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CS 445 - Project 1: Hybrid Images

Complete the claimed points and sections below.

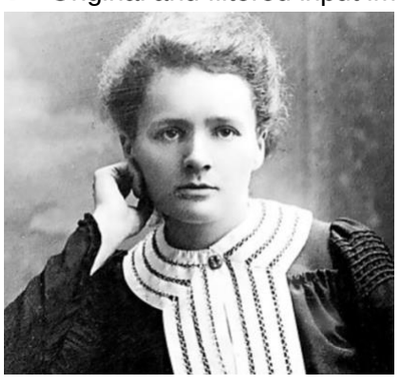
Total Points Claimed **[ ] / 130**

1. Hybrid image main result
    a. Main result and description [ ] / 45 ✅
    b. FFT images of main result [ ] / 15 ✅
2. Hybrid images: two additional results [ ] / 10 ✅
3. Image enhancement tasks (3rd is B&W)
    a. Contrast enhancement [ ] / 10 ✅
    b. Color enhancement [ ] / 10 ✅
    c. Color shift [ ] / 10 ✅
4. Quality of results / report [ ] / 10 ✅
5. Color Hybrid Image w/ explanation (B&W) [ ] / 5 ✅
6. Gaussian / Laplacian Pyramids (B&W) [ ] / 15 ✅

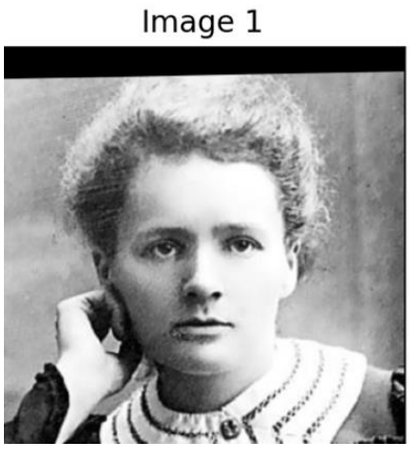
1. Hybrid image main result

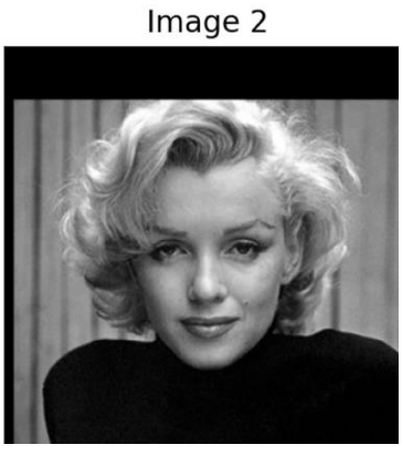
Include

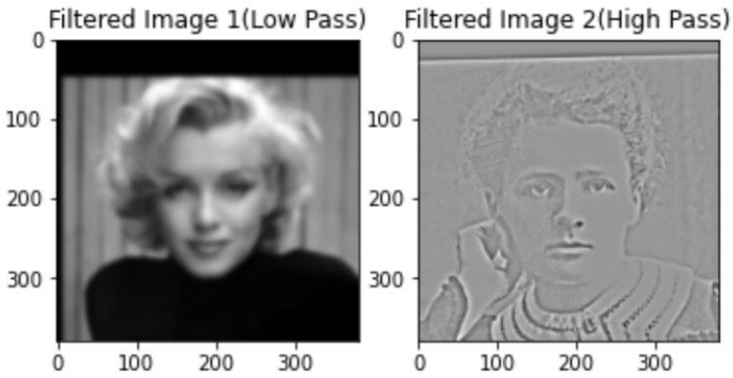
- Original and filtered input images


[1]

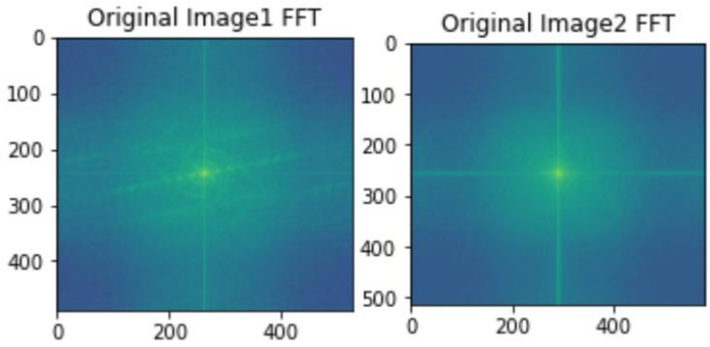

[2]

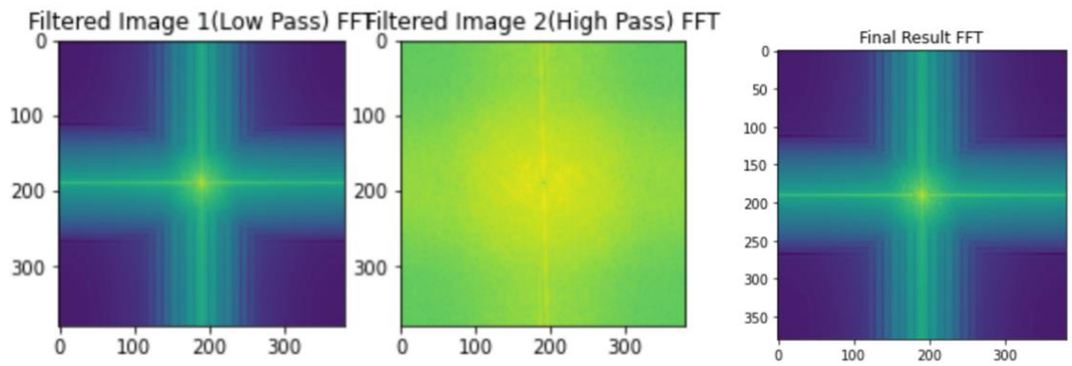






- FFT images of each original and filtered image and the hybrid image





- Description in a few sentences of how it works using the included images as illustrations. Explain parameter settings and any clever ideas that are incorporated.

  The hybrid image combines the low-frequency image with the high-frequency image. After converting the image to grayscale, I apply a low-pass Gaussian filter to the first image and a high-pass filter to the second, then merge them. The parameters sigma_low and sigma_high control the cutoff frequencies for the filters. These settings allow us to create images that appear different when viewed from various distances or resolutions, merging broad visual themes with detailed textures. For instance, if the first image features very smooth textures, a higher sigma_low (sigma_low=3 in this example)

may be necessary to adequately blur it. Conversely, if the second image contains fine details, a lower sigma_high (sigma_high=4 in this case) may be essential to preserve these details during the high-pass filtering process. By adjusting the sigma values, we can easily enhance the quality of our hybrid image. In my implementation, I also use np.clip to ensure the values stay within the appropriate range (0, 255).

2. Hybrid image additional results

Include

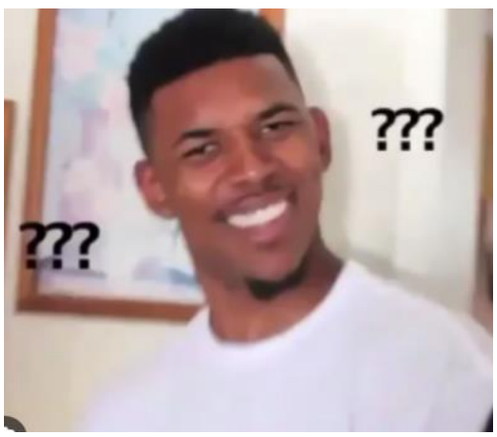
- At least two additional results (may not use provided samples). For each, include the input and hybrid image (do not need to show filtered or FFT images)

Additional Result 1

Image 1

Image 2

Additional Result 2



[3]

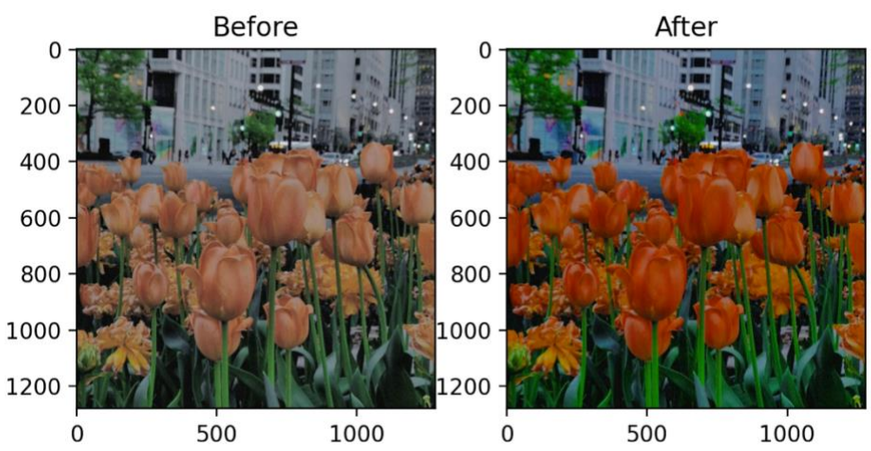
3. Image enhancement tasks (2 required, 3 for B&W)
Include

- For at least two out of three enhancement tasks (each is worth 10 points), display original image, modified image, and explanation of how the image was modified

Contrast enhancement:

For contrast enhancement, I first convert the image from BGR to HSV format. Then, I apply histogram equalization to the V (brightness) channel, which redistributes the image's brightness, spreading it out over the entire brightness range. Finally, I reassemble the image by merging the HSV channels and converting it back to the GBR, and then to the RGB color space to get the result image.

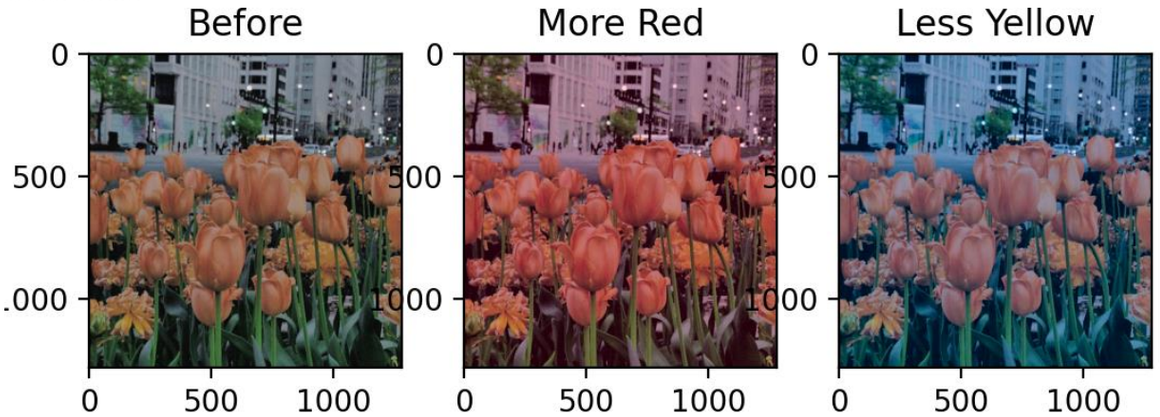
Color Enhancement:



For contrast enhancement, I also first convert the image from BGR to HSV format, where S represents the saturation. I then simply increase the S channel by doubling its value. I also

ensure the values are within the acceptable range (0 to 255) by using np.clip. After enhancing the colors, I reassemble the image by merging the HSV channels and converting it back to the BGR color space, and then to the RGB color space to obtain the final result.

Color Shift:



For the color shift task, I convert the image to LAB format. Since in LAB color space, A controls the spectrum from green (small A value) to red (large A value), and B controls the spectrum from blue (small B value) to yellow (large B value). Therefore, to make an image more red, we need to increase A. Similarly, to make it less yellow, B is decreased. These modified values are then clipped to ensure they stay within the range of (0, 255). The updated channels are then recombined and convert back to GBR first, and then to the RGB color space.

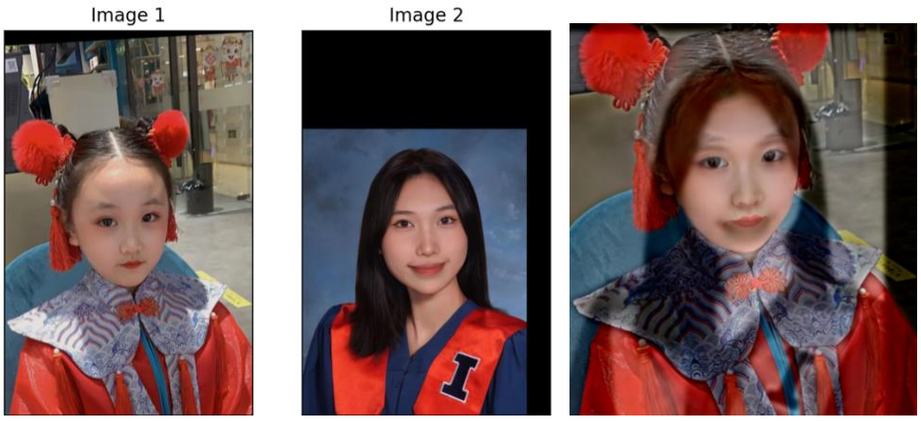
4. Quality of results and report

Nothing extra to include.

5. Color hybrid result (B&W)

Include

- Original images, hybrid image
- Explanation of method: Is it better to use color for the low-pass, the high-pass, or both?

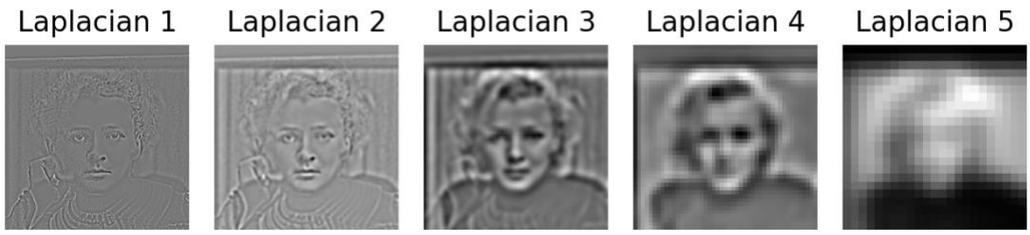


I think it depends on the specific image you're working with and the effect you want to achieve. I believe that using color for both the low-pass and high-pass components could provide a better result. From this example, we can see that applying the same process to color images actually produces a good hybrid image. This maintains overall color in the low-pass portions, while enhancing vivid detail and texture in the high-pass portions that is visible up close.
However, processing color images can be a bit more complicated than processing in grayscale. You might have to adjust the intensity, brightness, and saturation of the images to ensure they blend well together.

6. Gaussian and Laplacian Pyramids (B&W)

Include

- Gaussian pyramid of main hybrid image result (can be one row of images)
- Laplacian pyramid of main hybrid image result (another row of images)



Acknowledgments / Attribution
List any sources for code or images from outside sources

[1] BBC Radio 3 - The Essay, Five Portraits of Science, Marie Curie. (2013, January 17). *BBC*. https://www.bbc.co.uk/programmes/b01ppy0n
[2] Marilyn Monroe. (2023, December 28). *Biography*. https://www.biography.com/actors/marilyn monroe
[3] Ward, J. A. (2021, December 7). THE MEME DILEMMA: How memes help to destroy creative thought and popularize ignorance. *Medium*. https://jakewardmusician.medium.com/the-meme-dilemma-how-memes-help-to-destroy-creative-thought-and-popularize-ignorance-e5fa5f64d5a8