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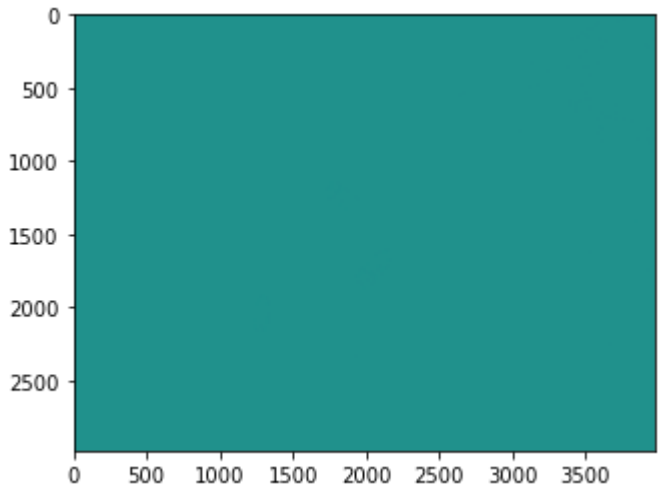
In [1]:
```
import cv2
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
def processImage(image):
    image = cv2.imread(image)
    image = cv2.cvtColor(src=image, code=cv2.COLOR_BGR2GRAY)
    return image
```

In [3]:
```
def convolve2D(image, kernel, padding=0, strides=1):
    # Cross Correlation
    kernel = np.flipud(np.fliplr(kernel))

    # Gather Shapes of Kernel + Image + Padding
    xKernShape = kernel.shape[0]
    yKernShape = kernel.shape[1]
    xImgShape = image.shape[0]
    yImgShape = image.shape[1]

    # Shape of Output Convolution
    xOutput = int(((xImgShape - xKernShape + 2 * padding) / strides) + 1)
    yOutput = int(((yImgShape - yKernShape + 2 * padding) / strides) + 1)
    output = np.zeros((xOutput, yOutput))

    # Apply Equal Padding to All Sides
    if padding != 0:
        imagePadded = np.zeros((image.shape[0] + padding*2, image.shape[1] + padd
        imagePadded[int(padding):int(-1 * padding), int(padding):int(-1 * padding
        print(imagePadded)
    else:
        imagePadded = image

    # Iterate through image
    for y in range(image.shape[1]):
        # Exit Convolution
        if y > image.shape[1] - yKernShape:
            break
        # Only Convolve if y has gone down by the specified Strides
        if y % strides == 0:
            for x in range(image.shape[0]):
                # Go to next row once kernel is out of bounds
                if x > image.shape[0] - xKernShape:
                    break
                try:
                    # Only Convolve if x has moved by the specified Strides
                    if x % strides == 0:
                        output[x, y] = (kernel * imagePadded[x: x + xKernShape, y
                except:
                    break

    return output
```

In [4]:
```
if __name__ == '__main__':
    # Grayscale Image
    image = processImage('guillaume-baudusseau-2ZMjnR2d3qk-unsplash.jpg')

    # Edge Detection Kernel
    kernel = np.array([[-1, -1, -1], [-1, 8, -1], [-1, -1, -1]])

    output = convolve2D(image, kernel, padding=2)
    plt.imshow(output)
    plt.show()
```

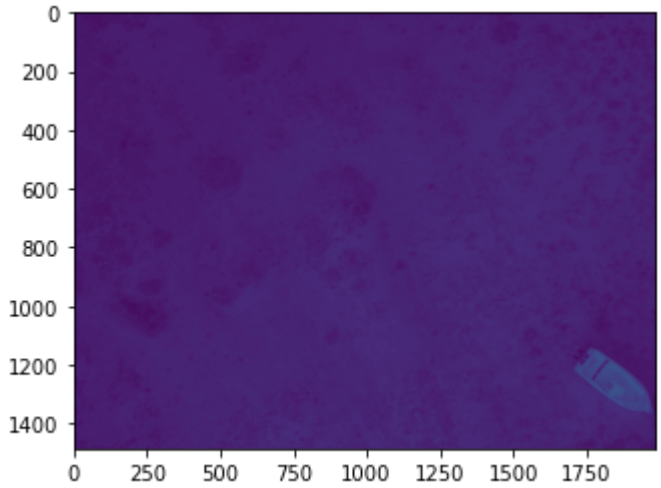
```
[[  0.   0.   0. ...   0.   0.   0.]
 [  0.   0.   0. ...   0.   0.   0.]
 [  0.   0.  69. ... 101.   0.   0.]
 ...
 [  0.   0.  63. ... 106.   0.   0.]
 [  0.   0.   0. ...   0.   0.   0.]
 [  0.   0.   0. ...   0.   0.   0.]]
```



Taking stride as 2 and kernel size as 5*5

In [5]:
```
stride=2
filter_size=5
```

In [6]:
```
kernel = np.array([[1, 1, 1,1,1], [1, 1, 1,1,1], [1, 1, 1,1,1],[1, 1, 1,1,1], [1,
# Convolve and Save Output
output2 = convolve2D(image, kernel,strides=2)
plt.imshow(output2)
plt.show()
```



In [7]:
```
output2
```

Out[7]:
```
array([[1637.,    0., 1643., ...,    0., 2235.,    0.],
       [   0.,    0.,    0., ...,    0.,    0.,    0.],
       [1617.,    0., 1637., ...,    0., 2236.,    0.],
       ...,
       [   0.,    0.,    0., ...,    0.,    0.,    0.],
       [1662.,    0., 1550., ...,    0., 1613.,    0.],
       [   0.,    0.,    0., ...,    0.,    0.,    0.]])
```

Taking stride as 1 but making an image padded with 0 padding

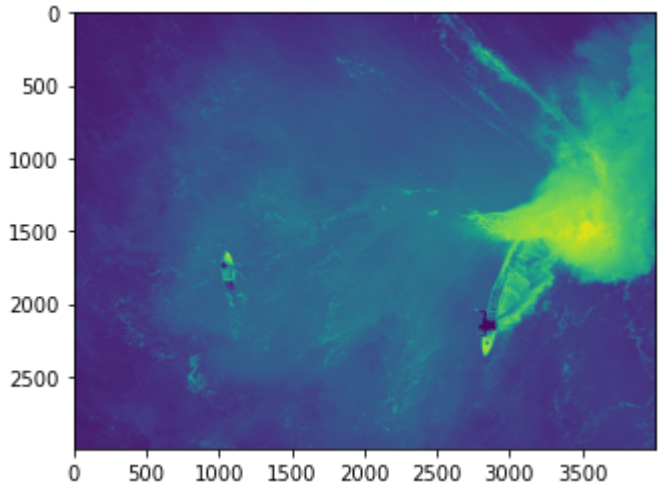
In [8]:
```
import numpy as np
import pandas as pd
from keras.models import Sequential
from keras.layers.convolutional import Conv2D
import cv2
from matplotlib import pyplot as plt
```

In [9]:
```
def processImage(image):

    image = cv2.imread(image)
    image = cv2.cvtColor(src=image, code=cv2.COLOR_BGR2GRAY)
    return image
```

In [10]:
```
def convolve2D(image, kernel, padding=0, strides=1):
    # Cross Correlation
    kernel = np.flipud(np.fliplr(kernel))

    # Gather Shapes of Kernel + Image + Padding
    xKernShape = kernel.shape[0]
    yKernShape = kernel.shape[1]
    xImgShape = image.shape[0]
    yImgShape = image.shape[1]

    # Shape of Output Convolution
    xOutput = int(((xImgShape - xKernShape + 2 * padding) / strides) + 1)
    yOutput = int(((yImgShape - yKernShape + 2 * padding) / strides) + 1)
    output = np.zeros((xOutput, yOutput))

    # Apply Equal Padding to All Sides
    if padding != 0:
        imagePadded = np.zeros((image.shape[0] + padding*2, image.shape[1] + padd
        imagePadded[int(padding):int(-1 * padding), int(padding):int(-1 * padding
        print(imagePadded)
    else:
        imagePadded = image

    # Iterate through image
    for y in range(image.shape[1]):
        # Exit Convolution
        if y > image.shape[1] - yKernShape:
            break
        # Only Convolve if y has gone down by the specified Strides
        if y % strides == 0:
            for x in range(image.shape[0]):
                # Go to next row once kernel is out of bounds
                if x > image.shape[0] - xKernShape:
                    break
                try:
                    # Only Convolve if x has moved by the specified Strides
                    if x % strides == 0:
                        output[x, y] = (kernel * imagePadded[x: x + xKernShape, y
                except:
                    break

    return output
```

In [11]:
```
image = processImage('michael-olsen-xbRe2QwIi-8-unsplash.jpg')
kernel = np.array([[1, 1, 1], [1, 1, 1], [1, 1, 1]])
output3 = convolve2D(image, kernel, padding=0)
plt.imshow(output3)
```

Out[11]:
```
<matplotlib.image.AxesImage at 0x12a219619a0>
```



In [12]:
```
output3
```

Out[12]:
```
array([[180., 170., 161., ..., 495., 487., 481.],
       [182., 174., 165., ..., 494., 488., 482.],
       [173., 169., 162., ..., 491., 488., 484.],
       ...,
       [217., 215., 208., ..., 386., 391., 391.],
       [213., 212., 204., ..., 390., 395., 390.],
       [213., 212., 204., ..., 389., 396., 388.]])
```

Calculating metrics i.e. entropy between original image and filtered image

In [13]:
```
import skimage.measure
entropy_original_image = skimage.measure.shannon_entropy(image)
```

In [14]:
```
print(entropy_original_image)
```

```
6.9196791409088245
```

In [15]:
```
import skimage.measure
entropy_for_1_stride = skimage.measure.shannon_entropy(output)
```

In [16]:
```
print(entropy_for_1_stride)
```

```
6.9588006035582275
```

In [17]:
```
import skimage.measure
entropy_for_2_stride = skimage.measure.shannon_entropy(output2)
```

In [18]:
```
print(entropy_for_2_stride)
```

```
3.491078469771006
```

In [19]:
```
import skimage.measure
entropy_for_0_padding = skimage.measure.shannon_entropy(output3)
```

In [20]:
```
print(entropy_for_0_padding)
```

```
10.074482698094565
```