ENSC 474

Assignment 5

Mask-based image processing

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Sobel Mask:

I created 3 different functions, one for each of the filters that were used. First was the Sobel function, which is where we take the value on top of the current value, and the one to the right, and minus them from 2 times the value of the current position.

This returns and edge image. The enhanced image is just the original image minus the edge image, which is equivalent to 3 times the current value minus values from one up and one right.

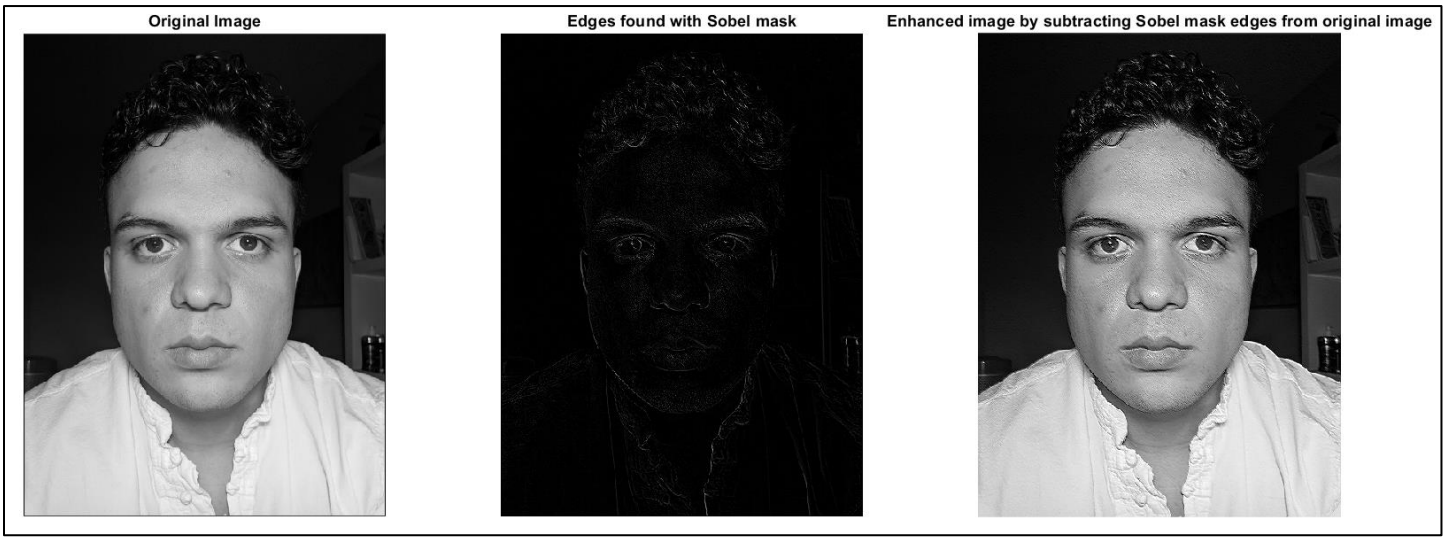

Figure 1: Original, edges, and enhanced image from Sobel filter

We can see the edges, but the Sobel function does not exaggerate them as much as other filters. This causes a slight "sharpening" of the original image, nothing drastic.

The advantage to the Sobel filter is in its simplicity in providing an approximation to the gradient magnitude. One issue with the Sobel filter is that it is very sensitive to noise, meaning that the magnitude of the edges will lower as the noise in the image increases, which causes the accuracy to also fall. In the end, the Sobel is simple to implement, but it cannot produce accurate edge detection with a thin and smooth edge.

This mean that our final enhanced image was a slight bit sharper (edges were enhanced) but this also caused our image to become blurrier. This may be due to the edges not being completely accurate, and some error or noise being present in the image when is was taken.

First Laplacian Mask:

Next was a composite Laplacian filter, which was to take 4 points directly connected (up down left right) to the current value and subtract it from 4 times the current value. This is less simple than the Sobel, and slightly more complicated and calculation intensive, but it follows the edges more accurately.

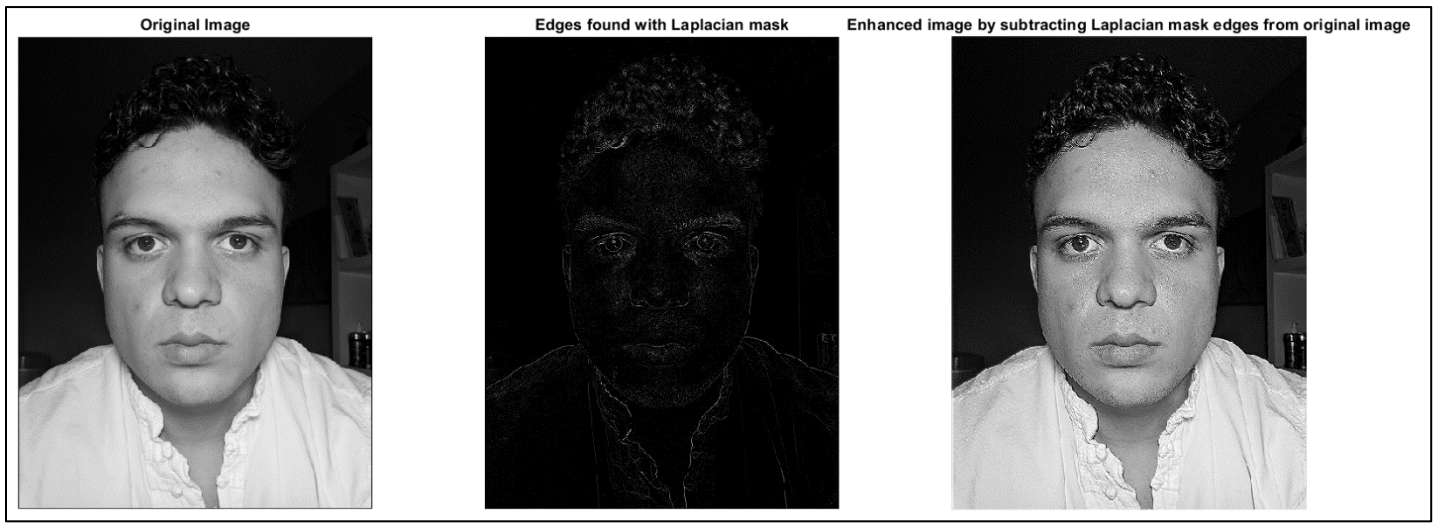

Figure 2: First composite Laplacian filter used in this assignment

With this composite Laplacian filter, we can see more intense edges, and more edges being shown. This is because for each point we are comparing with 4 surrounding values instead of 2. The resulting enhanced image is much sharper than the Sobel filters enhanced image, which caused the image to appear less blurry. The edges were very sharpened, especially those on the shirt, compared to the Sobel enhanced image.

This composite Laplacian filter seems to be a much more acurrate and dependable filter, but it does require many more additions to the calculation of each point, making is more complicated than the Sobel filter.

There are uses for each of these two filters, but for this assignment, this composite Laplacian filter is more useful (the difference in computation time is negligiable to the user for this assignment).

Second Laplacian Mask:

Finally, we had the second composite Laplacian filter shown to us in lecture, which consisted with all 8 immediately surrounding points to be subtracted by 8 times the current positions value. This was the most complicated filter that was done in this lab,

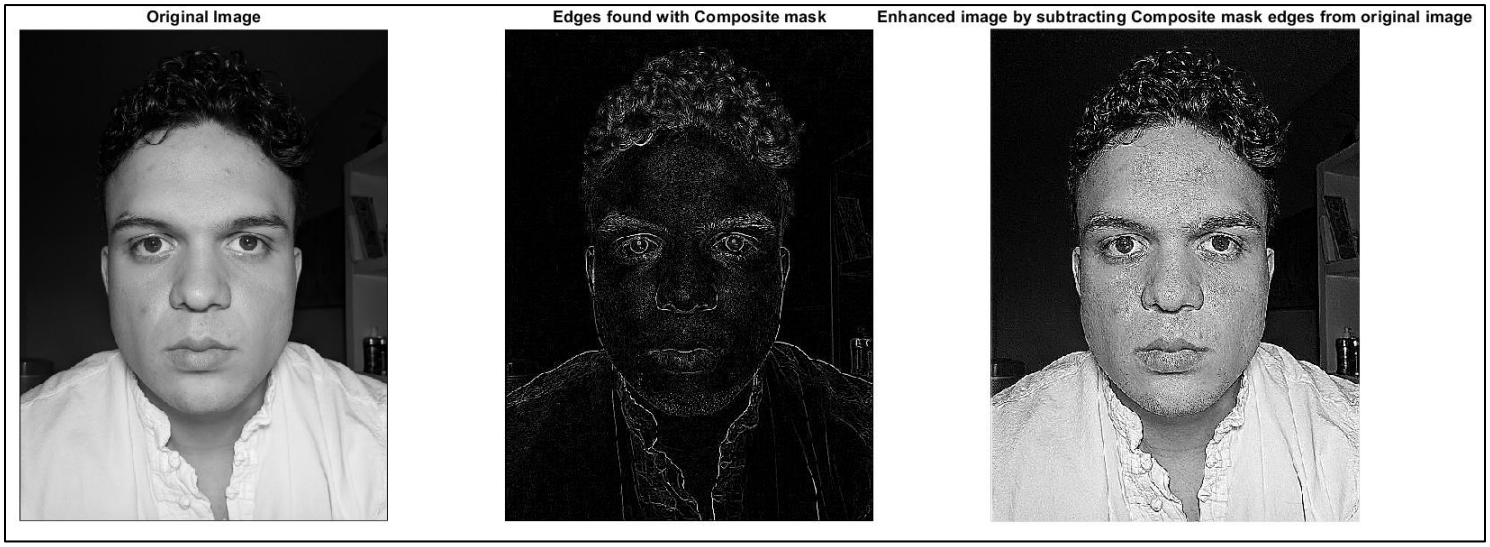

Figure 3: Second composite Laplacian filter used in this assignment

This second Laplacian filter produced the most intense and abundant edges. This may seem like a very positive thing, but for this mugshot image, it was registering portions of the image that one wouldn't want considered as an "edge". For example, it registers blackheads and pores on the face as edges, which causes the final image to be quite over sharpened.

This exaggeration of edges causes the final image to appear grainy, instead of properly sharpened and enhanced. This was not an ideal output.

When taking all three filters into consideration, the one that produced the best enhanced picture was the first composite Laplacian filter. It had a much simpler calculation that the second filter, and produced an image that had enough edge filtering, without going overboard. The first Laplacian was only a little bit more complicated than the Sobel filter, but produced a much more accurate and sharpened final image.

Average of the 3 filters:

According to Mike, one could apply filters sequentially, due to the additivity property. I decided to try this out and apply all three filters to the image. This was the resulting image:

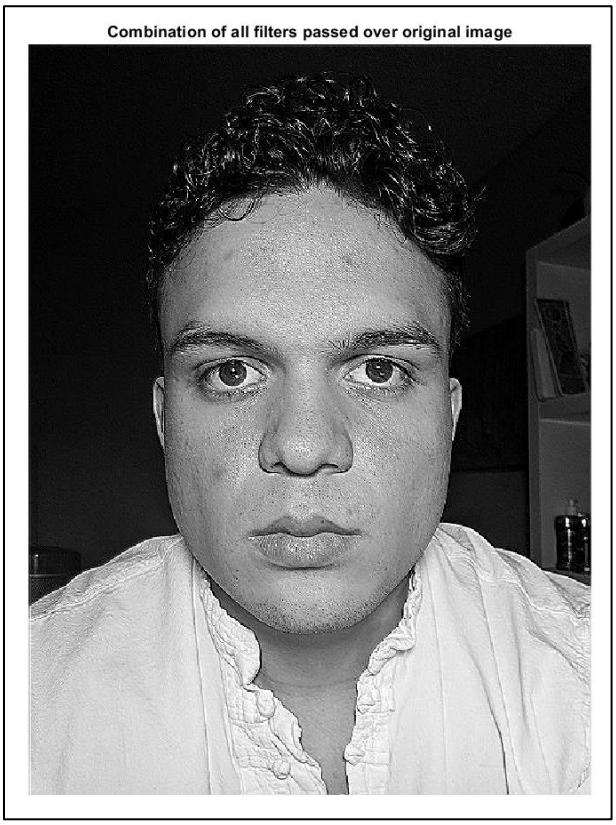

Figure 4: enhanced image using all 3 filters used in the lab

This image seems to be the cleanest resulting image, but I am not sure if it was done correctly, as it seems it may just be an average.

Using coefficients on the masks:

Next, I tested to see if coefficients in front of the masks affect the outputted image.

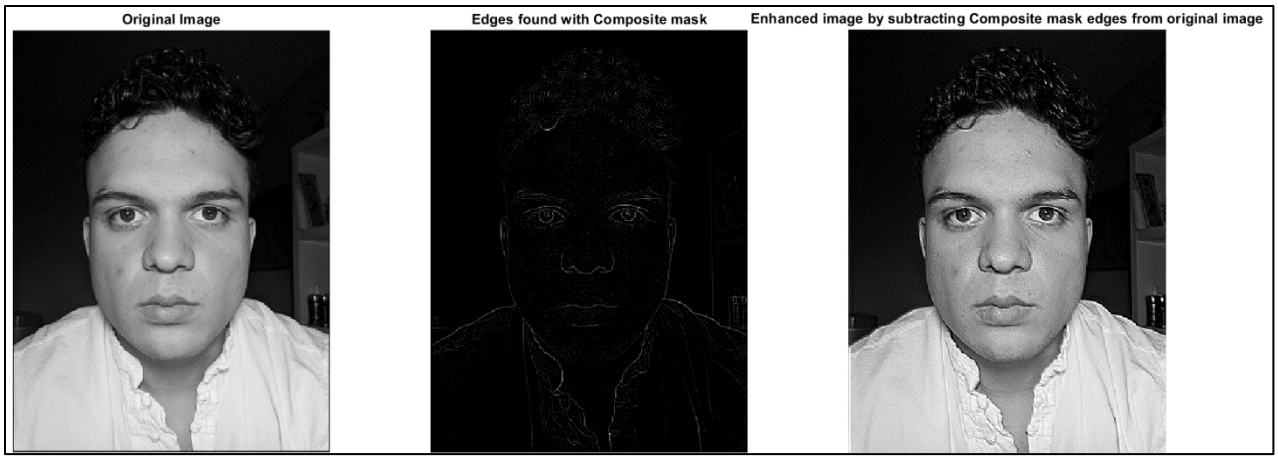

Figure 5: Second composite Laplacian done with coefficient of 0.25 infront

After including a constant to the masks, one can now affect how intense the edges outputted by each filter is. As one can see, we see that with a mask that was over emphasizing edges, suh as the second laplacian, when a coefficient below 1 is multiplied to it, it produces a clearer and more ideal enhanced image. Above is the second laplacian, but with the mask multiplied by 0.25, which produces a much better image than when a constant of 1 is used.

For the other images, the masks already returned good enhanced images, and applying coefficients overexaggerate or lowered the edges to points that were not as good as when the coefficient is 1.

Using larger masks:

Another method of testing the image was to increase the size of the mask. Usually masks are used with an odd side length, since then you have a fixed center. A larger mask can be very useful for large images, but if a large mask is applied to a small images it can “smear it”, causing the image to not be as clear as it would be with a smaller mask.

Since the image used in this lab is 300X200, I decided that using a larger mask will ruin the image.

Conclusion:

In conclusion, this lab allowed us to explore the simple algorithm's behind edge detection, and the pros and cons of each one. We also explored how to manipulate each filter, either by multiplying by a constant, or increasing the size of the mask itself.

These algorithms were very simple, which explains the large portion of error and deviation from the ideal enhanced image, but surprisingly, this lab produced quite satisfactory images with very little code.