Computer vision (**CSC I6716)**

Assignment 2

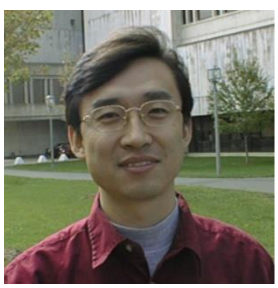
Prof. Zhigang Zhu

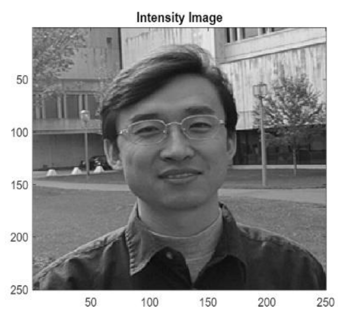
Sonali Shintre

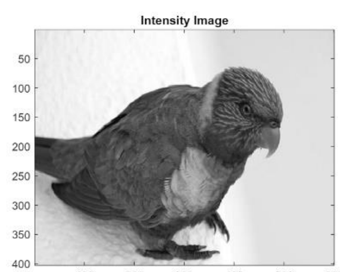
ID: 7602

1. (20 points) Generate the histogram of the image you are using, and then perform a number of histogram operations (such as contrast enhancement, thresholding and equalization) to make the image visually better for either viewing or processing (10 points). If it is a color image, please first turn it into an intensity image and then generate its histogram. Try to display your histogram (5 points), and make some observations of the image based on its histogram (5 points). What are the general distributions of the intensity values? How many major peaks and valleys does your histogram have? How could you use the histogram to understand, analyze or segment the image? Please also display the histograms of the processed images and provide a few important observations.

Original image intensity image



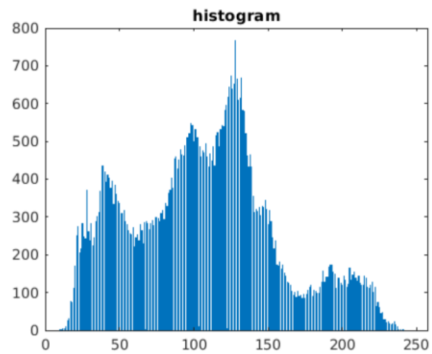


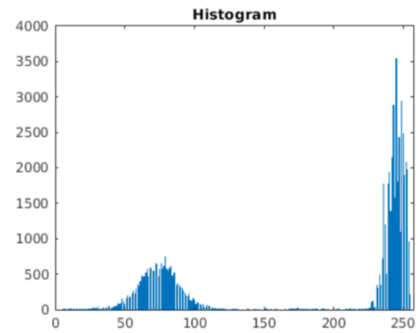


Original images are converted into intensity images using formula:

Intensity=0.2999*CR1+0.587*CG1+0.114*CB1;

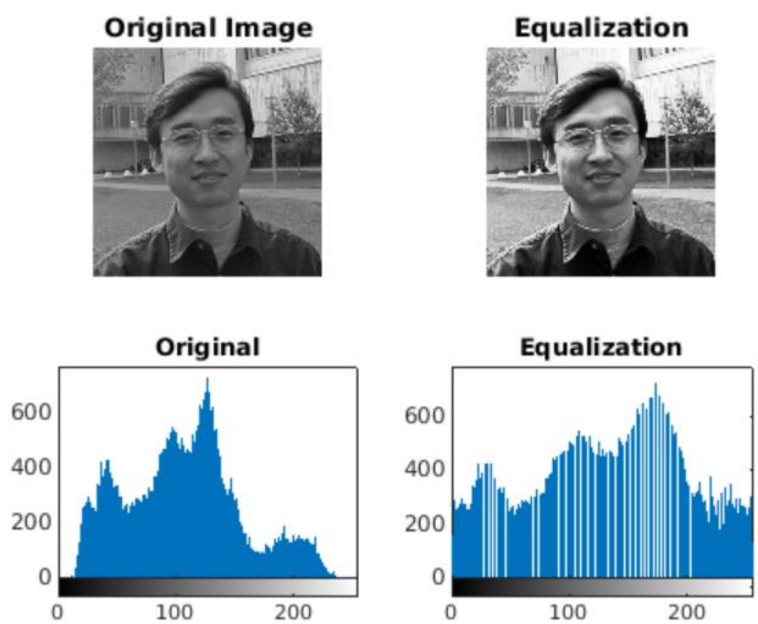
CR1, CB1, CG1 are all red, green, blue channels of the images.



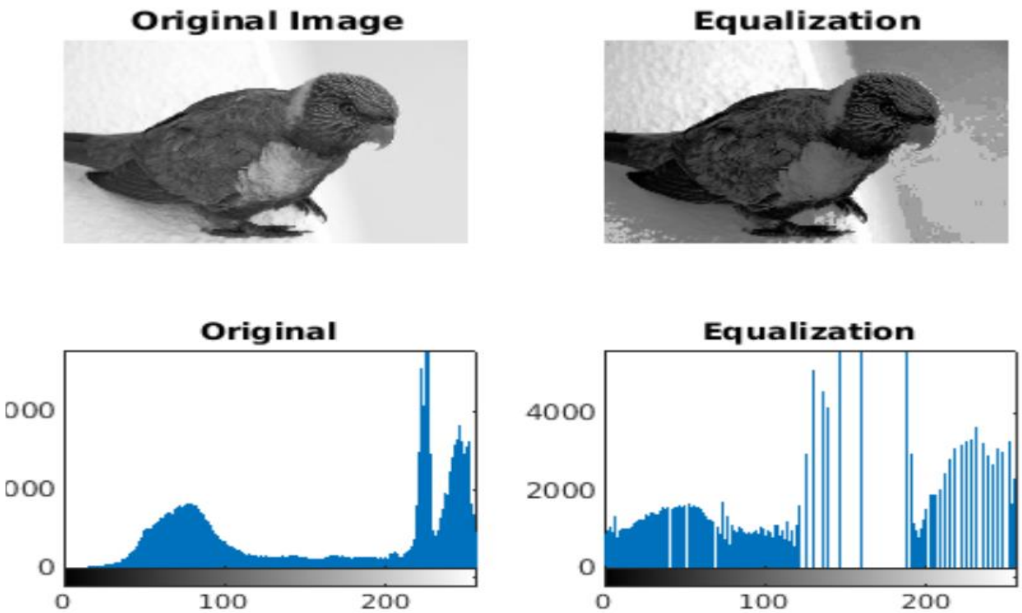


Left is the professor image histogram and right side is the bird histogram images, It’s the distributions of the intensity values. Peaks for the left image high between 100- 150. As we see shadow appear on the left side. Valley found is almost to 0.

In the second histogram of the bird image, there we found the two valleys on the left side and in the middle, this is due the shadow in the image.

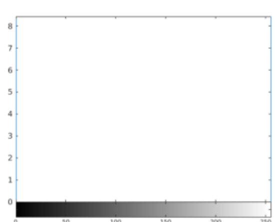


The idea of the histogram equalization is to change the gray histogram of the image from concentrated gray scale to uniform distribution over gray scale. Image will be brighter. As you can see from the images that the new image contrast has been enhanced and its histogram is equalized. During histogram equalization the overall shape of the histogram changes, but when histogram stretches the shape of histogram remains same. The Equalized image have more major peak spread out. Histogram quantifies the number of pixels for each intensity value. We see that all the pixel values has been shifted towards right and thus, it can be validated from the image that new image is darker and now the original image look brighter as compare to this new image.



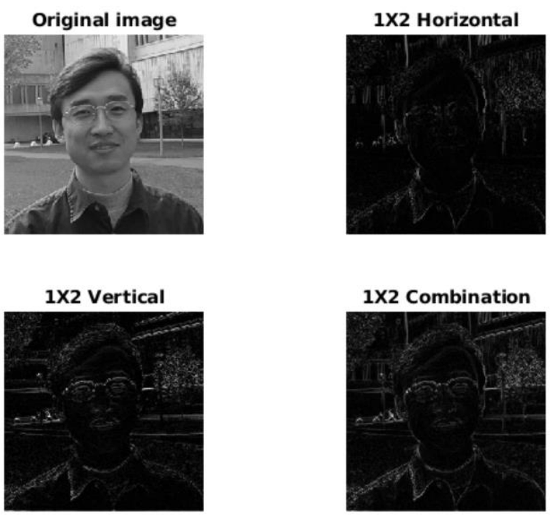
Thresholding:

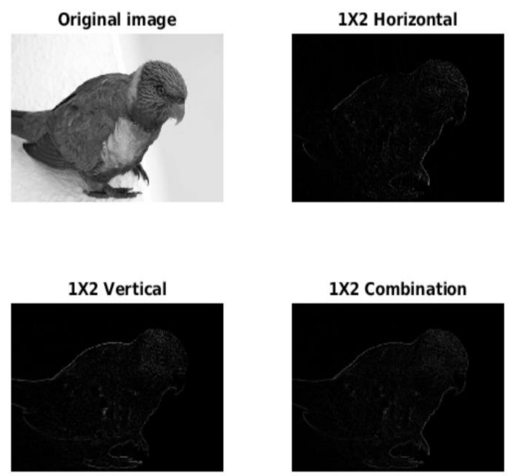
Thresholding enables to achieve image segmentation. dividing the complete image into a set of pixels in such a way that the pixels in each set have some common characteristics. Thresholding splits histogram, merges halves



2. (20 points) Apply the 1×2 operator and Sobel operator to your image and analyze the results of the gradient magnitude images (including vertical gradients, horizontal gradients, and the combined) (10 points). Please don't forget to normalize your gradient images, noting that the original vertical and horizontal gradients have both positive and negative values. I would recommend you to display the absolute values of the horizontal and vertical gradient images. Does the Sobel operator have any clear visual advantages over the 1×2 operator? Any disadvantages (5 points)? If you subtract the 1×2 edge image from the Sobel are there any residuals? You might use two different types of images: one ideal man-made image, and one image of a real scene with more details (5 points). **(**Note: don't forget to normalize your results as shown in slide # 29 of feature extraction lecture: part 2**)**

i. 1 x 2 operator: both for the original and man-made image



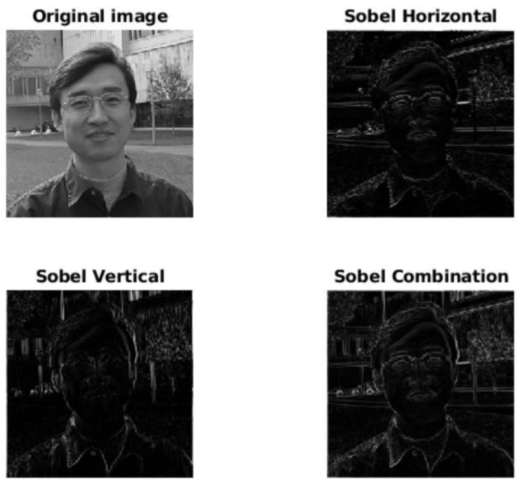


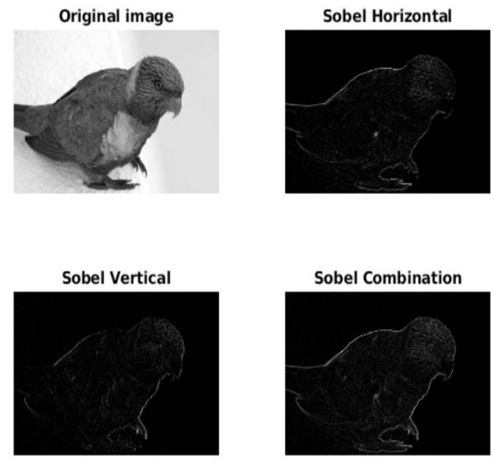
ii. Sobel operator: both for the original and man-made image:

The Sobel method: is the Edge Detection block finds edges of objects in an input image. The **Sobel**, **Prewitt**, or Roberts methods find the edges by approximating the gradient magnitude of the image, finding edges using the Sobel approximation to the derivative. It returns edges at those points where the gradient maximum

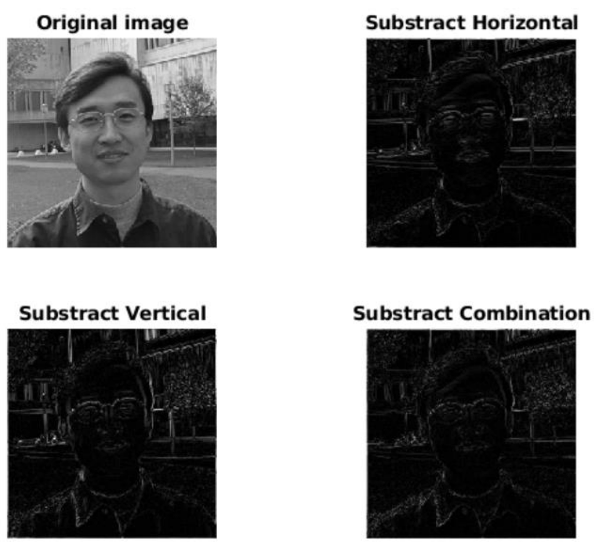
iii. Does the Sobel operator have any clear visual advantages over the 1×2 operator? Any disadvantages (5 points)?

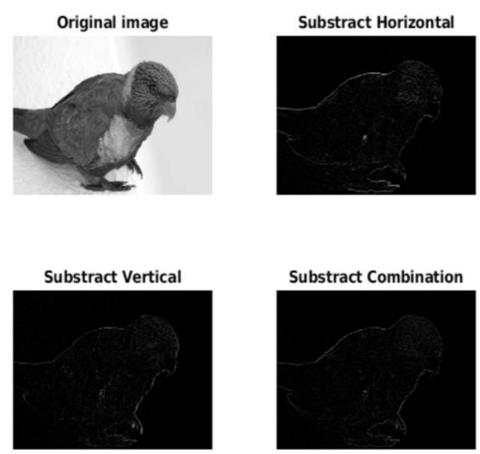
Yes. Sobel operator can better detect edges than the 1×2 operator. Sobel operator is more computation-intensive than 1×2 operator.





iv. subtract the 1×2 edge image from the Sobel operator





v. if you subtract the 1×2 edge image from the Sobel are there any residuals?

Yes, when we subtract the 1×2 edge image from the Sobel We do get some residual after the subtraction operation.

Advantage.

Yes the Sobel operator has advantages over the 1x2 operator the image on which we apply vertical mask, all the vertical edges are more visible than the original image. Similarly, in the second picture we have applied the horizontal mask and in result all the horizontal edges are visible, we can detect both horizontal and vertical edges from an image. Also, if you compare the result of sobel operator with 1X 2 operator, we find that sobel operator finds more edges or make edges more visible as compared to 1X 2 operator.

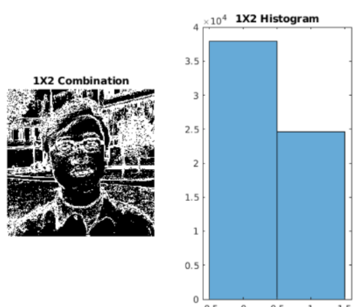
Disadvantage:

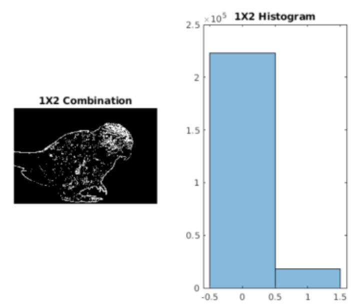
As the noise present in image increases edges will decay. As a result, Sobel operator accuracy suffers as the magnitude of the edges decreases also Sobel method cannot produce accurate edge detection with thin and smooth edge

3. (20 points) Generate edge maps of the above two combined gradient maps (10 points). An edge image should be a binary image with 1s as edge points and 0s as non-edge points. You may first generate a histogram of each gradient map, and only keep certain percentage of pixels(e.g. 5% of the pixels with the highest gradient values) as edge pixels (edgels). Use the percentage to automatically find a threshold for the gradient magnitudes. In your report, please write up the description and probably equations for finding the threshold, and discuss if 5% is a good value. If not what is (5 points)? You may also consider to use local, adaptive thresholds to different portions of the image so that all major edges will be shown up nicely (5 points). In the end, please try to generate a sketch of an image, such as the ID image of Prof. Zhu.

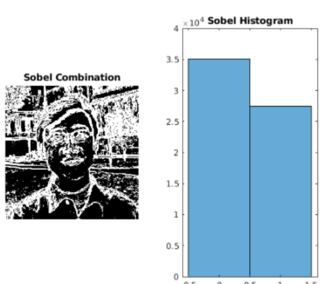
Function used is histo(img(i,j)+1)=histo(I,j)+1)+1

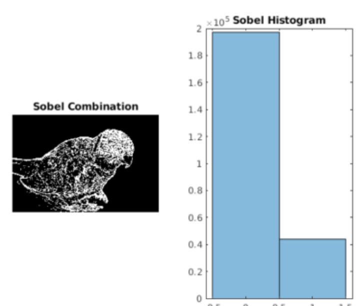
i. edge image for 1 x2 operator





ii. edge image for Sobel operator





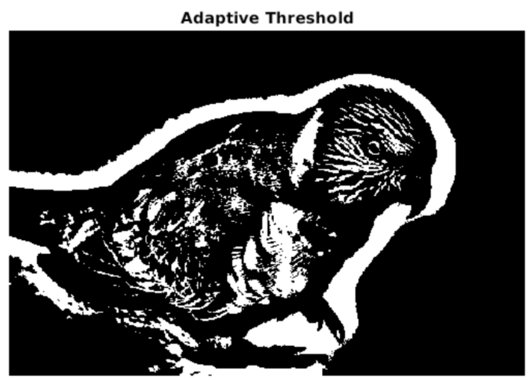
iii. please write up the description and probably equations for finding the threshold, and discuss if 5% is a good value. If not what is (5 points)?

To find the threshold with 5% of the pixels with the highest gradient values M, we need to set all pixels that is larger than M*5% to 1 and all pixels that is smaller than M*5% to 0.

I don't think 5% is a very good value. because edge of the image are not clear as there are more noise in it.

Using 20%, 25% are good values for the two images, since the white dots are about 5% of all pixels in this case. The edge image has less noise and the edges are clear than 5%.

iv. You may also consider to use local, adaptive thresholds to different portions of the image so that all major edges will be shown up nicely (5 points). In the end, please try to generate a sketch of an image, such as the ID image of Prof. Zhu.



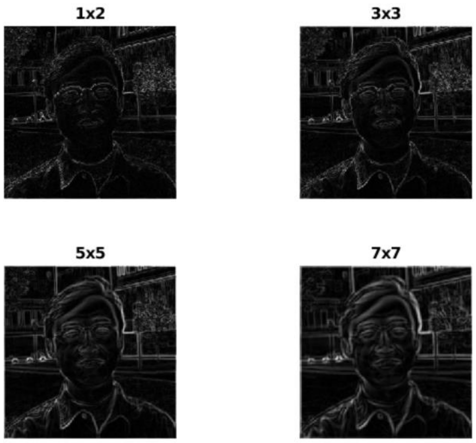
The value of the is (1:125,1:125), (126:250,1:125), (1:125,126:250), (126:250,126:250)

4. (20 points) What happens when you increase the size of the edge detection kernel from 1×2 to 3×3 and then to 5×5 , or 7×7? Discuss computational cost (in terms of members of operations, and the real machine running times – 5 points), edge detection results (5 points) and sensitivity to noise, etc. (5 points). Note that your larger kernel should still be an edge detector. Please list your kernels as matrices in your report, and tell us what they are good for (5 points).

1. computational cost

```
Elapsed time is 0.001153 seconds (1x2)
Elapsed time is 0.001056 seconds (3x3)
Elapsed time is 0.001137 seconds (5x5)
Elapsed time is 0.001637 seconds (7x7)
```

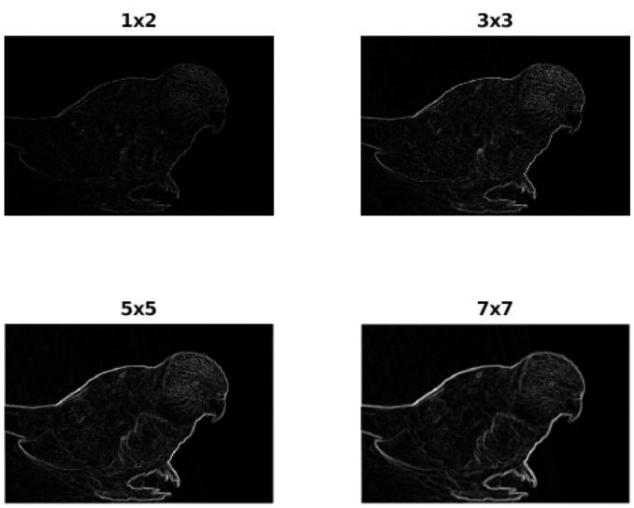
As the size of the convolution matrix increases, the real machine running times increase.



ii. edge detection results (5 points) and sensitivity to noise,

As increasing the size of the convolution matrix, edge detection results are less accurate.

sensitivity to noise: Increase in size of the convolution matrix, the edge detectors are less sensitive to local noise



iii. Please list your kernels as matrices in your report, and tell us what they are good for (5 points).

1x2: -1 1

3x3: 1 0 -1
2 0 -2
1 0 -1

5x5:

$$\begin{matrix} 2 & 1 & 0 & -1 & -2 \\ 3 & 2 & 0 & -2 & -3 \\ 4 & 3 & 0 & -3 & -4 \\ 3 & 2 & 0 & -2 & -3 \\ 2 & 1 & 0 & -1 & -2 \end{matrix}$$

7x7:

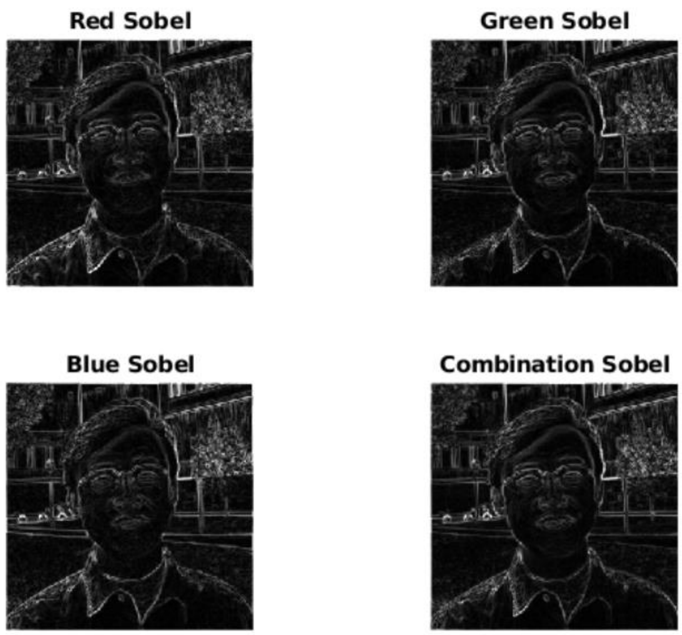
$$\begin{matrix} 3 & 2 & 1 & 0 & -1 & -2 & -3 \\ 4 & 3 & 2 & 0 & -2 & -3 & -4 \\ 5 & 4 & 3 & 0 & -3 & -4 & -5 \\ 6 & 5 & 4 & 0 & -4 & -5 & -6 \\ 5 & 4 & 3 & 0 & -3 & -4 & -5 \\ 4 & 3 & 2 & 0 & -2 & -3 & -4 \\ 3 & 2 & 1 & 0 & -1 & -2 & -3 \end{matrix}$$

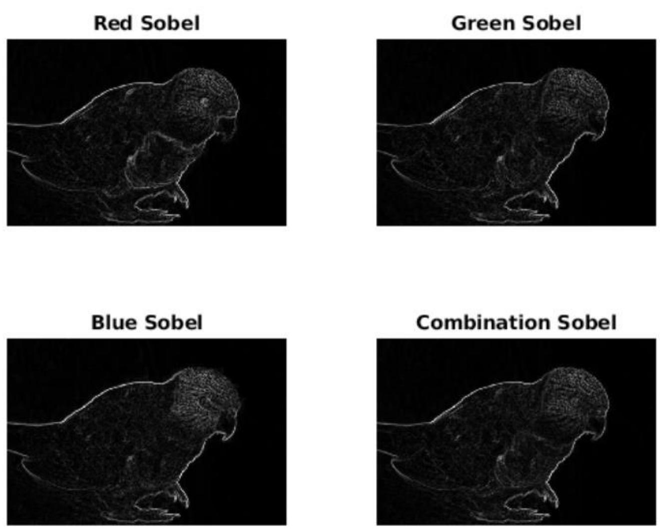
By increasing the size of the convolution matrix, edge detector is less sensitive to local noise. This is great for low contrast images where edges might not be easy to detect.

With filter matrix, this gives only a very soft blur 3X3 increase to 5x5 will have image which cause the image to be blur, as we move to 7X7 image will sharper. Which could be clearly seen the image with O(n^2). When we apply a 3x3 operator is less sensitive to noise. So 3x3 filter is too dark on the current image. X, Y is calculated will be pixel from the image to the left, right, top or bottom of x, y. To sharpen the image is very similar to finding edges, add the original image, and the image after the edge detection to each other, and the result will be a new image where the edges are enhanced, making it look sharper.

5. (20 points) Suppose you apply the Sobel operator to each of the RGB color bands of a color image. How might you combine these results into a color edge detector (5 points)? Do the resulting edge differ from the gray scale results? How and why (5 points)? You may compare the edge maps of the intensity image (of the color image), the gray-scale edge map that are the combination of the three edge maps from three color bands, or a real color edge map that edge points have colors (5 points). Please discuss their similarities and differences, and how each of them can be used for image enhancement or feature extraction (5 points). Note that you want to first generate gradient maps and then using thresholding to generate edge maps. In the end, please try to generate a color sketch of an image, such as the ID image of Prof. Zhu. You may also consider local, adaptive thresholding in generating a color edge map.

Color edge operators are able to detect more edges than gray-level edge operators. In color image edge detection, additional features can be obtained that may not be detected in Gray-level images. However, the most commonly used edge detection techniques are Gradient-based. For High resolution image the gradient will be spread over many pixels, but work good on low resolution images. The Sobel of Gray scale image produce Kind of Shallow edge and might not be for remove noise in an image, by decomposing the image into its channels, the resulting edge differ from the gray scale results. Changes in color are detected even when the grayscale color of two pixels are the same. The edge strength is typically greater or equal to the magnitude obtained by filtering





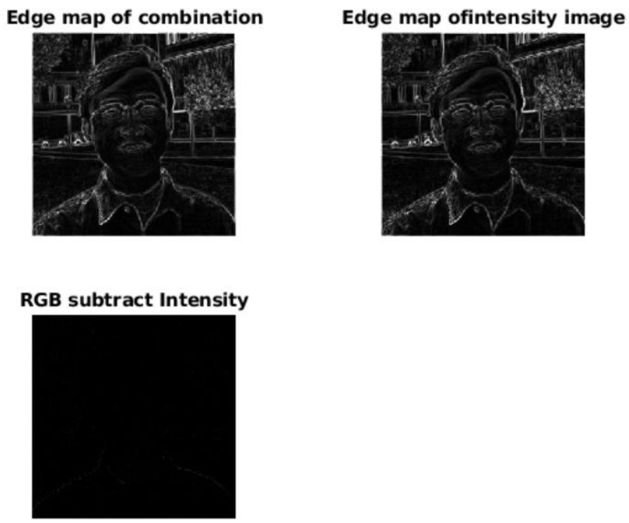
Sobel operator and the prewitt operator are used to detect two kinds od the edges 1.vertical direction and horizontal direction

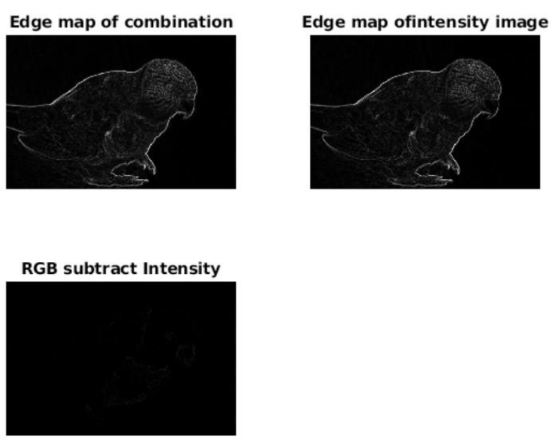
i. **you apply the Sobel operator to each of the RGB color bands of a color image. How might you combine these results into a color edge detector (5 points**

Using the combine results into a color edge detector: I = 0.299 * G + 0.587 * G + 0.114 * B;

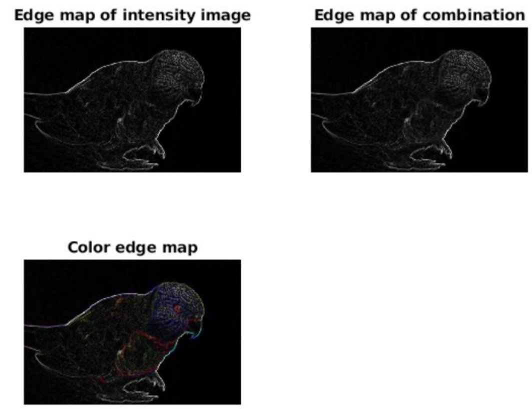
ii. Do the resulting edge differ from the gray scale results? How and why (5 points)?

Yes, From the images below we can see that there is slight difference between the edge maps of RGB combination and the edge maps of intensity image because RGB image has more details than intensity image

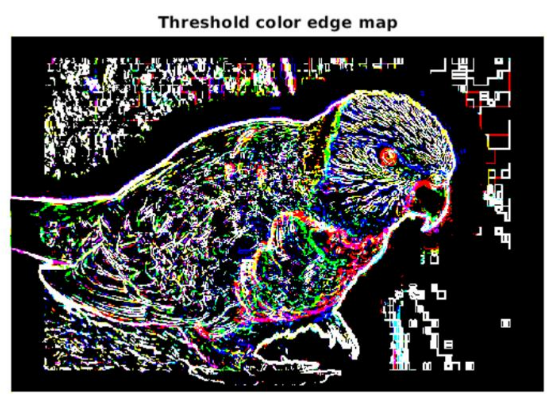




iii. compare the edge maps of the intensity image (of the color image), the gray-scale edge map that are the combination of the three edge maps from three color bands, or a real color edge map that edge points have colors (5 points).



iv.please try to generate a color sketch of an image, such as the ID image of Prof. Zhu. You may also consider local, adaptive thresholding in generating a color edge map.



Thresholding shows some RGB colore in the image which is similar to color image edge detector.