Computer Vision
HW2 Report

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Introduction:

In this assignment, we have three tasks to do. Here is some brief introduction on three tasks.

1.Hybrid Image: One image processed by low-pass filtered, and the other image processed by high-pass filtered. After merging this two images into one, it is called a hybrid image. We also can modify the proportion of this two images by changing cut-off frequency.

2.Image Pyramid: An image pyramid is a collection of some different image resolution. First, we build an image with Gaussian, and then subsampling it. We can get an image of the Laplacian pyramid by Gaussian pyramid. After getting an image of the Laplacian pyramid, we can show their corresponding magnitude spectrum.

3.Colorizing the Russian Empire: Input a digitized Prokudin-Gorskii glass plate image and using image processing techniques, automatically produce a color image with as few visual artifacts as possible. We aligned R channel, G channel, B channel to recover a colorful original image.

Implementation procedure:

1.Hybrid Image:

1) Multiply the input image by $(-1)^{x+y}$ to center the transform.
2) Compute Fourier transformation of input image, F(u,v)
3) Multiply F(u,v) by a filter function H(u,v).
   Gaussian high/low-pass filter $H(u,v) = 1 - e^{\frac{-D^2(u,v)}{2D^2}}$
4) Compute the inverse Fourier transformation of the result in (3).
5) Obtain the real part of the result in (4).
6) Multiply the result in (5) by $(-1)^{x+y}$.
7) Merge two images into one hybrid image

2.Image Pyramid:

1) Input an image to Gaussian low-pass filter, and subsample it. Repeat it four times,then we can obtain a Gaussian pyramid which has a resolution from high to low.

2) The Laplacian pyramid represents the difference between two adjacent layers in the Gaussian pyramid.
3) We can obtain a new image by upsampling the upper layer image in the Gaussian pyramid, and using this image to subtract the lower layer image in the Gaussian pyramid. Then we can get an image which is part of the Laplacian pyramid.
4) Repeat (3) four times, we can get the whole Laplacian pyramid.
5) Last, we represent two pyramids in frequency domain by Fourier transformation, and show their corresponding magnitude spectrum.

3.Colorizing the Russian Empire:

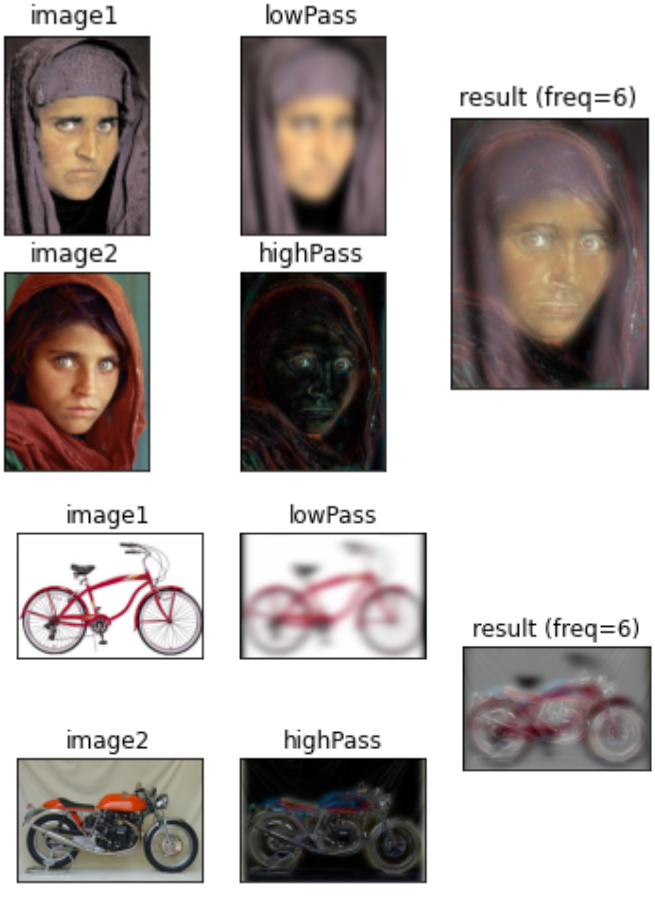
1) Remove a few parts of edges for the image.
2) Get the RGB images from the glass plate image.
3) Calculate the offset from R and G to B by normalizing the cross correlation.
4) Shift the R and G image to align the B image according to the offset we get in (3).
5) Concatenate R, G and B channels to get the colorful image.

Experimental result :

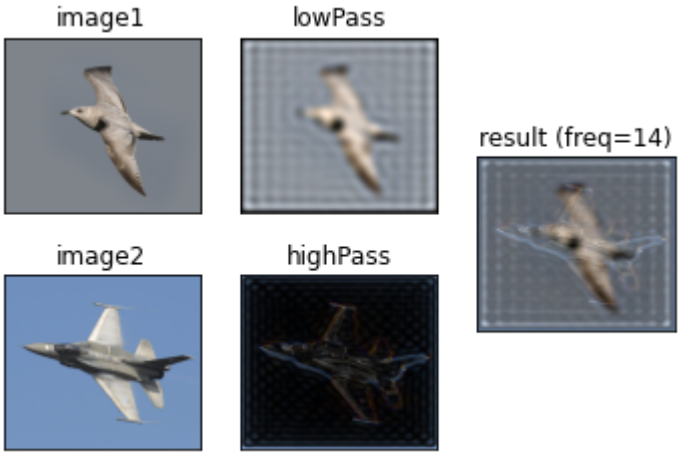
1) Hybrid Image:

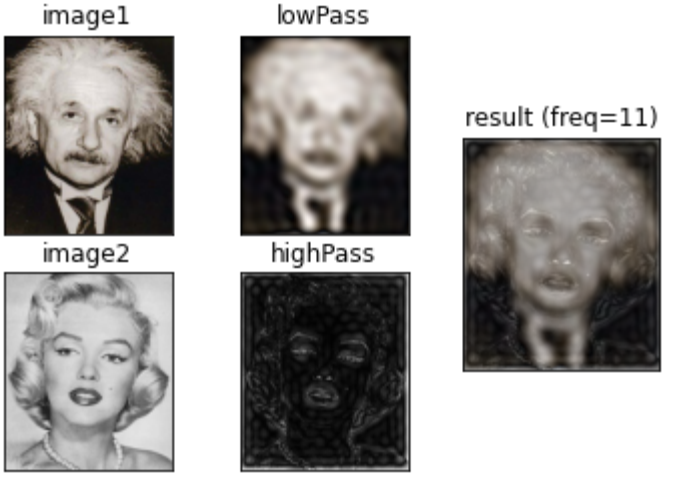
Ideal Filter

Gaussian Filter

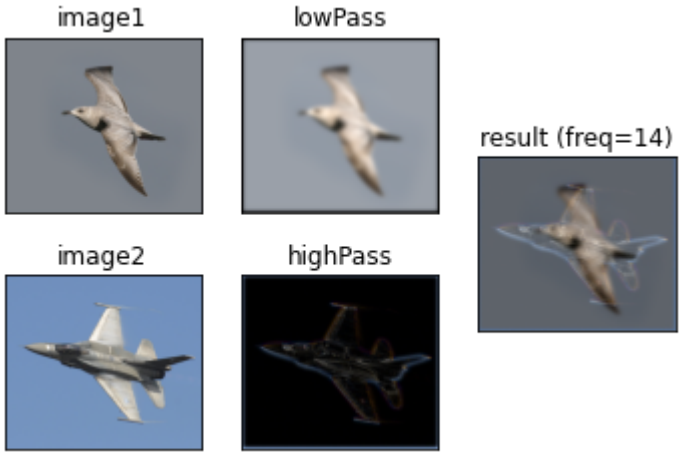


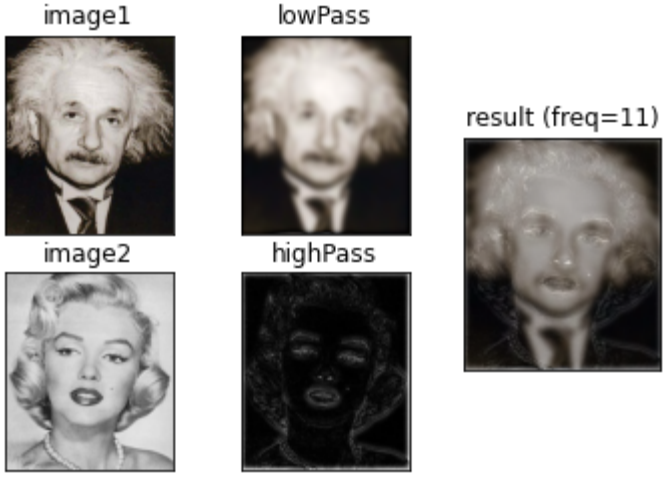
Ideal Filter



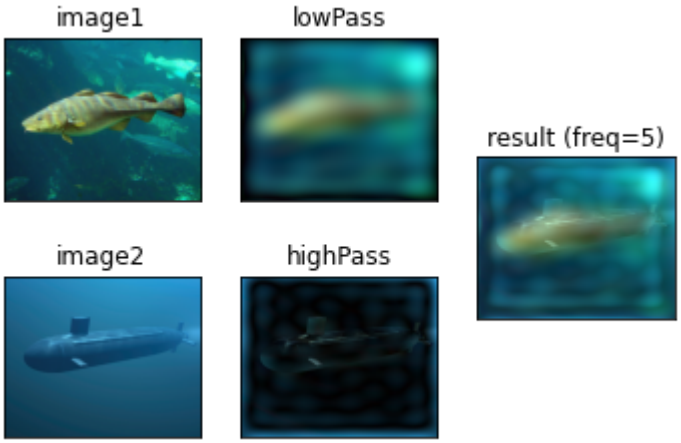


Gaussian Filter

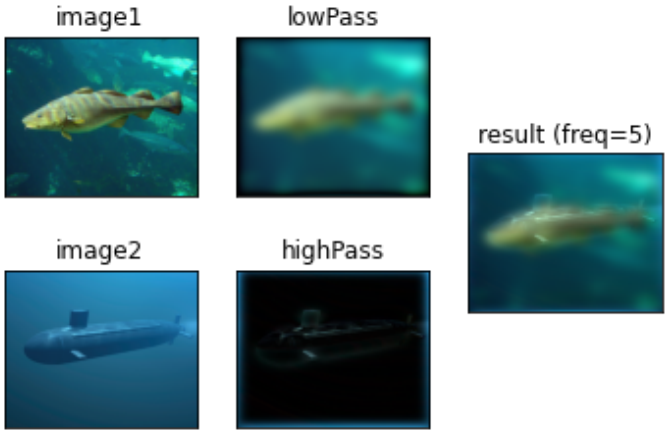




Ideal Filter



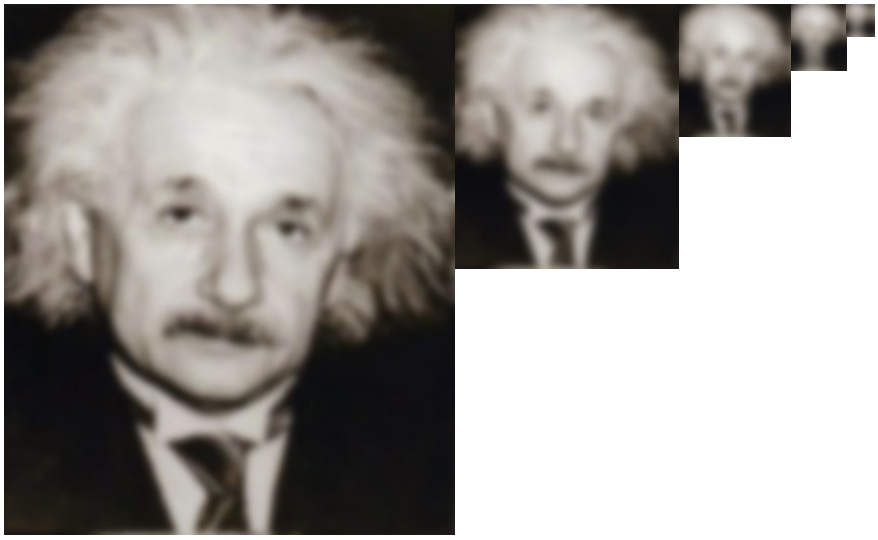
Gaussian Filter



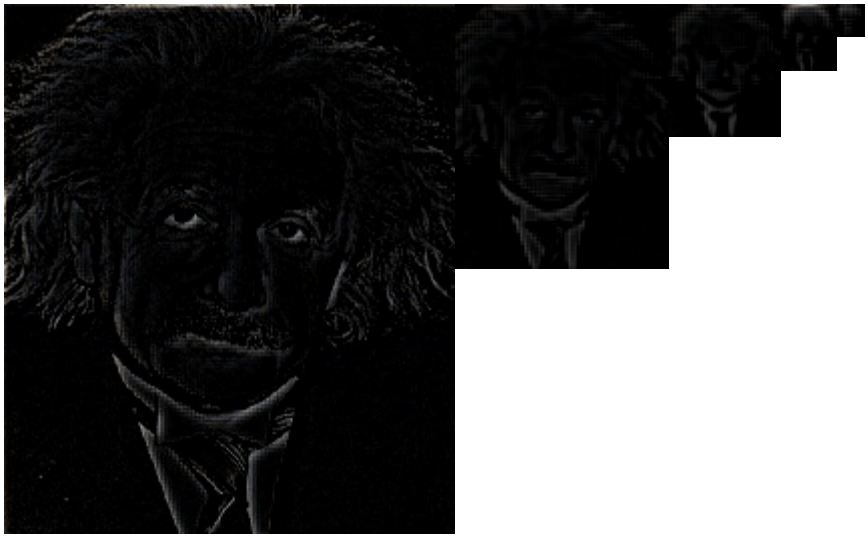
Our Testing data:

2) Image Pyramid:

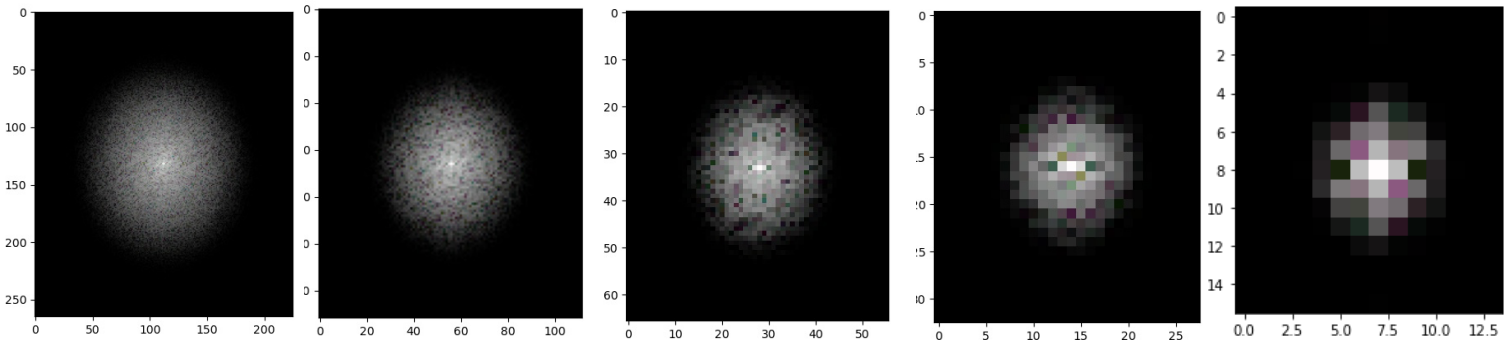
A. Gaussian pyramid



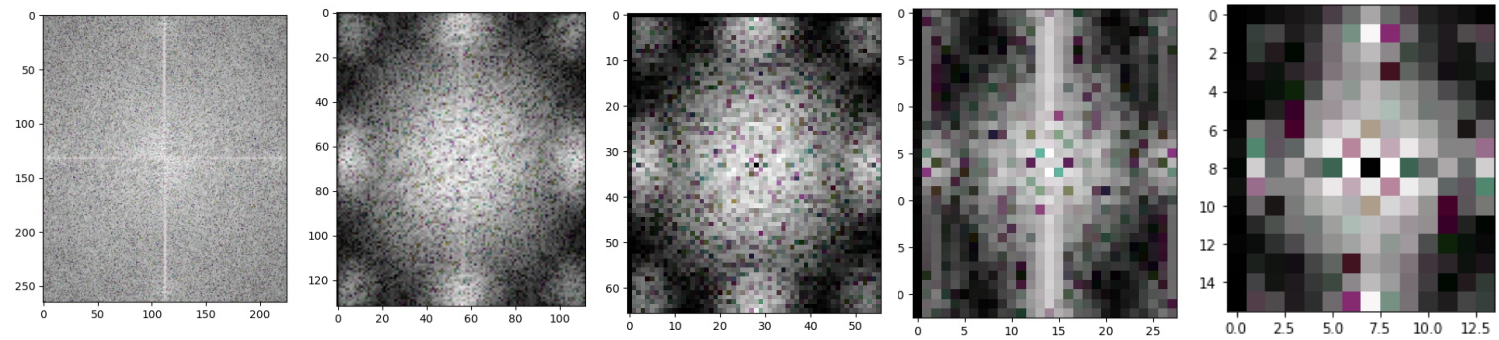
B. Laplacian pyramid



C. Spectrum of Gaussian pyramid



D. Spectrum of Laplacian pyramid

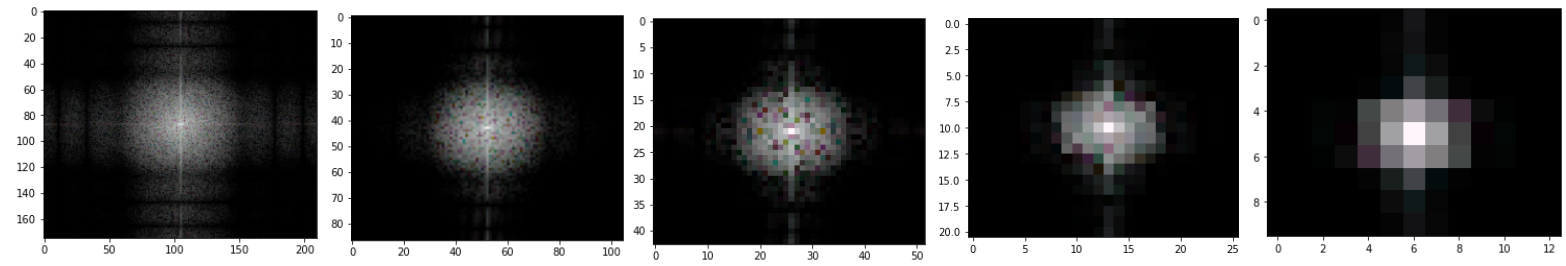


Our Testing data:

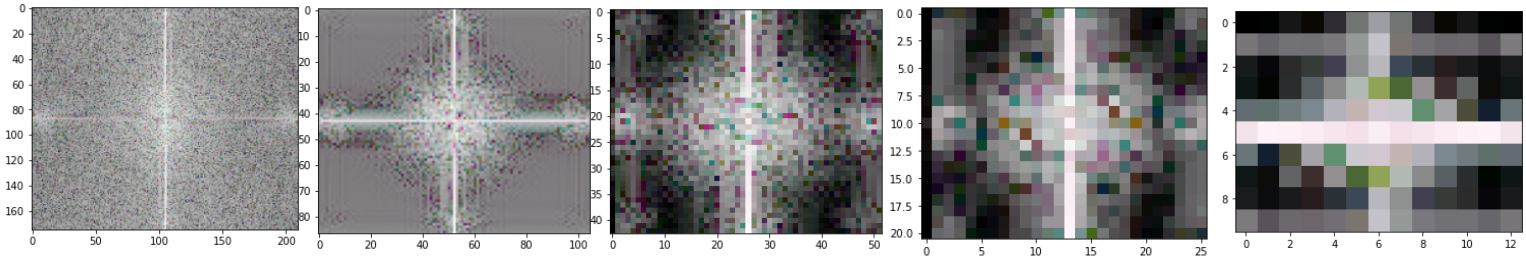
Gaussian pyramid

Laplacian pyramid

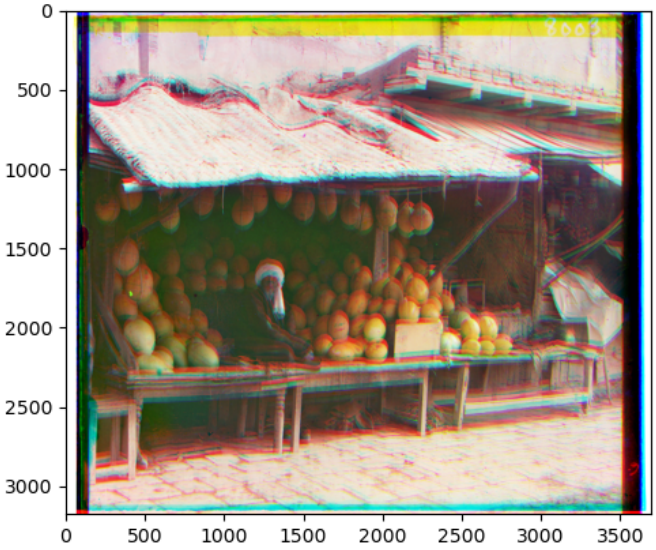
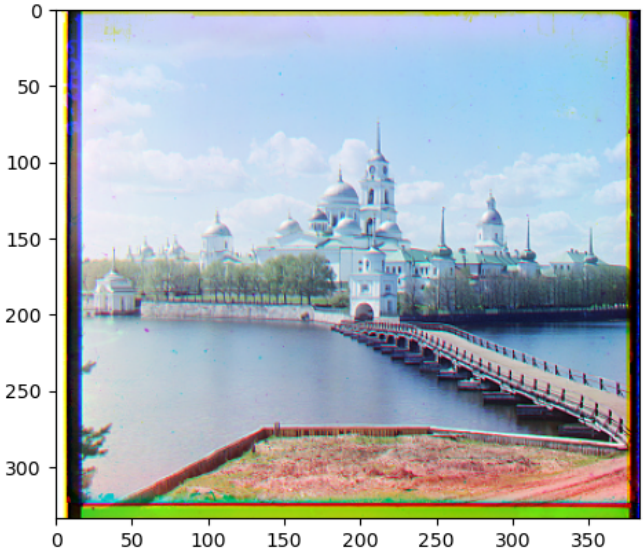
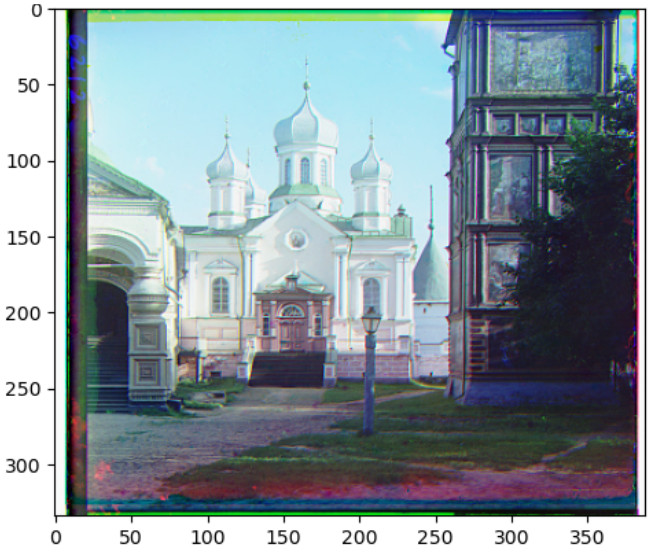
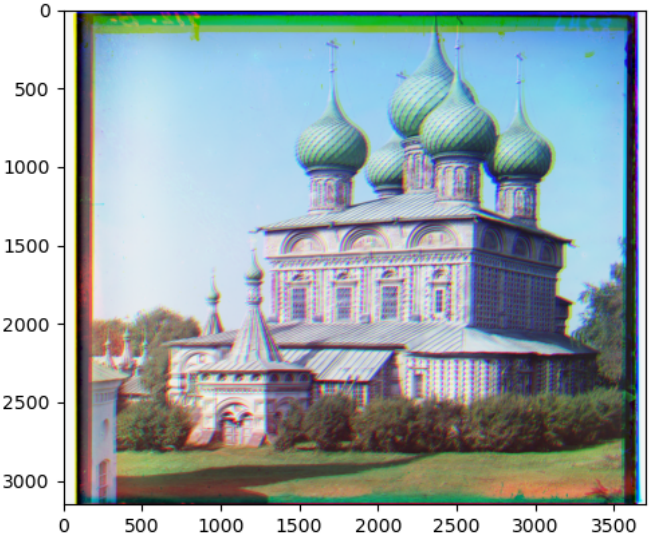
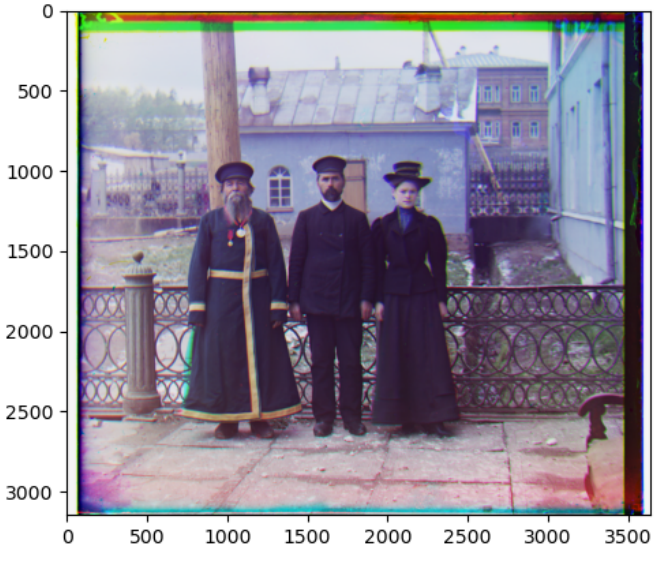
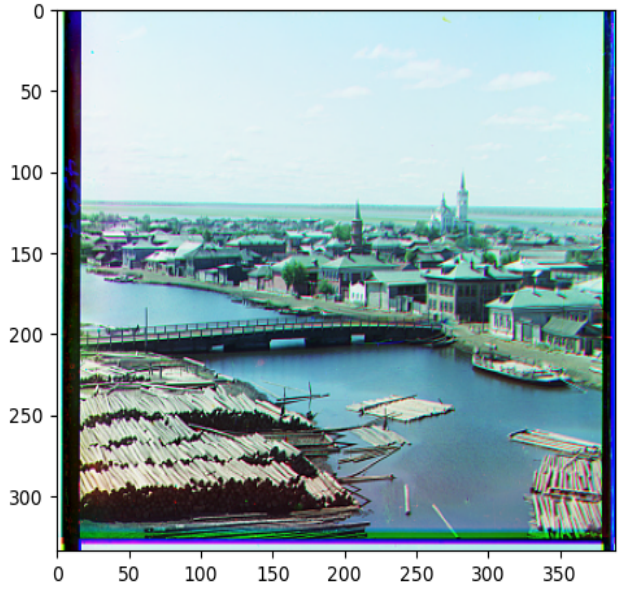
Spectrum of Gaussian pyramid

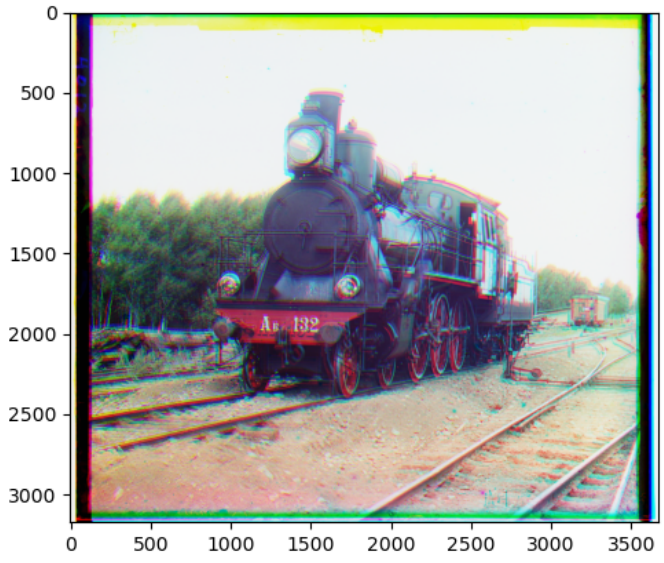


Spectrum of Laplacian pyramid



3) Colorizing the Russian Empire: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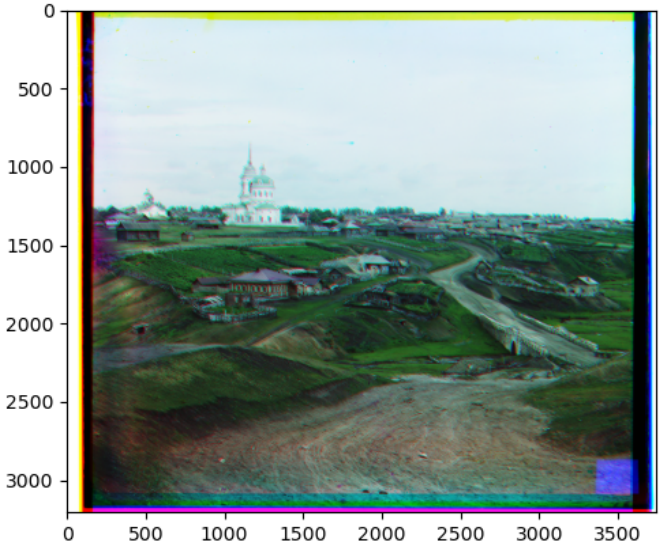
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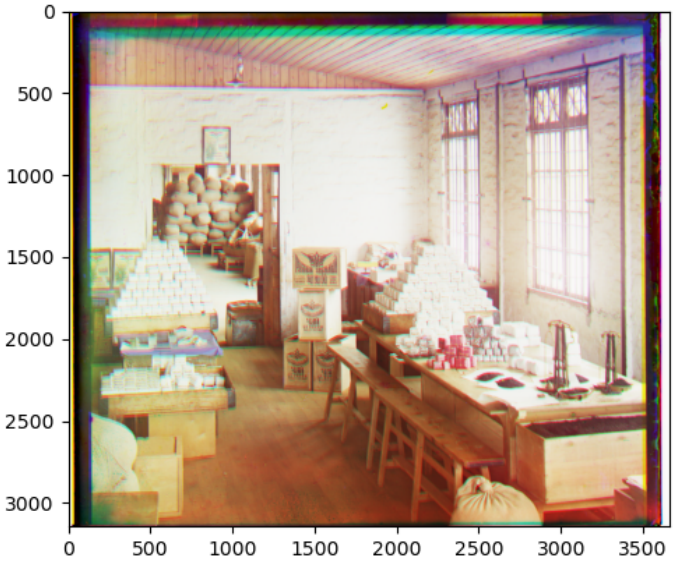
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Discussion:

1.Hybrid Image:

The difficulty of this task is to find a better match cutoff-frequency. A higher cutoff-frequency means less parts of Loss-pass and more parts of High-pass image. However, it's difficult to find the best cutoff-frequency through watching the image by human eye. So, it took time to try different cutoff-frequency to find the best cutoff-frequency that makes the image look good.

2.Image Pyramid:

"Spectrum of Laplacian pyramid" images are too bright with all pixel 0, so we normalize the pixel value to 0~255. After doing normalization, it looks better than before.

3.Colorizing the Russian Empire

The digitized Prokudin-Gorskii glass plate images are white/black border, and we have to decide the best "border clipping ratio" for each image. After trying some different border clipping ratios, the result looks good.

Conclusion:

These three tasks are all related to the frequency of images.

In the Task1 and 2, we found that high-pass filters can extract the features like edges and corners in the image ,and low-pass filters can smooth (or blur) the image which is similar to that we stand far away from the image. The implementation result shows the importance of the distance between observer and object. The far distance which we stand from, the more distinct the part of high frequency is, the more blurry the part of low frequency is. However, to make a good hybrid image is not so easy. Besides using appropriate cutoff-frequency, It is also important that the source images have similar shapes and share a lot of edges so that they blend well.

In the Task3, there are three methods to use: Zero-mean ,SSD and Normalized cross-correlation. Basically, SSD is a great method because it is fast and sensitive. However, according to different conditions, we should choose the others like NCC in order to keep local average intensity and contrast for aligning.

Work assignment plan between team members:

main code: 郭俊廷
data & test result: 曾揚
report: 曾揚, 郭俊廷