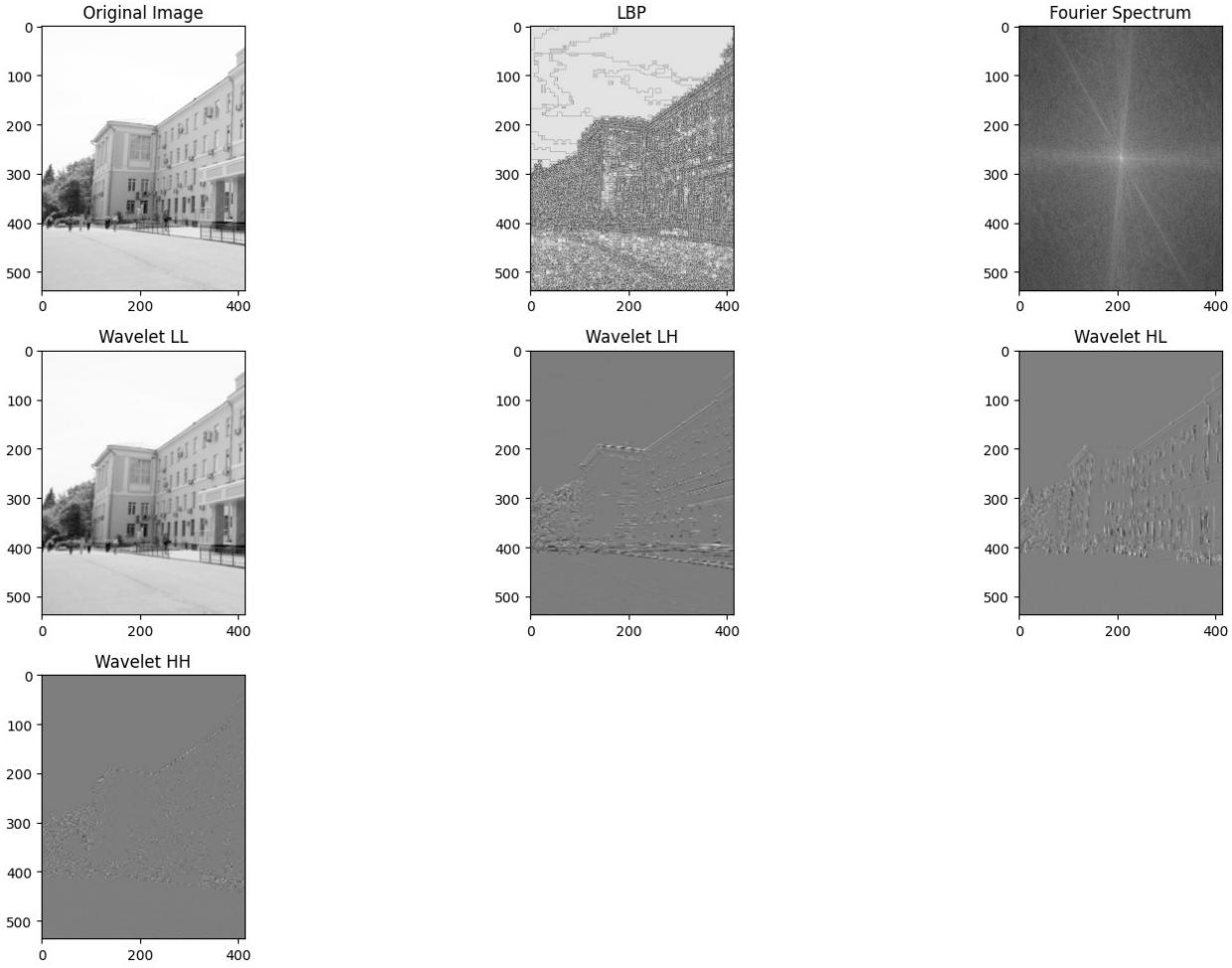
```
import numpy as np
import cv2
import pywt
from skimage.feature import local_binary_pattern, graycomatrix,
graycoprops
from skimage.feature import peak_local_max
from skimage.segmentation import watershed
from scipy import ndimage as ndi
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt

img_origin = cv2.imread('001.JPG')
img = cv2.cvtColor(img_origin, cv2.COLOR_BGR2GRAY)

# 1. Текстурные признаки

radius = 1
n_points = 8 * radius
lbp = local_binary_pattern(img, n_points, radius, method='uniform')

# Матрица взаимной встречаемости (GLCM)
distances = [1]
angles = [0, np.pi/4, np.pi/2, 3*np.pi/4]
glcm = graycomatrix(img, distances=distances, angles=angles,
levels=256, symmetric=True, normed=True)
contrast = graycoprops(glcm, 'contrast')[0, 0]
energy = graycoprops(glcm, 'energy')[0, 0]
homogeneity = graycoprops(glcm, 'homogeneity')[0, 0]
correlation = graycoprops(glcm, 'correlation')[0, 0]

# Признаки Фурье
f = np.fft.fft2(img)
fshift = np.fft.fftshift(f)
magnitude_spectrum = 20*np.log(np.abs(fshift))

# Вейвлет-признаки
def compute_wavelet_features(image):
    coeffs2 = pywt.dwt2(image, 'bior1.3')
    LL, (LH, HL, HH) = coeffs2
    # Увеличиваем LL до исходного размера изображения с помощью
интерполяции
    LL_resized = cv2.resize(LL, (image.shape[1], image.shape[0]),
interpolation=cv2.INTER_LINEAR)
    LH_resized = cv2.resize(LH, (image.shape[1], image.shape[0]),
interpolation=cv2.INTER_LINEAR)
    HL_resized = cv2.resize(HL, (image.shape[1], image.shape[0]),
interpolation=cv2.INTER_LINEAR)
    HH_resized = cv2.resize(HH, (image.shape[1], image.shape[0]),
interpolation=cv2.INTER_LINEAR)
    return LL_resized, LH_resized, HL_resized, HH_resized
```

```
LL, LH, HL, HH = compute_wavelet_features(img)

# Кодирование каждого пикселя
encoded_img = np.zeros((img.shape[0], img.shape[1], 7),
dtype=np.float32)  # 7 признаков
encoded_img[:, :, 0] = lbp  # LBP
encoded_img[:, :, 1] = contrast  # GLCM (контраст)
encoded_img[:, :, 2] = magnitude_spectrum  # Фурье
encoded_img[:, :, 3] = LL  # Вейвлет LL
encoded_img[:, :, 4] = LH  # Вейвлет LH
encoded_img[:, :, 5] = HL  # Вейвлет HL
encoded_img[:, :, 6] = HH  # Вейвлет HH

# Визуализация
plt.figure(figsize=(15, 10))
plt.subplot(3, 3, 1), plt.imshow(img, cmap='gray'),
plt.title('Original Image')
plt.subplot(3, 3, 2), plt.imshow(lbp, cmap='gray'), plt.title('LBP')
plt.subplot(3, 3, 3), plt.imshow(magnitude_spectrum, cmap='gray'),
plt.title('Fourier Spectrum')
plt.subplot(3, 3, 4), plt.imshow(LL, cmap='gray'), plt.title('Wavelet
LL')
plt.subplot(3, 3, 5), plt.imshow(LH, cmap='gray'), plt.title('Wavelet
LH')
plt.subplot(3, 3, 6), plt.imshow(HL, cmap='gray'), plt.title('Wavelet
HL')
plt.subplot(3, 3, 7), plt.imshow(HH, cmap='gray'), plt.title('Wavelet
HH')
plt.tight_layout()
plt.show()

print("Первые 5x5 пикселей закодированного изображения:\n",
encoded_img[:5, :5, :])
```




```
Первые 5x5 пикселей закодированного изображения:
 [[[  3.        153.1843   135.09175  502.         0.         0.
     0.      ]
  [  5.        153.1843   129.4227   502.         0.         0.
     0.      ]
  [  5.        153.1843   134.0569   502.         0.         0.
     0.      ]
  [  5.        153.1843   125.149536 502.         0.         0.
     0.      ]
  [  5.        153.1843   116.24404  502.         0.         0.
     0.      ]]

 [[  5.        153.1843   137.78569  502.         0.         0.
     0.      ]
  [  8.        153.1843   134.47343  502.         0.         0.
     0.      ]
  [  8.        153.1843   123.851135 502.         0.         0.
     0.      ]
  [  8.        153.1843   122.182884 502.         0.         0.
     0.      ]
```

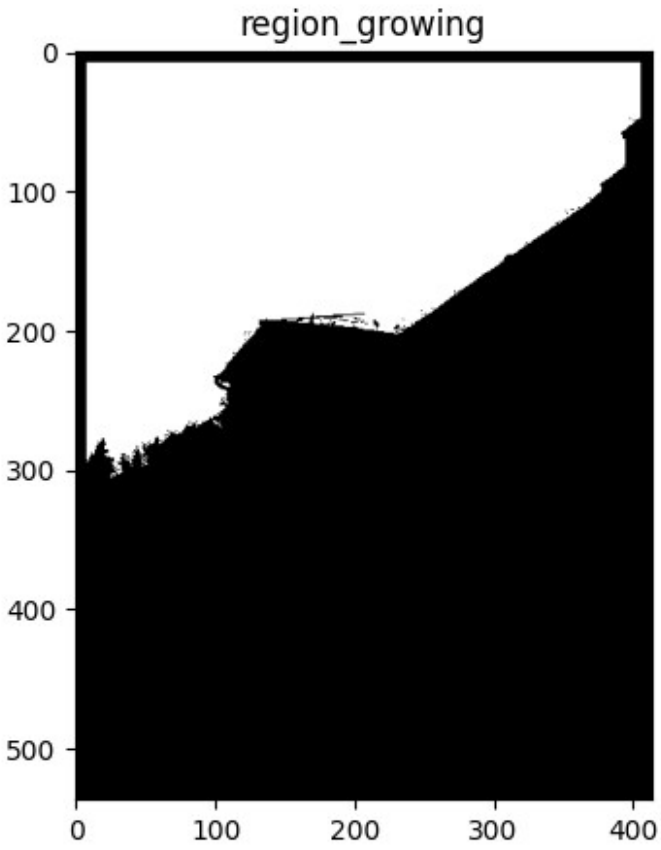
```
  [  8.        153.1843   136.83646  502.         0.         0.
     0.      ]]

 [[  5.        153.1843   143.10866  502.         0.         0.
     0.      ]
  [  8.        153.1843   117.696106 502.         0.         0.
     0.      ]
  [  8.        153.1843   135.47055  502.         0.         0.
     0.      ]
  [  8.        153.1843   136.71889  502.         0.         0.
     0.      ]
  [  8.        153.1843   118.70554  502.         0.         0.
     0.      ]]

 [[  5.        153.1843   141.39848  502.         0.         0.
     0.      ]
  [  8.        153.1843   131.45853  502.         0.         0.
     0.      ]
  [  8.        153.1843   133.53484  502.         0.         0.
     0.      ]
  [  8.        153.1843   138.78172  502.         0.         0.
     0.      ]
  [  8.        153.1843   131.564    502.         0.         0.
     0.      ]]

 [[  5.        153.1843   151.4836   502.         0.         0.
     0.      ]
  [  8.        153.1843   138.59645  502.         0.         0.
     0.      ]
  [  8.        153.1843   134.9698   502.         0.         0.
     0.      ]
  [  8.        153.1843   118.52829  502.         0.         0.
     0.      ]
  [  8.        153.1843   140.03629  502.         0.         0.
     0.      ]]]
```

```python
# 2. Сегментация изображения
#Алгоритм разрастания регионов
import math
img_origin = cv2.imread('001.JPG')
img = cv2.cvtColor(img_origin, cv2.COLOR_BGR2GRAY)
def homo_average(img, mask, point, T):
    av_val = img[mask > 0].sum() / np.count_nonzero(img[mask > 0])

    if abs(av_val - img[point]) <= T:
        return True

    return False

def region_growing(image, seed_point,homo_fun,r, T):
```

```
    mask = np.zeros(img.shape, np.uint8)
    mask[seed_point] = 1
    count = 1
    while count > 0:
        count = 0
        local_mask = np.zeros(img.shape, np.uint8)
        for i in range(r,image.shape[0] - r):
            for j in range(r,image.shape[1] - r):
                if mask[i,j]==0 and mask[i - r:i + r, j-r: j+r].sum()
> 0:
                    if homo_fun(image, mask, (i,j), T):
                        local_mask[i,j] = 1
        count = np.count_nonzero(local_mask)
        print(count)
        mask += local_mask

    return mask*255

seed_point = (10, 10)
mask = region_growing(img,seed_point,homo_average, 8 , 10)
plt.figure(figsize=(15, 5))
plt.subplot(1, 3, 1), plt.imshow(mask, cmap="gray"),
plt.title('region_growing')
```

```
120
240
368
496
624
752
880
1008
1136
1264
1392
1520
1648
1776
1904
2032
2160
2288
2416
2544
2672
2800
2781
2509
2449
```

```
2397
2369
2306
2279
2280
2221
2115
1913
1697
1481
1285
1190
1111
1078
1032
989
944
902
855
813
750
666
602
358
122
0

(<Axes: title={'center': 'region_growing'}>,
 <matplotlib.image.AxesImage at 0x25a69d11310>,
 Text(0.5, 1.0, 'region_growing'))
```




```
#K-means

flags = cv2.KMEANS_RANDOM_CENTERS

z = img.reshape((-1,3))
z = np.float32(z)
criteria = (cv2.TERM_CRITERIA_EPS + cv2.TERM_CRITERIA_MAX_ITER, 10,
1.0)
K = 3
ret,label,center=cv2.kmeans(z,K,None,criteria,10,cv2.KMEANS_RANDOM_CEN
TERS)
center = np.uint8(center)
res = center[label.flatten()]
res2 = res.reshape((img.shape))
plt.figure(figsize=(15, 5))
plt.subplot(1, 3, 2),plt.imshow(res2, cmap="gray"), plt.title('K-
means')

#Watershed+Distance transform

ret, thresh = cv2.threshold(img,0,255,
cv2.THRESH_BINARY_INV+cv2.THRESH_OTSU)
```

```
#plt.imshow(thresh, cmap="gray")

dist = cv2.distanceTransform(thresh, cv2.DIST_L2, 5)
#plt.imshow(dist, cmap="gray")

ret, sure_fg = cv2.threshold(dist, 0.2 * dist.max(), 255,
cv2.THRESH_BINARY)
#plt.imshow(sure_fg, cmap="gray")

sure_fg = sure_fg.astype(np.uint8)

ret, markers = cv2.connectedComponents(sure_fg)

#plt.imshow(markers, cmap="gray")

markers = cv2.watershed(img_origin, markers)
plt.subplot(1, 3, 3), plt.imshow(markers, cmap="gray"),
plt.title('Watershed+Distance transform')
```

```
(<Axes: title={'center': 'Watershed+Distance transform'}>,
 <matplotlib.image.AxesImage at 0x25a683e4e10>,
 Text(0.5, 1.0, 'Watershed+Distance transform'))
```