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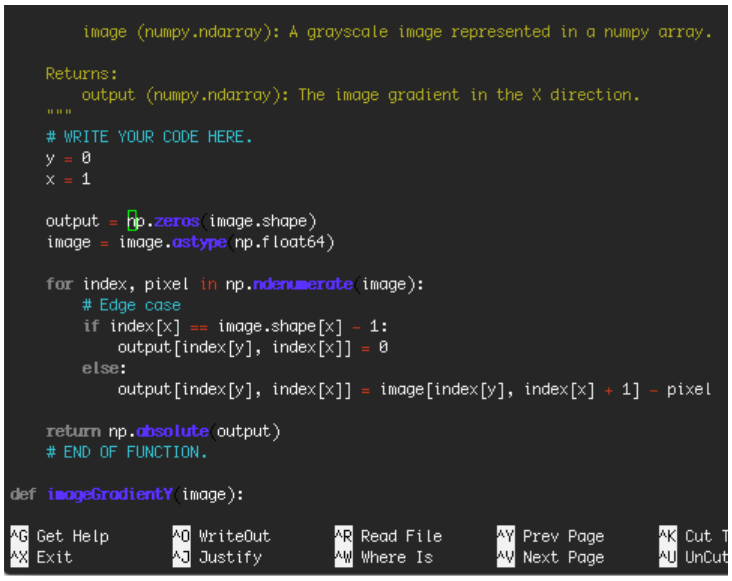
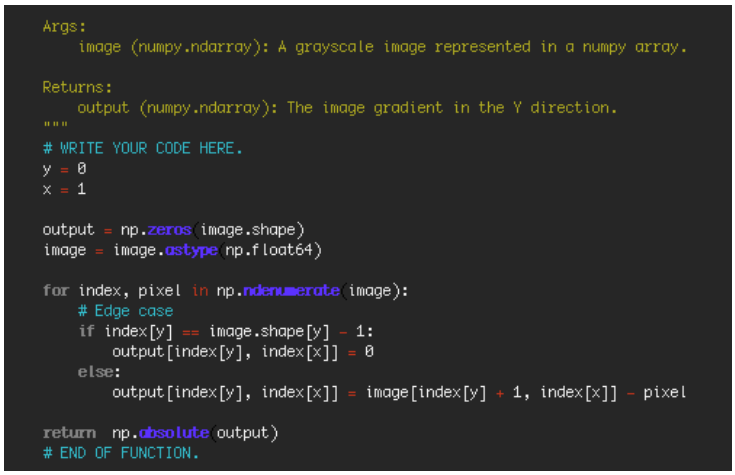
Assignment 5

1. To implement the imageGradientX() function I used numpy.ndenumerate() function to iterate over the image. This function returns an iterator with pairs of array indices and values. I used the indices to capture the value of the next pixel in the x direction, which I then used to calculate the change. I set the pixels along the edges to 0 indicating that there is no change because there are no more pixels to compare. After calculating the gradient I used numpy.absolute() function to convert that to the magnitude of the gradient.



2. The imageGradientY() function was almost exactly the same except I used the indices to capture the value of the next pixel in the y direction, which I then used to calculate the change. I found I needed to convert the image array to float64 when my initial attempts resulted in noise. This was due to overflow errors as the input array was uint8.



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3. To implement the computeGradient() function I again used the numpy.ndenumerate() function to iterate through the image as well as the kernel. I first checked the bounds of the image to ensure the cross-correlation would take place in the bounds of the image. I then looped through the kernel using the image and kernel indices to capture the proper pixels to perform the cross-correlation on.

```
    Returns:
        output (numpy.ndarray): The computed gradient for the input image.
    """
    # WRITE YOUR CODE HERE.
    output = np.zeros(image.shape)
    image = image.astype(np.float64)

    y = 0
    x = 1

    for imageIndex, imagePixel in np.ndenumerate(image):
        # offset the kernel to prevent out of bounds exception
        if imageIndex[x] > 0 and imageIndex[y] > 0 \
           and imageIndex[x] < image.shape[x] - 1 \
           and imageIndex[y] < image.shape[y] - 1:

            sum = 0
            for kernelIndex, kernelValue in np.ndenumerate(kernel):
                u = kernelIndex[x] - 1
                v = kernelIndex[y] - 1

                sum += image[imageIndex[y] + v, imageIndex[x] + u] * kernelValue

            output[imageIndex[y], imageIndex[x]] = sum

    return output
    # END OF FUNCTION.

^G Get Help   ^O WriteOut   ^R Read File   ^Y Prev Page   ^K Cut Text
^X Exit       ^J Justify    ^W Where Is    ^V Next Page   ^U UnCut Text
```

4. I started with the following image while experimenting with edge detection:

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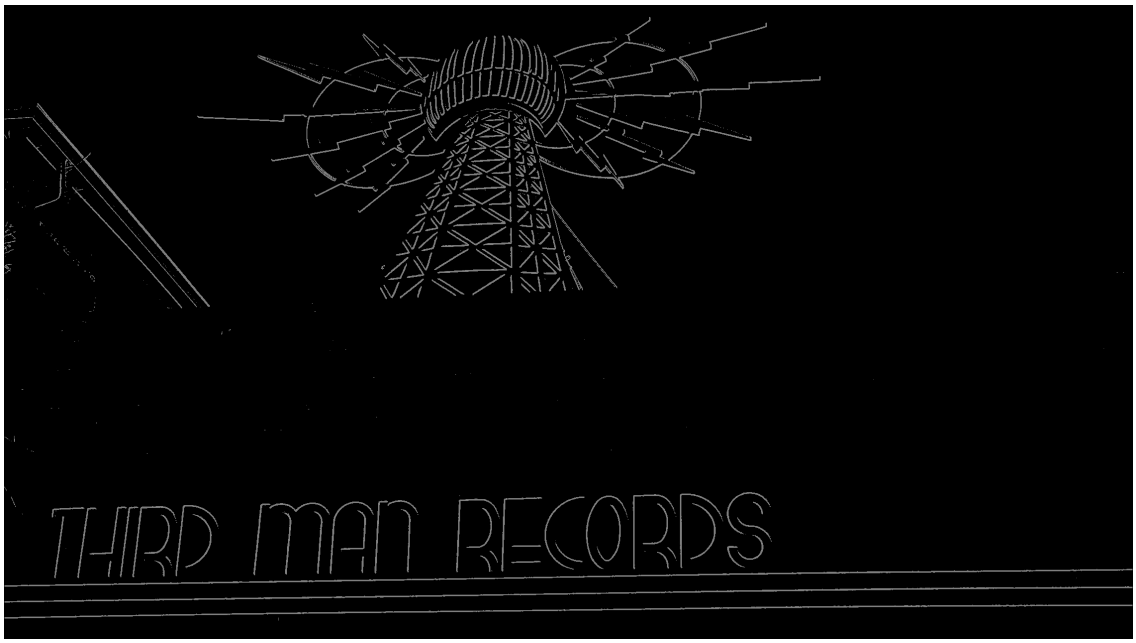
After experimenting with several kernels, left/right average derivative, Prewitt, Sobel, Gaussian derivative, etc. I found the Sobel kernel provided the most accurate depiction of the edges. After taking the X and Y gradients I converted them to black and white. I used a threshold of 96 when converting the gradient in the X direction and used a threshold of 128 when converting the gradient in the Y direction. To create the final image shown below I averaged the X and Y gradients after applying the threshold.



For reference I have included the cv2.Canny() result of my original image: