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CS 445 - Project 1: Hybrid Images

Complete the claimed points and sections below.

Total Points Claimed **[115] / 130**

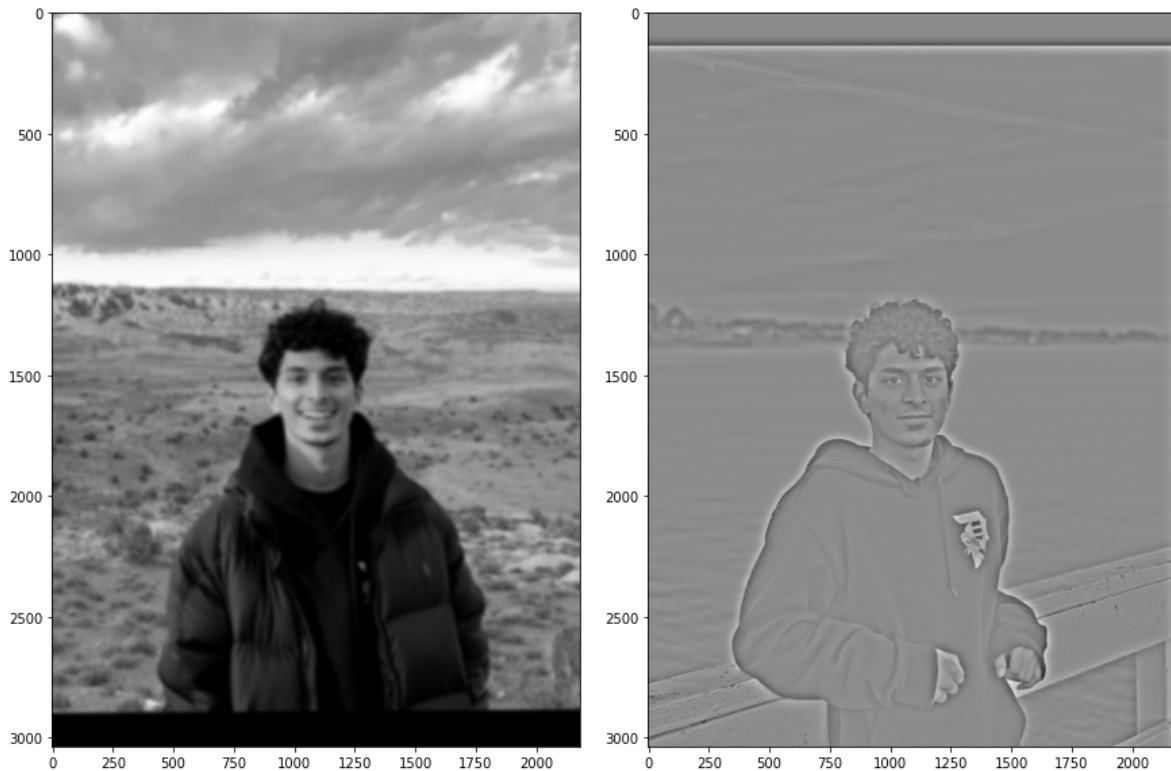
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1. Hybrid image main result

Below are the original images of my friend Arman. In one, he is smiling and the other he is not.



Below are the filtered images. The left one is low-pass filtered and the right one is high-pass filtered.



Below is the combined, hybrid result. When viewed up close, it doesn't look like he is smiling. When viewed from further away, it is clear that he is. I chose these photos to experiment with a change of expression using hybrid images. Following the same pattern as the Oliva, Torralba, and Schyns paper, I used a high-pass filter on the smug expression photo and low-pass filter on the smiling one. This created a much better result than the swapped version. The low-pass filter uses a sigma of 5 and the high-pass filter uses a sigma of 25. To create these photos, I used the recommended algorithms from the paper. For the low-pass filter, I used a standard 2D gaussian filter and for the high-pass I used the impulse minus the Gaussian filter.

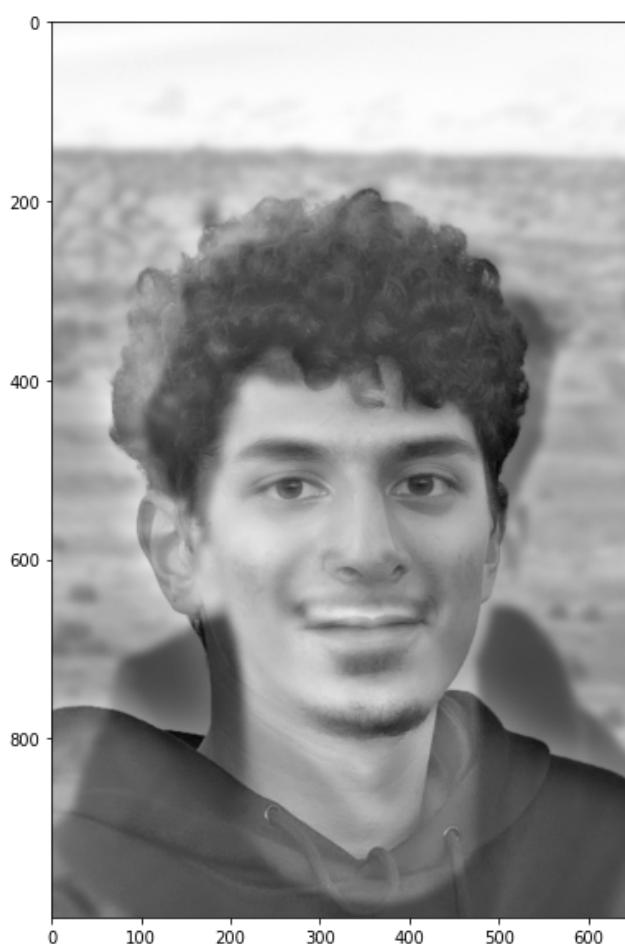


Image 1 FFT, before and after high-pass filter:

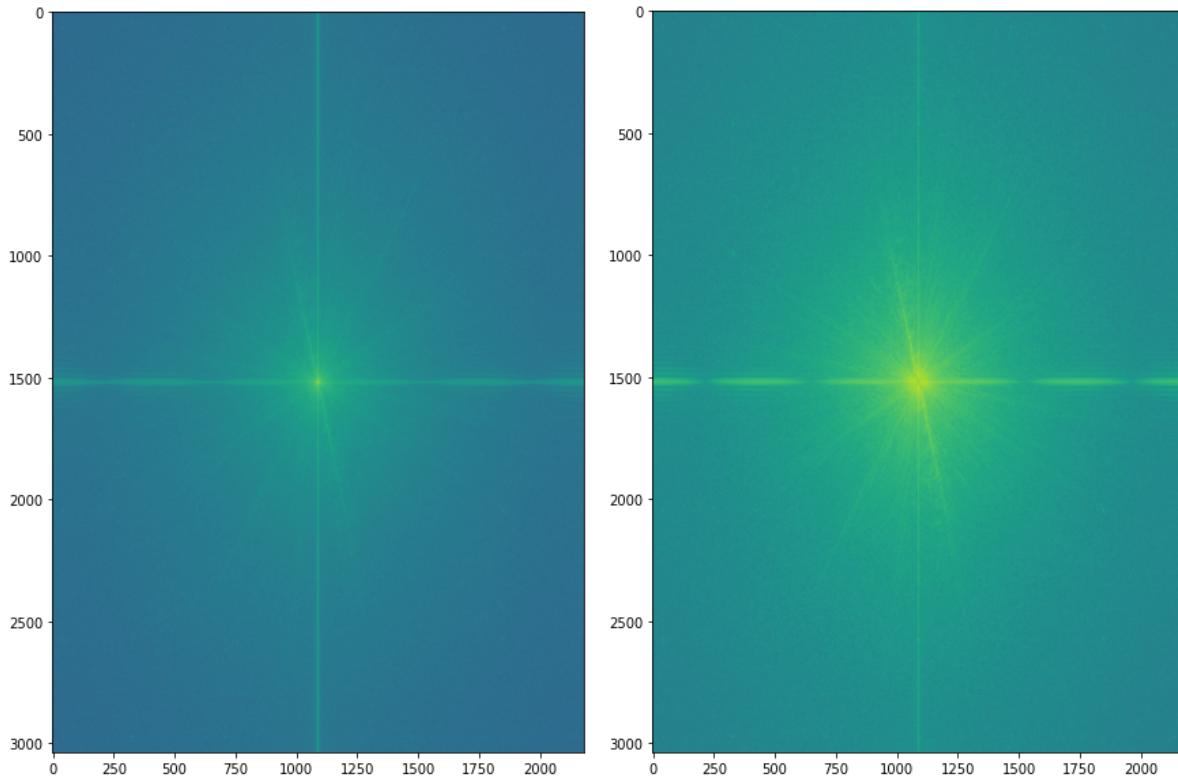
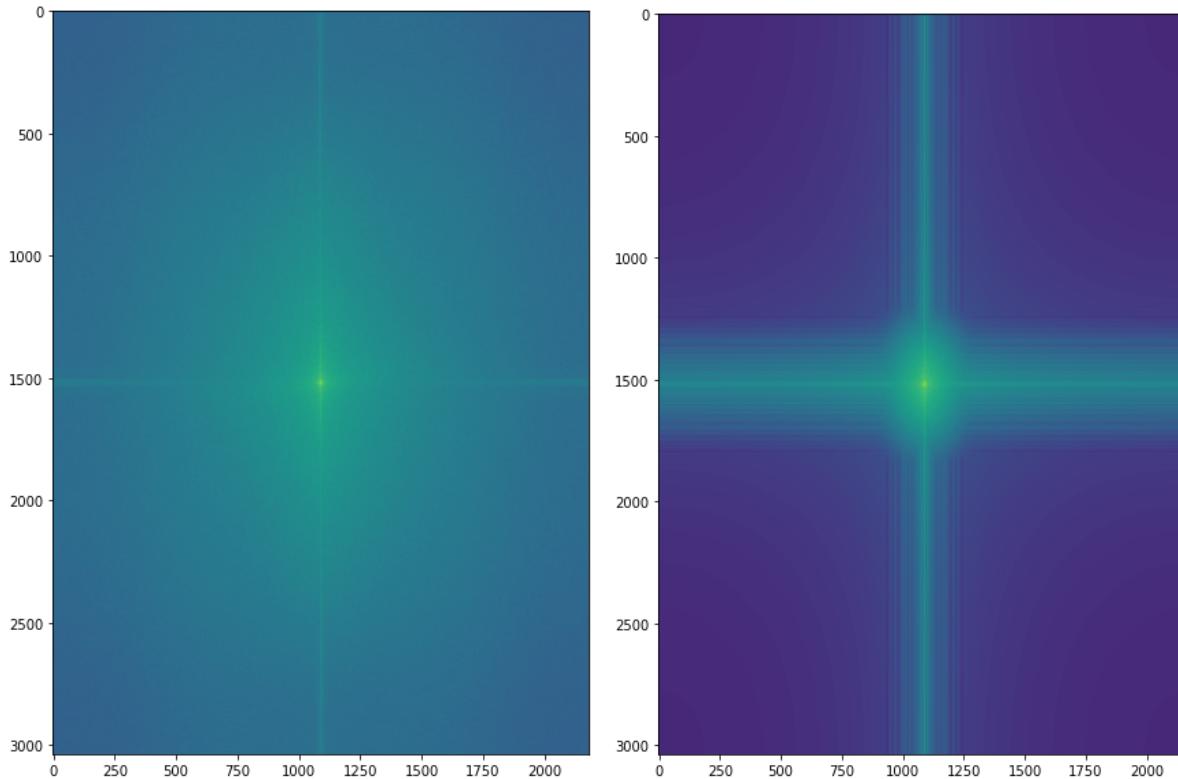
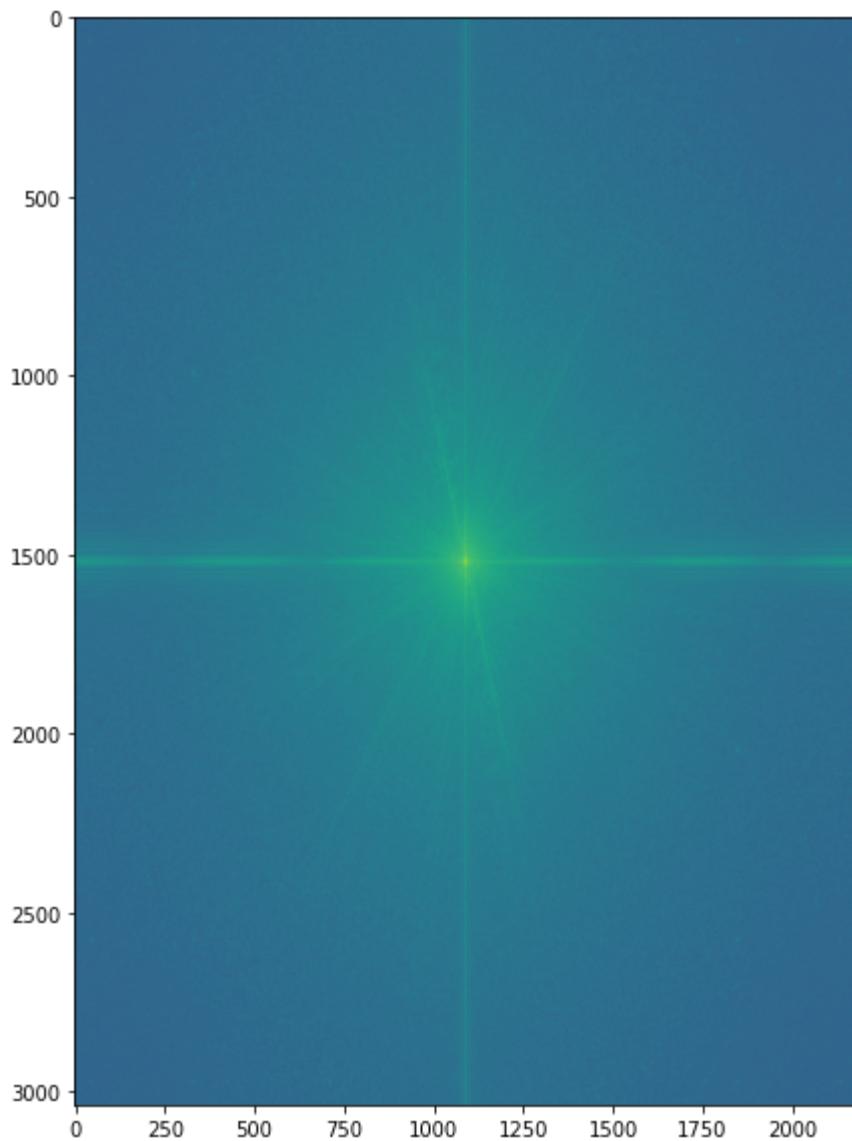


Image 2 FFT, before and after low-pass filter:



From the FFT of the original images, the dominant horizontal and vertical patterns tell us that there are significant rectangular components in both of the original images. This makes sense since in both images the skyline is parallel with the image frame. The higher amount of horizontal and vertical lines in the low pass filter indicate that these rectangular patterns in the original images tend to be of low frequency, which again makes sense as the skylines and clouds are far apart. The more expansive brightness at the center of the high-pass FFT image indicates more content at higher frequencies than the original image, which makes sense.

Hybrid Image FFT:



The hybrid image shows elements of both filtered FFT plots. The vertical and horizontal components indicate rectangular patterns in the original image, and the more dominant horizontal line likely comes as a result of the many vertical lines in the hybrid image. The many green rays protruding from the center of the image represent the high frequency content that is visible in the FFT for the high-pass filter. It's clear that this combined FFT includes both high-frequency and low-frequency components.

2. Hybrid image additional results

Additional Result 1:

Original Images: Me and my dog, Riley (High-pass and low-pass filtered, respectively)



Hybrid Result 1:



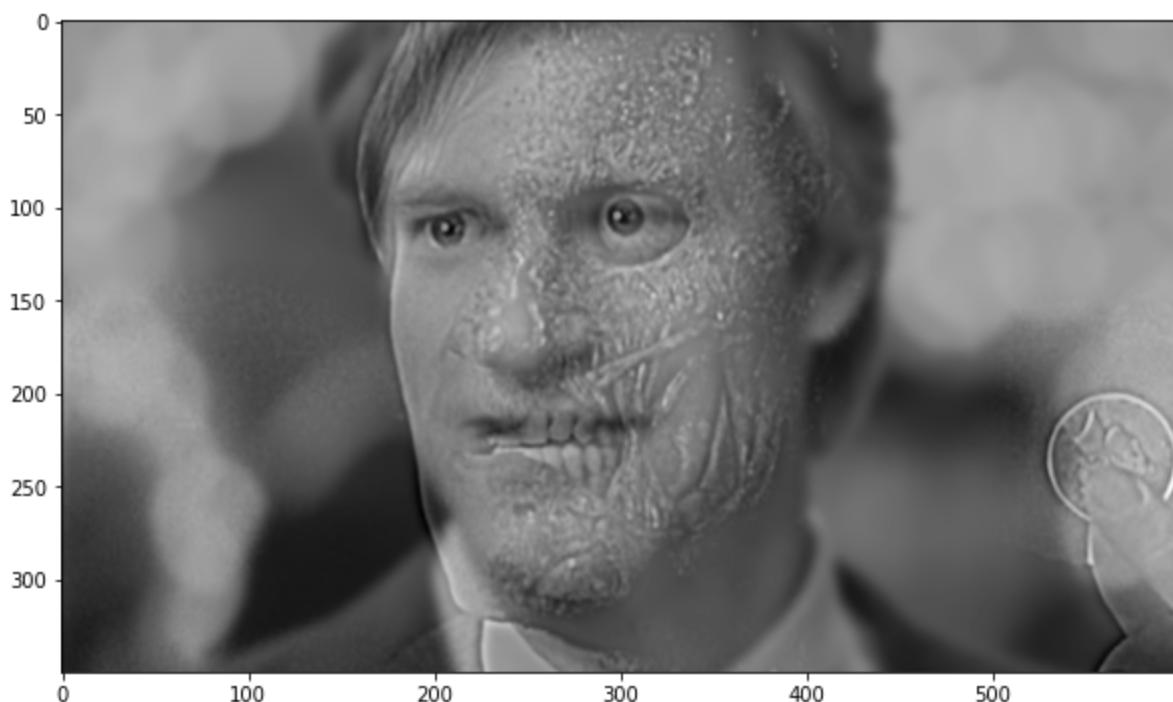
When up close, you can see me pretty clearly with only a shadow of Riley. When further away, you can see her much more clearly and I mostly fade away. I think this isn't a great result, however, since you can see her too prevalently up close due to the stark lighting contrast between the two photos.

Additional Result 2:

Original Images: Harvey Dent and Two-Face (High-pass and low-pass filtered, respectively)



Hybrid Result 2:



I thought it would be fun to experiment with a character with two identities or personas, and I was somewhat successful in creating a hybrid image of Harvey Dent and his later persona, Two-Face. The hybrid image works pretty well due to the similarity between the input images, and high-frequency details in the Two-Face image. As you get further from the image, the burn scars fade away and you can mostly just see Harvey Dent.

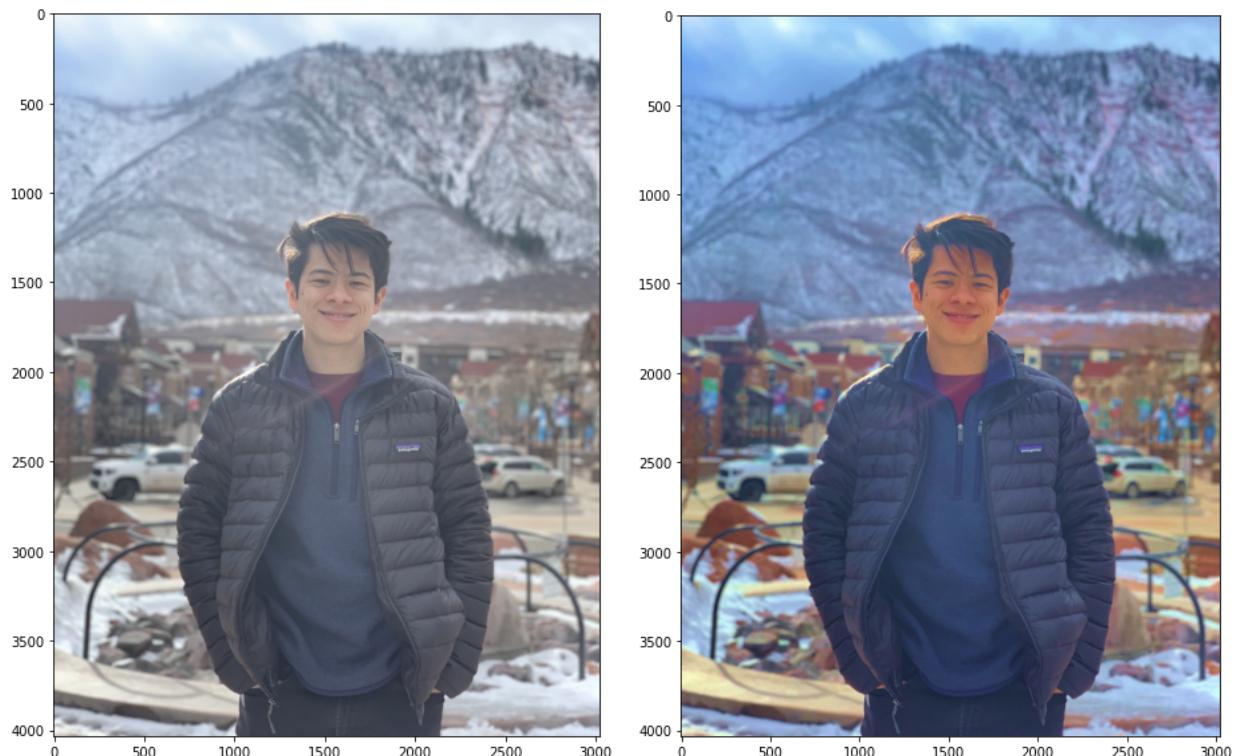
3. Image enhancement tasks (2 required, 3 for B&W)

Contrast Enhancement:



On the left is the original image and on the right is the contrast enhanced image. I chose this image I took of an abandoned house, because I felt like it was a neat photo but I wanted to see the colors pop more. I increased the contrast by using histogram equalization, which I chose because I felt like the monotonous color palette of the image would be significantly impacted by histogram equalization. Additionally, the `equalizeHist()` function built into the cv2 library made this pretty simple to accomplish. Essentially, I equalized the histogram for each RGB color channel separately, then combined the separate channels back into one using the `cv2.merge()` function. The enhanced image has much stronger bright and dark sections, and the colors are more vivid as hoped for.

Color Enhancement:



On the left is the original image and on the right is the color-enhanced one. I chose this image because I felt like it had muted colors, and I wanted them to be more vibrant - specifically in the areas of my jacket and the street signs in the background. I did this by converting the image to the HSV color space and using a gamma correction on the saturation channel to increase the

vibrance of the colors. I implemented the gamma correction using a lookup table that matches the original saturation value with a new gamma corrected value. In the image above, I used a gamma value of 0.5. I also ran the color enhancement on the graffiti photo from above, since I wanted to see more vibrant colors without increasing the contrast. The image below was created using a gamma value of 0.6.



Color Shift:

Original Image:



Color shifted, more red:



Color Shifted, less yellow:



The first image is the original, the second is the version that is more red, and the third is the one that is less yellow. I used the LAB color space and added a constant in the a-channel to increase the redness. To decrease the yellowness, I multiplied all of the positive (yellow) values by a scaling factor alpha ($0 < \alpha < 1$) to decrease the yellowness of those pixels. In this example, alpha was 0.2.

4. Quality of results and report

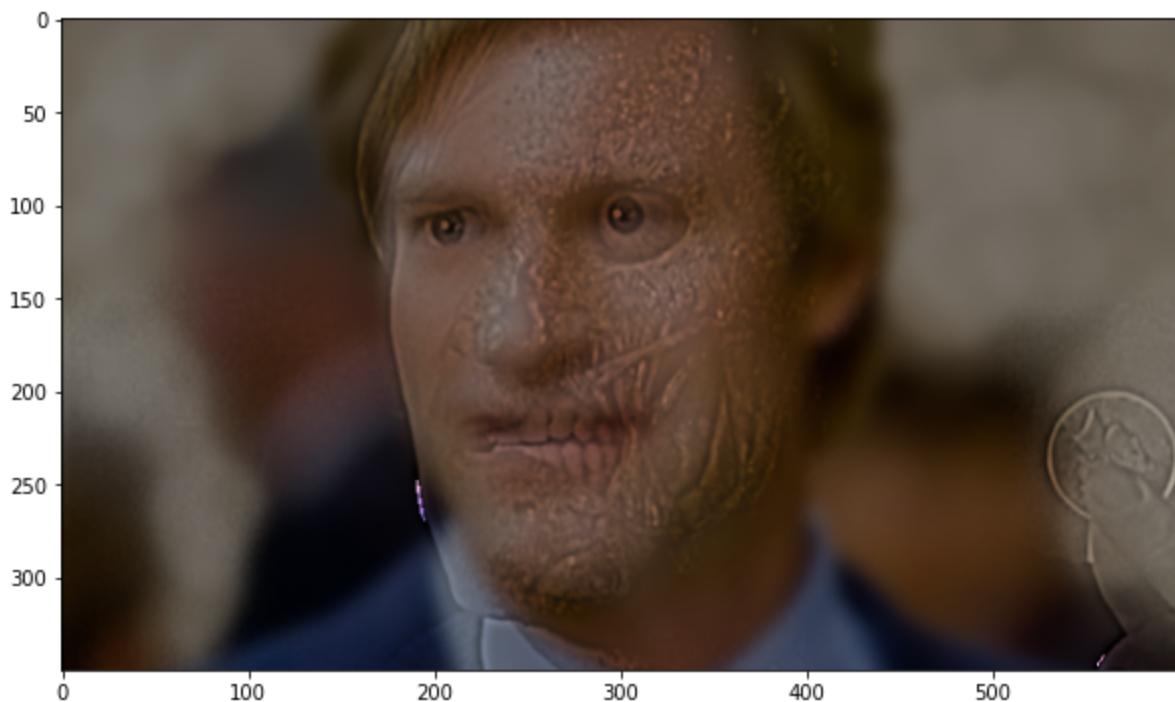
Nothing extra to include.

5. Color hybrid result (B&W)

Original Images: Harvey Dent and Two-Face (High-pass and low-pass filtered, respectively)

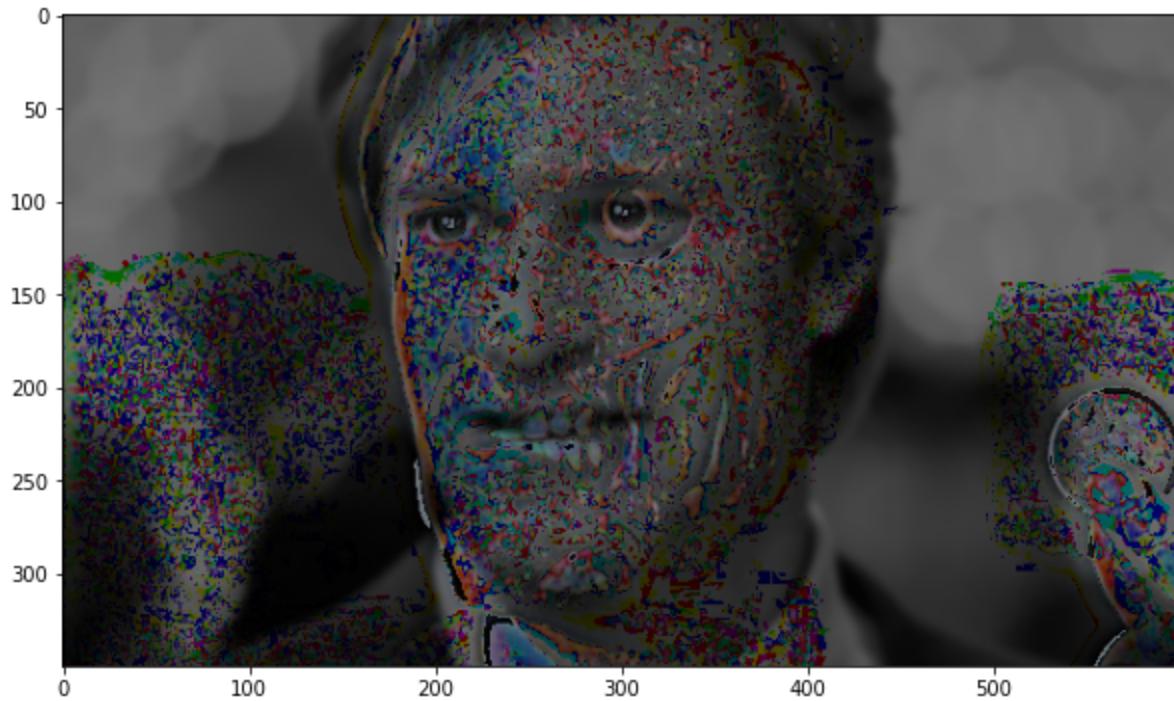


Colored Low-Pass, Grayscale High Pass Result:



I made this hybrid image by following the same procedure as the grayscale hybrid images, except I ran the low-pass filter on the colored version of the original image. After applying both filters, I converted the colored low-pass filtered image to the HSV color space and added the high-passed grayscale image to the V channel. This increased the darkness for these pixels without changing the hue or saturation, which successfully produced the hybrid image. Unfortunately, the high-pass filter produced strange results on colored images, so the combinations of using color for the high-pass filter or both filters produced undesirable results. This is shown in the hybrid image below. In conclusion, the hybrid image using color for the low pass and grayscale for the high pass is best. This is also what the Oliva, Torralba, and Schyns paper did for their hybrid colored images, which makes sense as it produced the best results for me.

Grayscale Low-Pass, Colored High Pass Result:



6. Gaussian and Laplacian Pyramids (B&W)

N/A; Did not attempt

Acknowledgments / Attribution

List any sources for code or images from outside sources

Code:

The AI Learner, Laplacian of Gaussian

<https://theailearner.com/tag/cv2-laplacian/>

OpenCV Docs, Linear Transforms & Gamma Correction

https://docs.opencv.org/3.4/d3/dc1/tutorial_basic_linear_transform.html

Images:

Harvey Dent Photo:

<https://www.charactour.com/hub/characters/view/Harvey.Dent.The-Dark-Knight>

Two-Face Photo:

<https://movieweb.com/the-dark-knight-aaron-eckhart-two-face/>