clip(combined_cwt_add_first_5, 0, 255)

plt.imshow(combined_cwt_add_first_5, cmap='gray')
plt.title('Combined CWT First 5 (Added)')
```

Out[35]: Text(0.5, 1.0, 'Combined CWT First 5 (Added)')



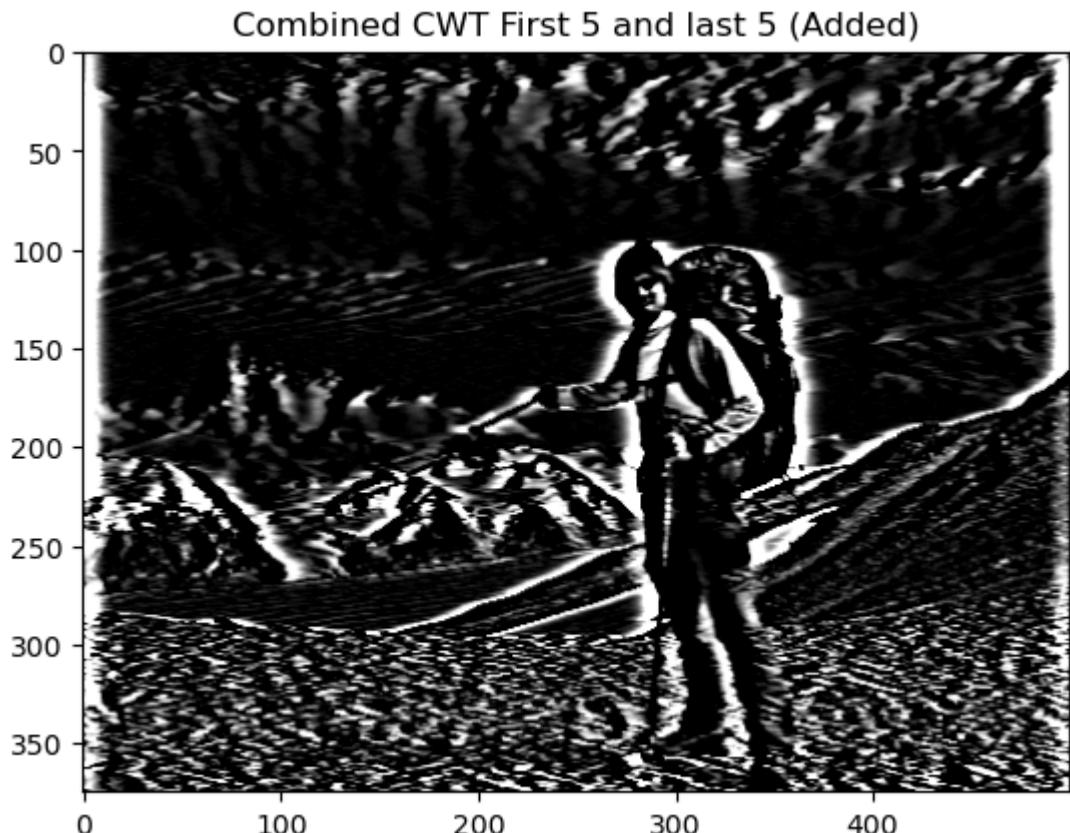
```
In [36]: combined_cwt_add_first_last_5 = np.zeros_like(cwt_matr[0])

for i in range(5):
    combined_cwt_add_first_last_5 += cwt_matr[i]

for i in range(20,30):
    combined_cwt_add_first_last_5 += cwt_matr[i]

combined_cwt_add_first_last_5 = np.clip(combined_cwt_add_first_last_5,
                                         plt.imshow(combined_cwt_add_first_last_5, cmap='gray')
plt.title('Combined CWT First 5 and last 5 (Added)')
```

Out [36]: Text(0.5, 1.0, 'Combined CWT First 5 and last 5 (Added)')



```
In [44]: from PIL import Image, ImageFilter  
  
gim = Image.open('/Users/sakshi/Desktop/img.jpg').convert('L')  
  
laplacian = gim.filter(ImageFilter.Kernel((3, 3), (-1, -1, -1, -1, 8,  
laplacian
```

Out[44]:



```
In [47]: laplacian_filtered = gimg.filter(ImageFilter.Kernel((3, 3), (-1, -1, -1, -1, 1, 1, 1, 1, 1))

laplacian_array = np.array(laplacian_filtered)

widths = np.arange(1,31)
cwt_matr, freqs = pywt.cwt(image,widths,'mexh')

combined_add = laplacian_array + np.mean(cwt_matr, axis=0)
combined_add = np.clip(combined_add,0,255)

combined_avg = (laplacian_array + np.mean(cwt_matr, axis=0)) / 2
combined_avg = np.clip(combined_avg,0,255)

plt.figure(figsize=(15,10))

plt.subplot(2,2,1)
plt.imshow(image,cmap='gray')
plt.title('Original Image')

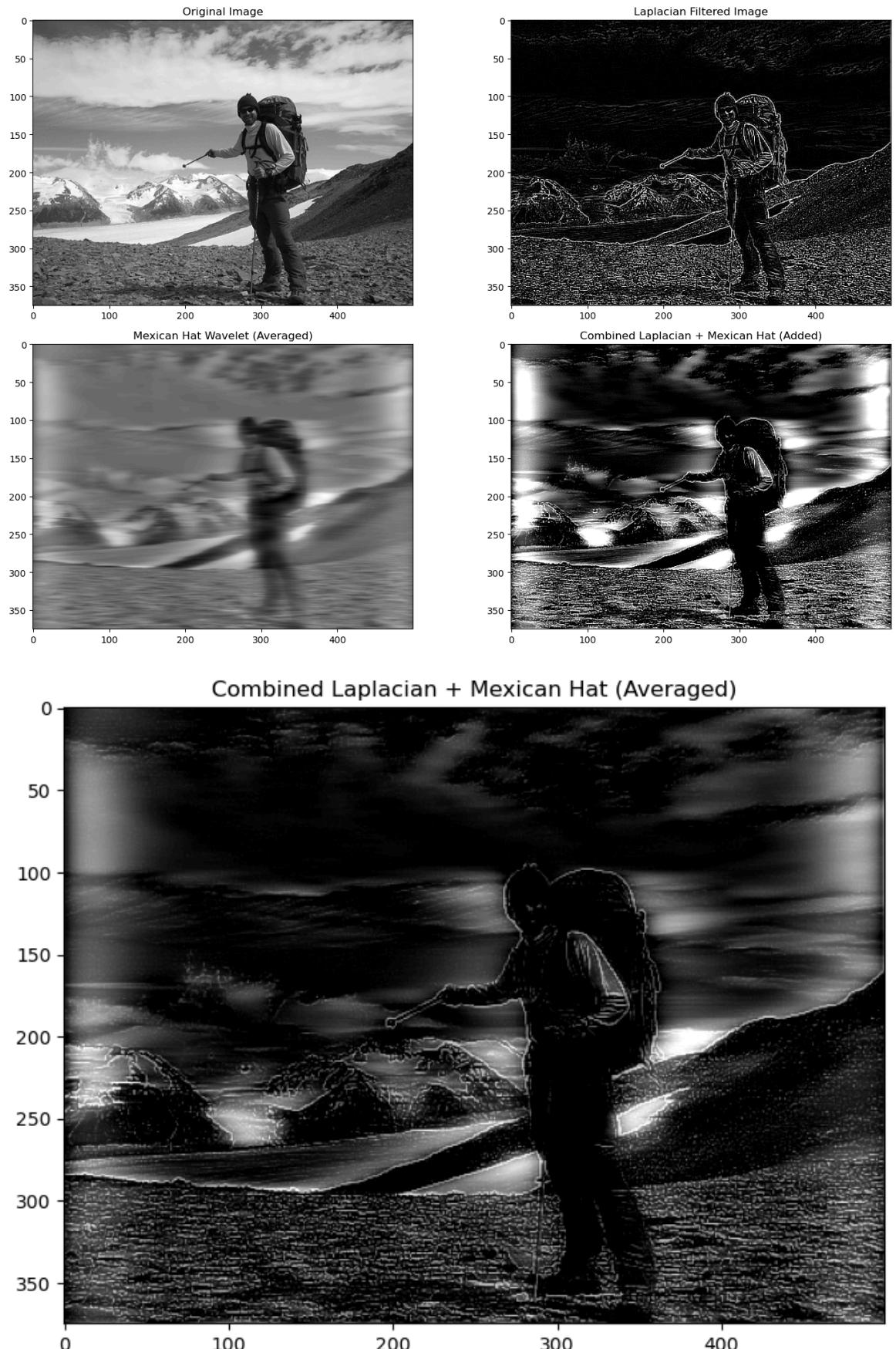
plt.subplot(2,2,2)
plt.imshow(laplacian_array,cmap='gray')
plt.title('Laplacian Filtered Image')

plt.subplot(2,2,3)
plt.imshow(np.mean(cwt_matr, axis=0),cmap='gray')
plt.title('Mexican Hat Wavelet (Averaged)')

plt.subplot(2,2,4)
plt.imshow(combined_add,cmap='gray')
plt.title('Combined Laplacian + Mexican Hat (Added)')

plt.tight_layout()
plt.show()

plt.figure(figsize=(8,6))
plt.imshow(combined_avg, cmap='gray')
plt.title('Combined Laplacian + Mexican Hat (Averaged)')
plt.show()
```



```
In [49]: cwt_avg_first_15 = np.mean(cwt_matr[:15], axis=0)

cwt_avg_first_15 = np.clip(cwt_avg_first_15, 0, 255)

combined_add_first_15_laplacian = laplacian_array + cwt_avg_first_15
combined_add_first_15_laplacian = np.clip(combined_add_first_15_laplacian, 0, 255)

combined_avg_first_15_laplacian = (laplacian_array + cwt_avg_first_15)
combined_avg_first_15_laplacian = np.clip(combined_avg_first_15_laplacian, 0, 255)

plt.subplot(2,2,1)
plt.imshow(laplacian_array,cmap='gray')
plt.title('Laplacian Filtered Image')

plt.subplot(2,2,2)
plt.imshow(cwt_avg_first_15,cmap='gray')
plt.title('Mexican Hat Wavelet (First 15 Scales Averagead)')

plt.subplot(2,2,3)
plt.imshow(combined_add_first_15_laplacian,cmap='gray')
plt.title('Combined Laplacian+ CWT (Added)')

plt.subplot(2,2,4)
plt.imshow(combined_avg_first_15_laplacian,cmap='gray')
plt.title('Combined Laplacian+ CWT (Averaged)')

plt.tight_layout()
plt.show()
```

