import numpy as np

import cv2

import matplotlib.pyplot as plt

def haar\_wavelet\_transform(image):

lp\_filter = np.array([1/np.sqrt(2), 1/np.sqrt(2)])

hp\_filter = np.array([1/np.sqrt(2), -1/np.sqrt(2)])

low\_rows = np.apply\_along\_axis(lambda row: np.convolve(row, lp\_filter, mode='full')[::2], axis=1, arr=image)

high\_rows = np.apply\_along\_axis(lambda row: np.convolve(row, hp\_filter, mode='full')[::2], axis=1, arr=image)

low\_low = np.apply\_along\_axis(lambda col: np.convolve(col, lp\_filter, mode='full')[::2], axis=0, arr=low\_rows)

low\_high = np.apply\_along\_axis(lambda col: np.convolve(col, hp\_filter, mode='full')[::2], axis=0, arr=low\_rows)

high\_low = np.apply\_along\_axis(lambda col: np.convolve(col, lp\_filter, mode='full')[::2], axis=0, arr=high\_rows)

high\_high = np.apply\_along\_axis(lambda col: np.convolve(col, hp\_filter, mode='full')[::2], axis=0, arr=high\_rows)

return low\_low, low\_high, high\_low, high\_high

def plot\_dwt\_results(image, low\_low, low\_high, high\_low, high\_high):

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

plt.subplot(2, 2, 1)

plt.imshow(low\_low, cmap='gray')

plt.title('Approximation (LL)')

plt.subplot(2, 2, 2)

plt.imshow(low\_high, cmap='gray')

plt.title('Horizontal Detail (LH)')

plt.subplot(2, 2, 3)

plt.imshow(high\_low, cmap='gray')

plt.title('Vertical Detail (HL)')

plt.subplot(2, 2, 4)

plt.imshow(high\_high, cmap='gray')

plt.title('Diagonal Detail (HH)')

plt.show()

image = cv2.imread('image.jpg', cv2.IMREAD\_GRAYSCALE)

low\_low, low\_high, high\_low, high\_high = haar\_wavelet\_transform(image)

plot\_dwt\_results(image, low\_low, low\_high, high\_low, high\_high)