Brendan Bassett
CS3150: Image Processing
10/06/2021

Assignment 2: Report

For this project I tried to make as many sizes and variations of each filter as possible. That way I could see firsthand how careful choices like a particular Laplacian filter could impact results. The image I chose for similar reasons. It has many different textures and shapes, with lines, dots, curves and gradients of various sizes. It ended up being an excellent choice, really showing what each filter affects most.

For example, the average filter created a very consistent blurriness across the image, but it removed important details indiscriminately. The Gaussian filter was more effective at adding blur without dramatically impacting important smaller features. In the larger sizes this was ever more noticeable. It’s hard to describe but the larger Gaussian kernels seemed more “natural” than the larger average filters. The median filter did not really add blur so much as it removed intense spots like in the starry texture on my hoodie. It did add some blur here and there as a side-effect (like in my hair) so I would want to use it carefully. Confining the filter to a certain region like the hoodie would do the trick.

As for edge detection there were minor but interesting differences between each. The Sobel filter gradient stood out as quite accurate. It captured many fine lines but still responded well to the larger ones. However, the vertical filter allowed horizontal information in and the horizontal filter let in vertical information. That I attribute to the 1 values in the corners of the 3x3 kernel. That diagonal consideration may be good to produce an accurate gradient, but it would be less useful for specifically picking out only horizontal or vertical change. For that the central difference kernel was surprisingly useful, though it was not very responsive. The Prewitt kernel was also useful for showing purely horizontal or vertical information, though more “bleed” from one orientation to another was still clearly present.

Out of the two Laplacian filters, I would choose the one with all 1s in the outer cells of the kernel. It was much more responsive and showed diagonal edges much better. The one filter that truly baffled me was the Laplacian of Gaussian. It did not produce very results. The smaller kernels left quite a lot of noise, so it would be hard to use it for edge detection in this case. The larger kernels seemed to “sort out” the less intense edges better, but the edges interfered with each other. Maybe it would be better used on an image with larger, more defined features.

Finally the iris image required a few steps to analyze for the pupil location. Though it did not need averaging to produce good results. The details around the eye itself was well enough defined and there were practically no curved objects to interfere with the ring detection. Instead I started with the Sobel Gradient filter to find the edges of the image. Then I applied a 128x128 ring mask that contained 1s within a 35-45 pixel ring around the center, and 0s elsewhere. Convolving this with the Sobel-filtered image produced an image showing where ring-shaped elements might be within the image. Then I used thresholding to remove all but the very most important ring location information. That left me with a single dot depicting the exact center of the pupil within the original image.

Original Images:

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 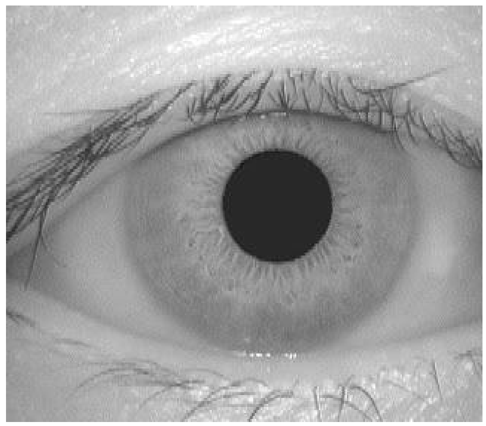

Average Filters:

3x3 **5x5**

 

9x9 **13x13**

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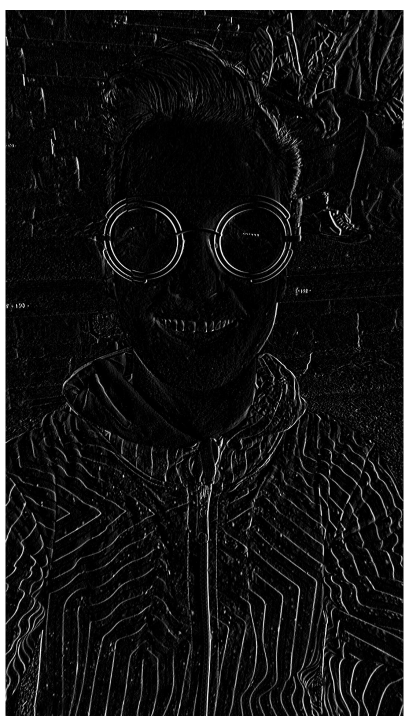
Sobel:

Horizontal **Vertical** **Gradient**



Laplacian:

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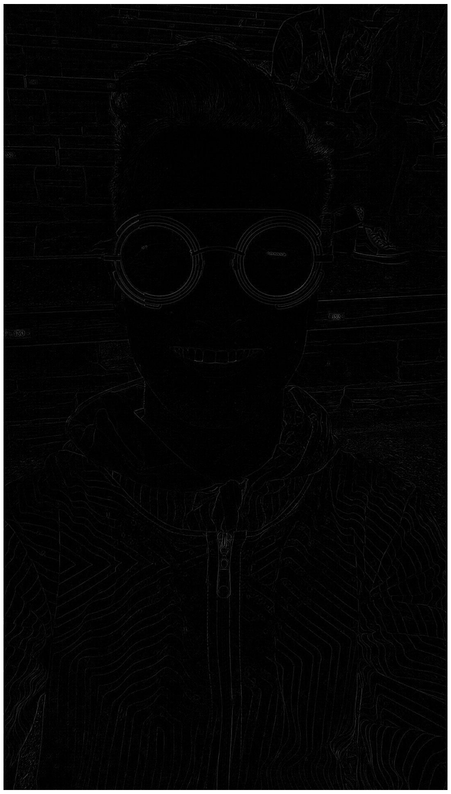
#1 **#2**



Median: **3x3** **5x5** **7x7**

Gaussian:

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3x3

5x5 #1

5x5 #2

7x7

Central Difference:

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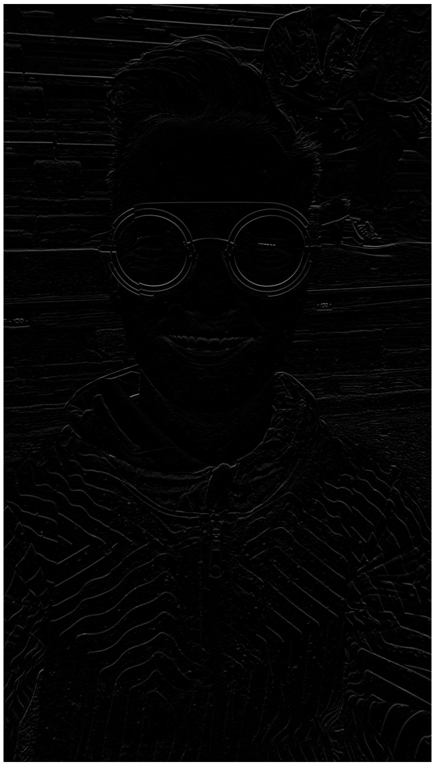
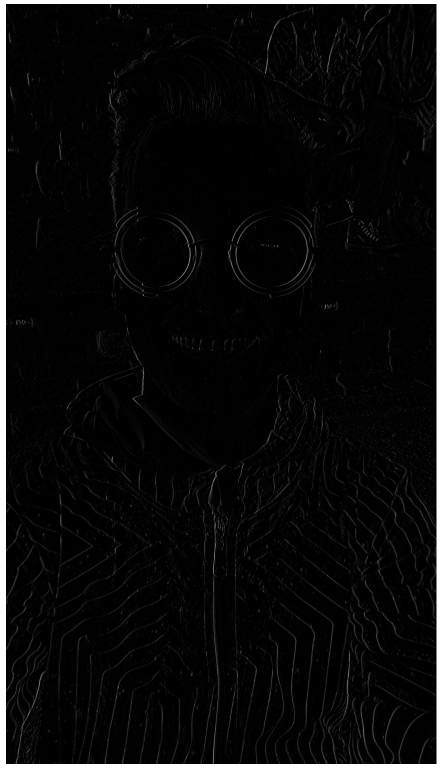
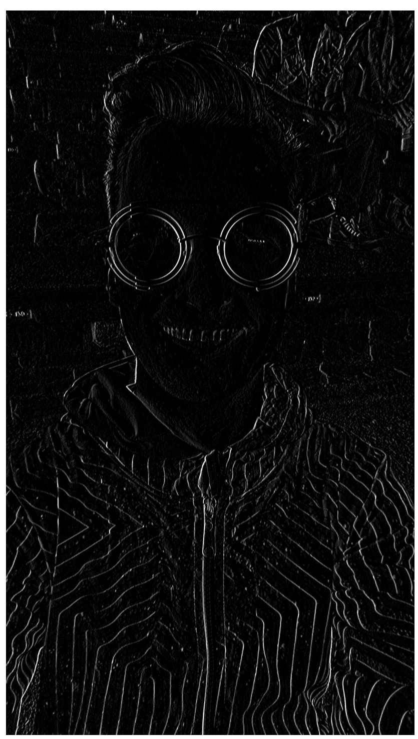
Horizontal **Vertical**





Prewitt:

Horizontal **Vertical**



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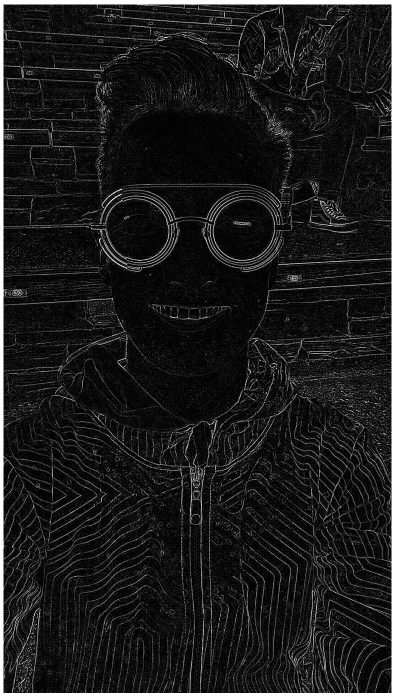
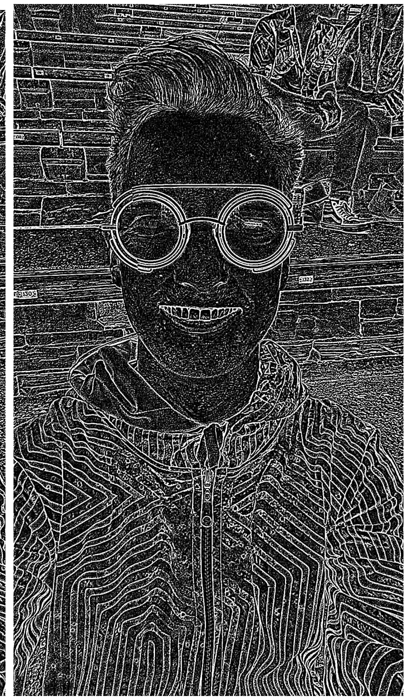
Laplacian of Gaussian:

5x5



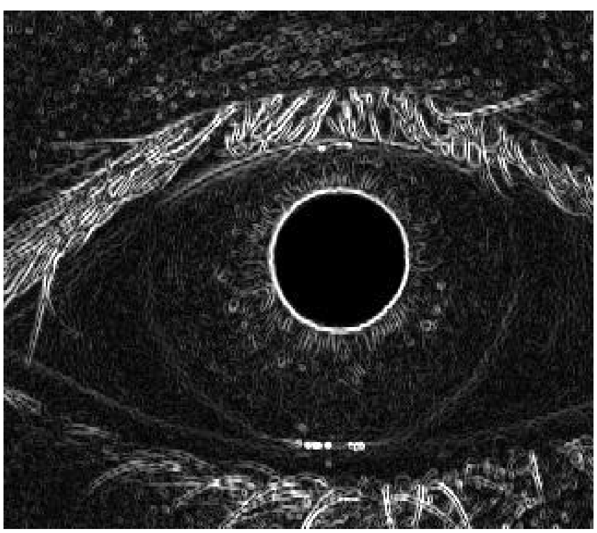
7x7

9x9

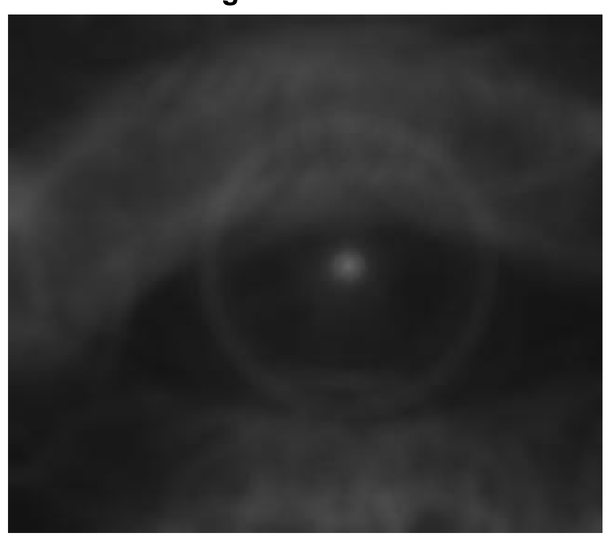


Iris Detection:

Sobel Gradient



Ring Convolution



Thresholding

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