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CS 445 - Project 1: Hybrid Images

Complete the claimed points and sections below.
Total Points Claimed   [110] / 130

1. Hybrid image main result
   a. Main result and description   [45] / 45
   b. FFT images of main result   [15] / 15
2. Hybrid images: two additional results   [10] / 10
3. Image enhancement tasks (3rd is B&W)
   a. Contrast enhancement   [10] / 10
   b. Color enhancement   [10] / 10
   c. Color shift   [10] / 10
4. Quality of results / report   [10] / 10
5. Color Hybrid Image w/ explanation (B&W) [0] / 5
6. Gaussian / Laplacian Pyramids (B&W)   [0] / 15

1. Hybrid image main result
Include
- Original and filtered input images
- Hybrid image result
- 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.
- All results must be based on your own images (can be from web with attribution, but not provided samples)
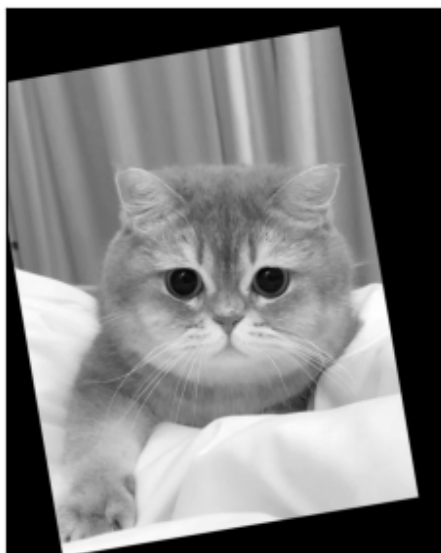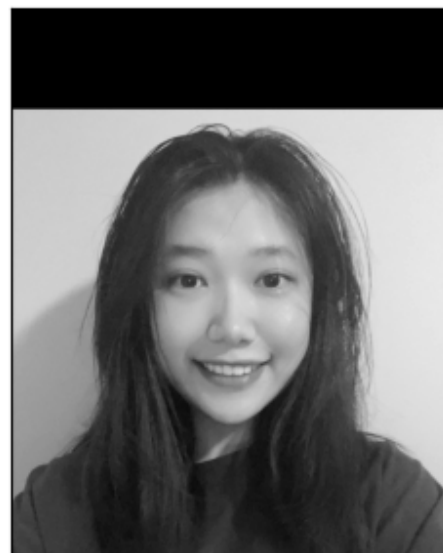
Original images

Image 1

Image 2

Filtered images

Low Pass

High Pass

Hybrid image result

FFT images

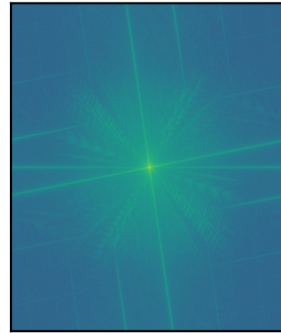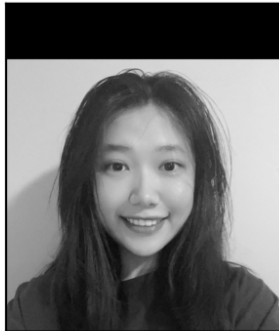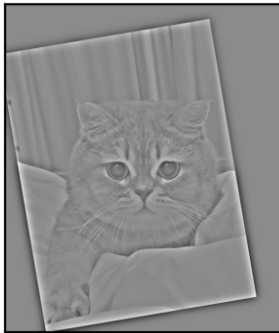**Original images**

Image 1

FFT Image 1

Image 2

FFT Image 2
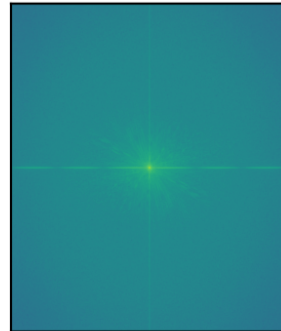
Filtered images
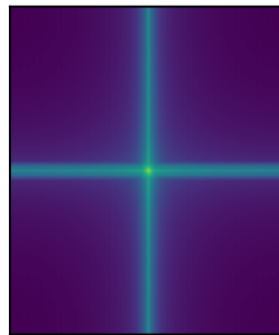
High Pass

FFT High Pass
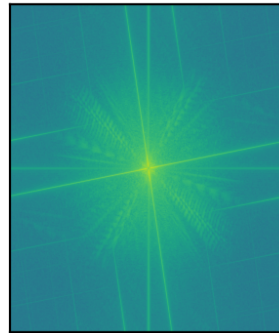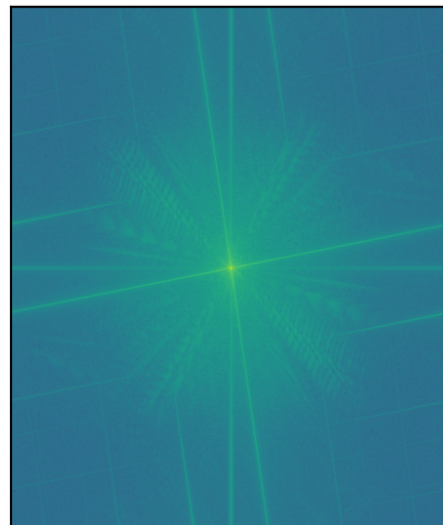
Low Pass

FFT Low Pass

Hybrid images

Hybrid Image

FFT Hybrid Image

Description
The input image 1 is my friend's cat, Kamen, and the input image 2 is myself. The power of FFT images for the input images are circle-shape centered in the low frequency.

Then I performed standard 2D Gaussian filter with **standard deviation (sigma) = 15** and **kernel half size = 3*sigma=45** to image 2. The Gaussian kernel makes image 2 a low-pass image, which decreases the power in the higher frequencies shown in the FFT image for filter images.

I also performed the impulse filter minus the Gaussian filter with **sigma=20** and **kernel half size=3*sigma=60** to image 1. Then the image 1 becomes a high-pass image, which strengthens the power around the center shown in the FFT image.
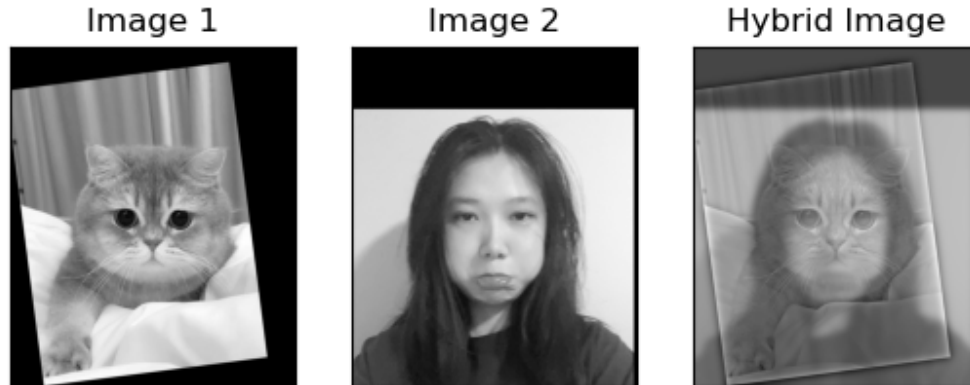
Finally, I add the low-pass image and high-pass image together with equal weight to generate the hybrid image.

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)

Image 1   Image 2   Hybrid Image
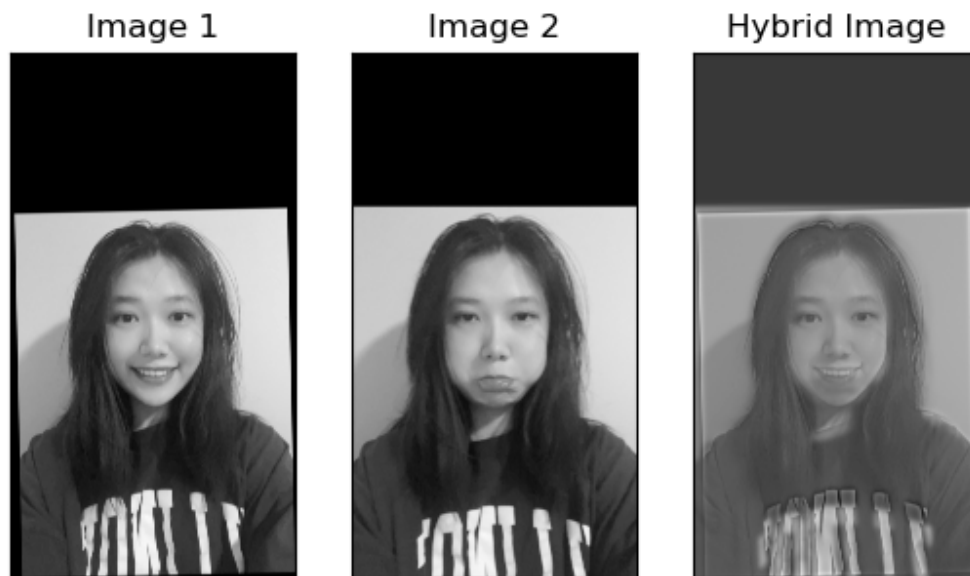
3. Image enhancement tasks (2 required, 3 for B&W)

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

Original Image

Histogram Equalized Image

I apply **histogram equalization** for contrast enhancement since this method is able to make the intensity level of each pixel more evenly distributed. This enhances the contrast of the original

image as the higher intensity parts can be strengthened and the lower intensity parts can be suppressed.

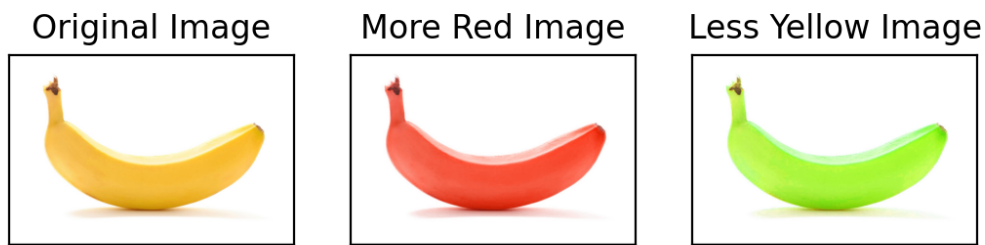**Color Enhancement**

Original Image

Color Enhancement Image

I first convert the image to **HSV color space**, dividing it into hue, saturation, and value channels. Then, I multiply the value channel by 5 to make the colors brighter and keep the hue and saturation channel the same to avoid affecting the vividness of the colors. I also set values which exceed 255 as 255 to map them between the range defined by the OpenCV (0-255). Finally, I convert the image back to RGB color space for presentation.

Color Shift

I first convert the image to **HSV color space**, dividing it into hue, saturation, and value channels. For the image that needs to be more red (more red image), I multiply the value channel by 0.2; for the image that needs to be less yellow (less yellow image), I multiply the value channel by 2 and constraint the value into the range of 0-255.

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?

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

- Banana image for color shift:
  https://www.smithsonianmag.com/science-nature/building-a-better-banana-70543194/