HW2 Report

Group17

1. Introduction

   In this homework assignment, there are three tasks we need to do. Below is the brief introduction for these tasks.

   1) Hybrid image : A hybrid image is the sum of a low-pass filtered version of the one image and a high-pass filtered version of a second image. So we implemented two kinds of low and high pass filters (Ideal, Gaussian) to produce hybrid images.

   2) Image pyramid : An image Pyramid is a collection of images at different resolutions. We need to first build Gaussian pyramid, and then easily obtain Laplacian pyramid by Gaussian pyramid. In addition, we also show their corresponding magnitude spectrum.

   3) Colorizing the Russian Empire : The input image is a glass plate image, and there are three images in it, which represents the RGB channels of an image. Therefore, our task is to recover the original colorful image by aligning the G and R channels to B channel.

2. Implementation procedures
   1) Hybrid image :
      Follow the steps introduced in the instructions pdf but little different.
      I. Normalize whole image by dividing 255 to each pixel.
      II. Mulitply the image by $(-1)^{x+y}$ to center the transform.
      III. Compute Fourier transformation to the image, called it F.
      IV. Multiply F by the filter function H.
      V. Compute the inverse Fourier transformation for the result in IV.
      VI. Take the absolute value of result in V. (same as multilply $(-1)^{x+y}$)
      VII. Multiply 255 to restore the image.

      Since we have low pass filter and high pass filter, we can get two images by applying the above steps. Finally, sum these two images up, we can get a hybrid image, and what we seen from this image depends on the distance we see it.

   2) Image pyramid :
      I. Use the Gaussian low pass filter to smooth the original image, and then subsample it. Repeat this step we can thus get the Gaussian pyramid(a collection of images which resolution goes from high to low).
      II. Since Laplacian pyramid represents the difference between two adjacent layers in Gaussian pyramid, we can first upsample the upper layer image in Gaussian pyramid to produce a new image which has

the same size of lower layer image, and then use the lower layer image to subtract from the new image obtained by upsampling. This image is one of images in Laplacian pyramid. Below is the description of how we implement the subsampling and upsampling.

III. Subsampling : Remove the even rows and columns of the input image.

IV. Upsampling : Pad zeros by rows interpolation and columns interpolation to ensure the size of input image to match the target image.

V. Finally, we also represent two pyramids in frequency domain by Fourier transformation, and thus we can show their corresponding magnitude spectrum.

3) Colorizing the Russian Empire :

I. Remove few parts of edges for the image.

II. Get the RGB images from the glass plate image.

III. If the image is tif, subsample RGB images to the size of 1/10 in order to accelerate the next step. Otherwise, it's not need to subsample the input image, because jpg has smaller file size and already blurred by compression procedure.

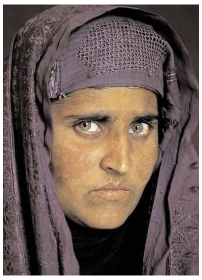
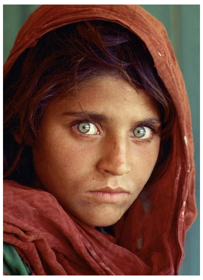
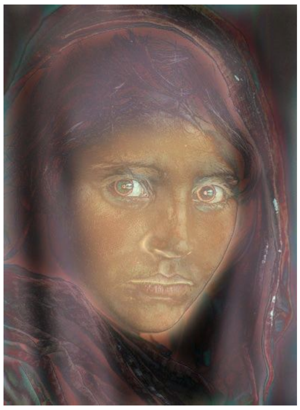
IV. Calculate the offset from the R and G to B by normalized cross correlation.

V. Shift the R and G image to align the B image according to the offset we get in III.

VI. Concate 3 channels to get the colorful image.

3. Experimental results (we should also try our own data)

1) Hybrid image :

Original (L:lowpass,R:highpass)	**Ideal**	**Gaussian**	**Cutoff Ratio**
 			6

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 	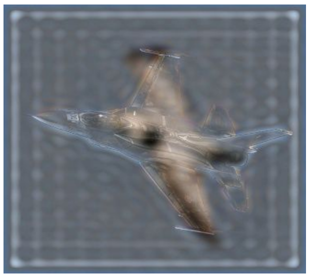		14
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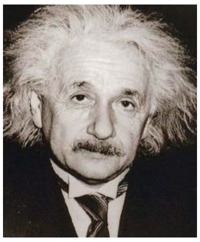
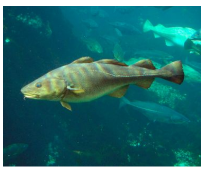
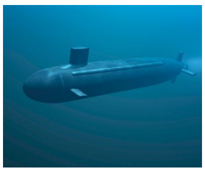
 			10
 			5

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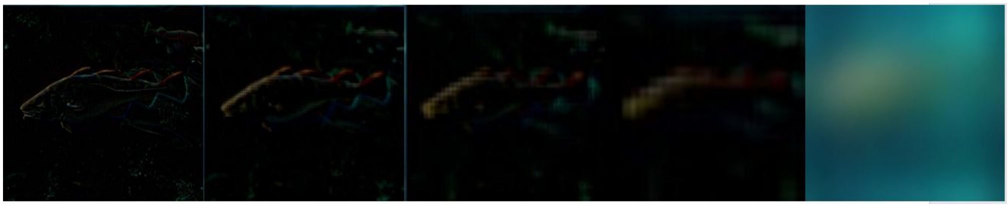
Our test data :

cutoff frequency = 6

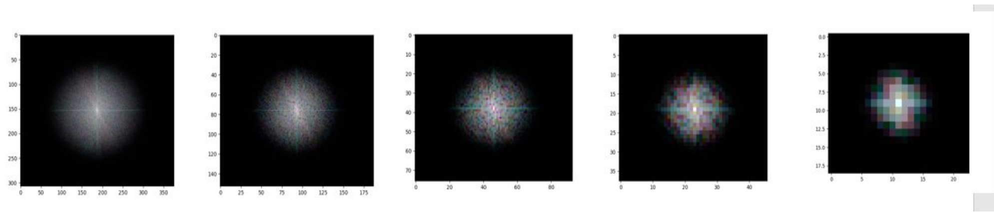
2) Image pyramid :

A. Gaussian pyramid

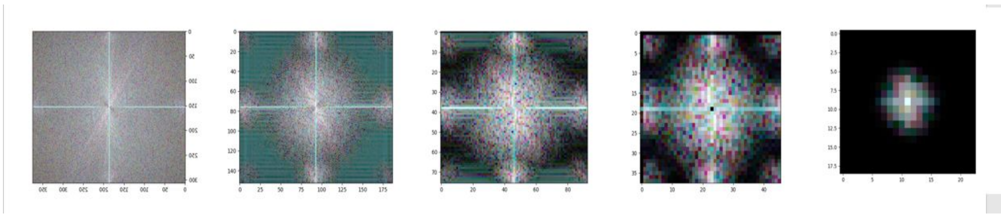
B. Laplacian pyramid



C. Spectrum of Gaussian pyramid

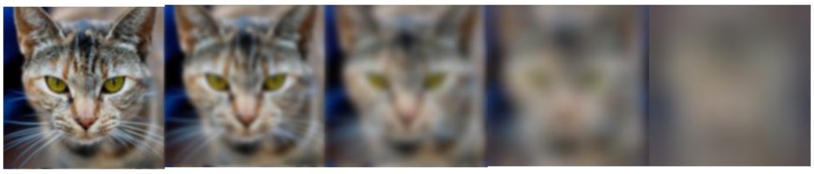


D. Spectrum of Laplacian pyramid



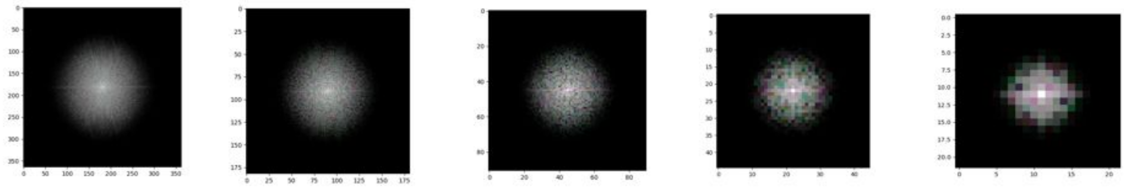
Our test data

A. Gaussian pyramid

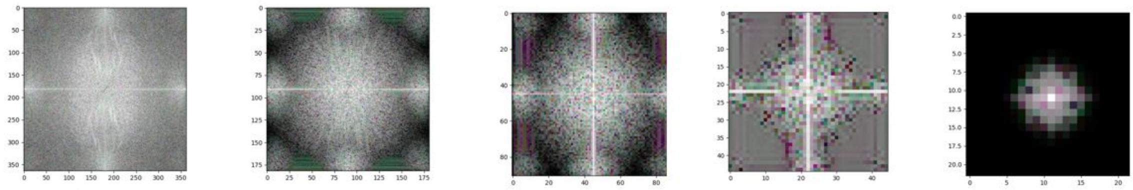


B. Laplacian pyramid

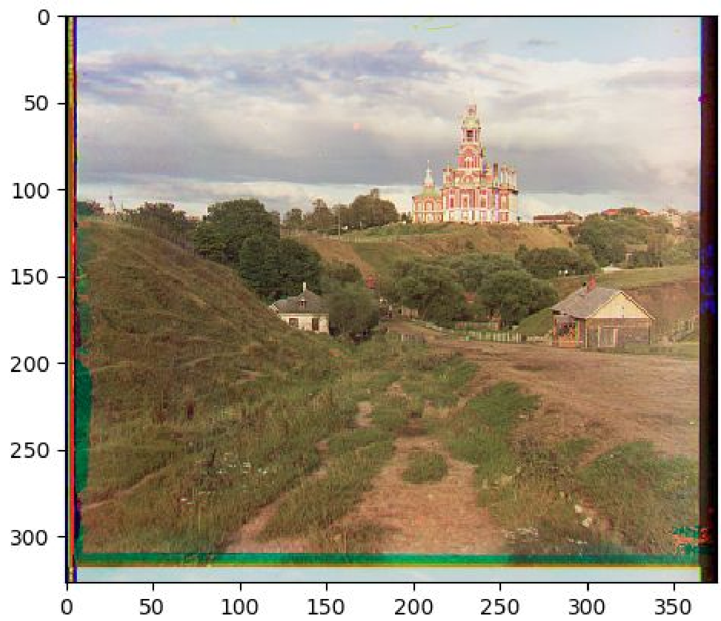
C. Spectrum of Gaussian pyramid

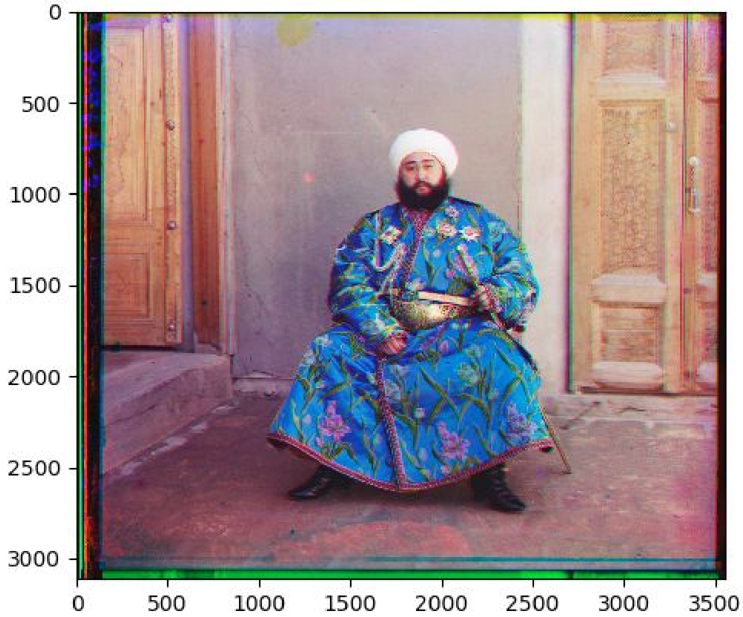


D. Spectrum of Laplacian pyramid



3) Colorizing the Russian Empire :

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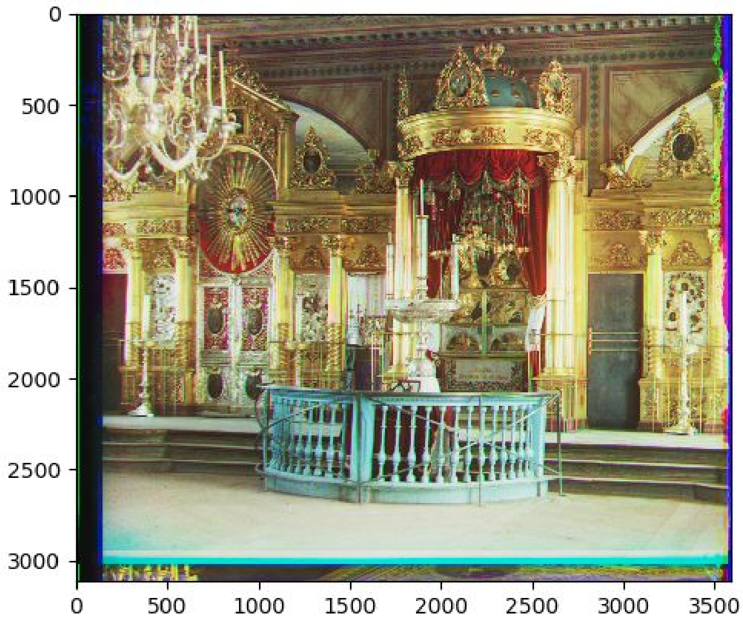
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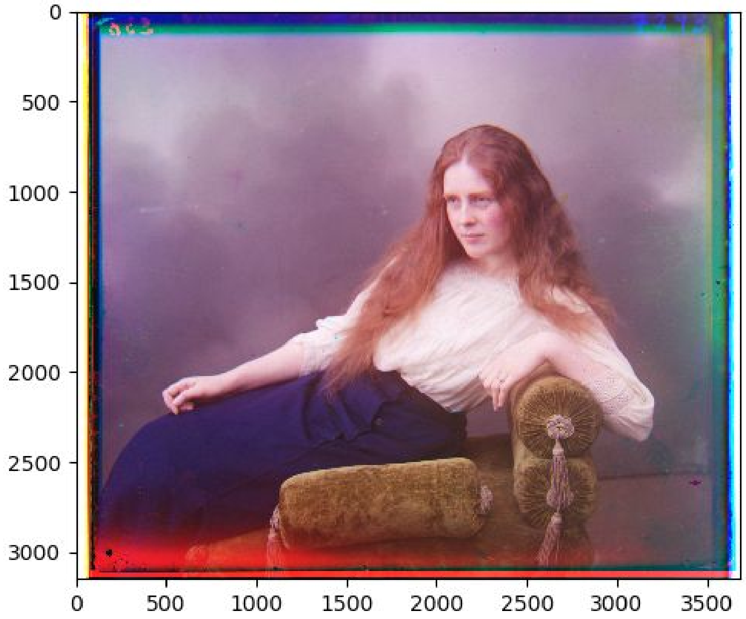
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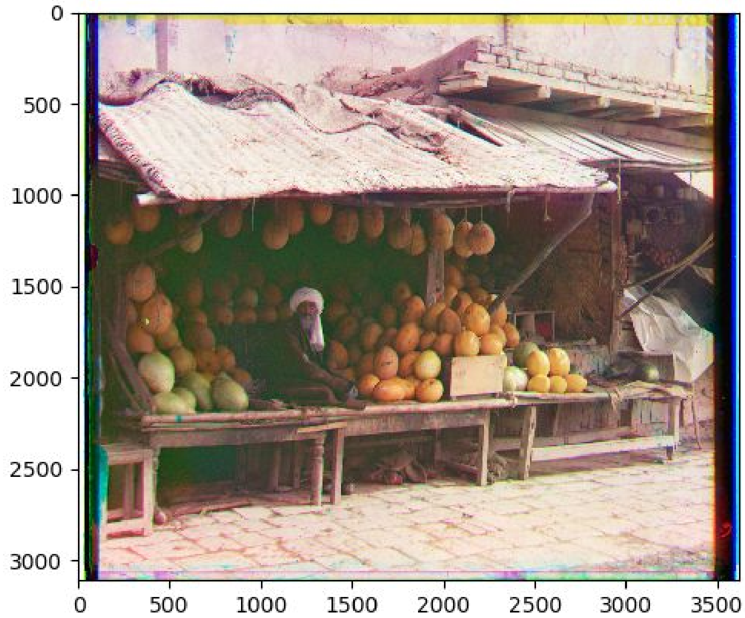
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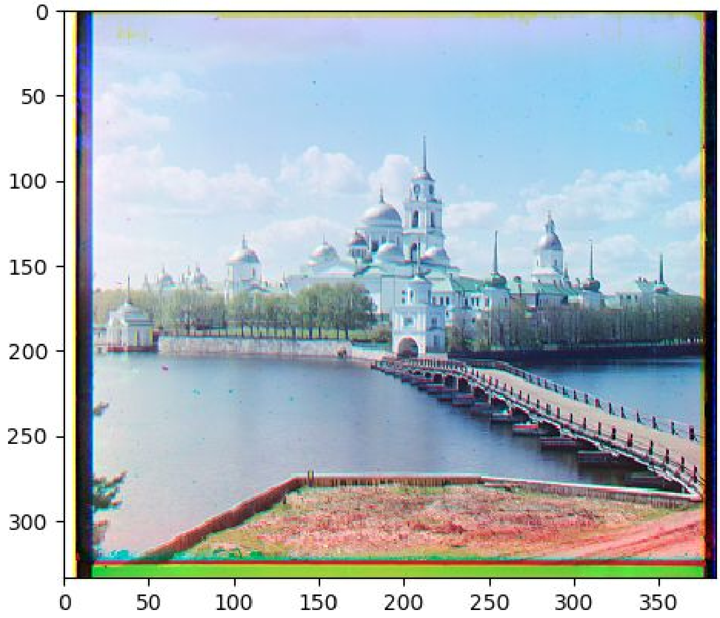
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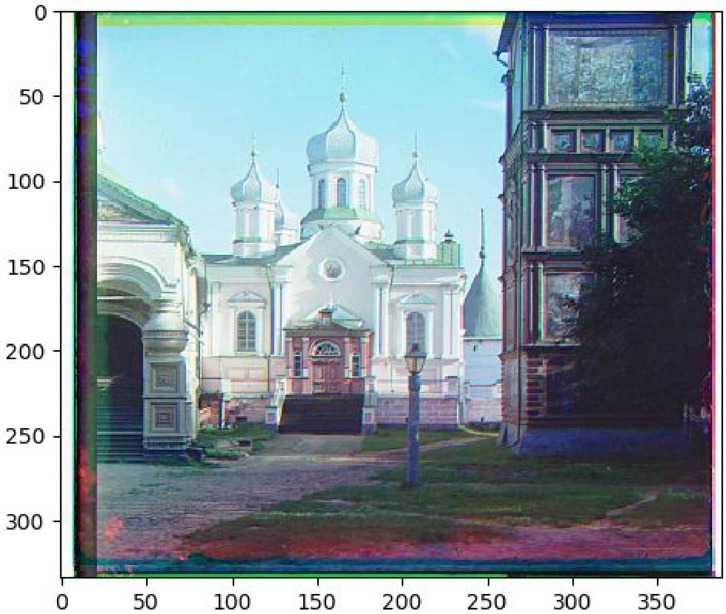
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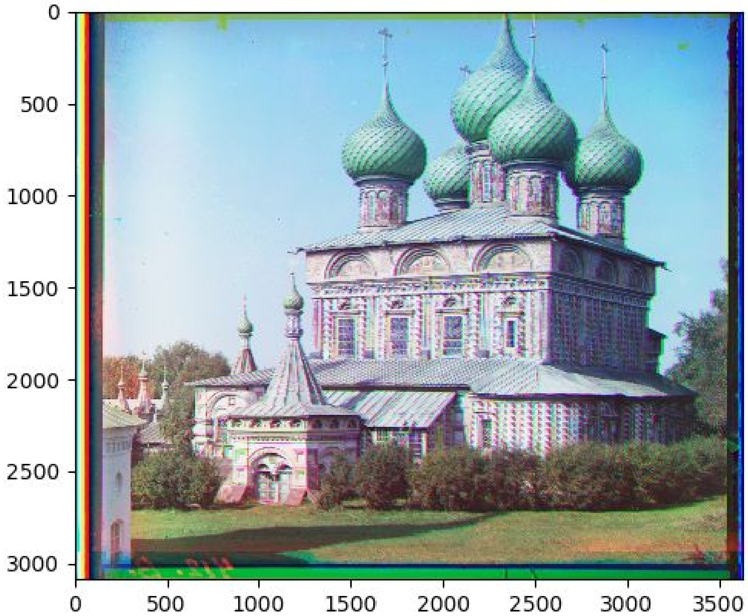
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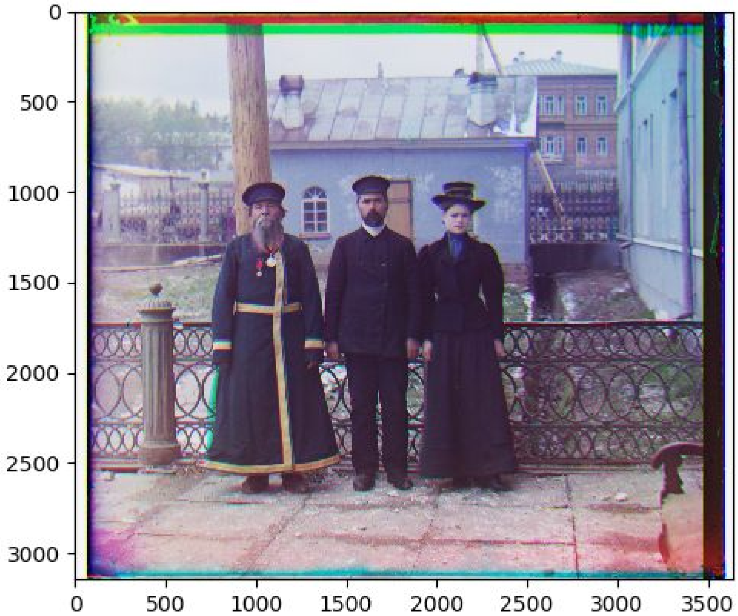
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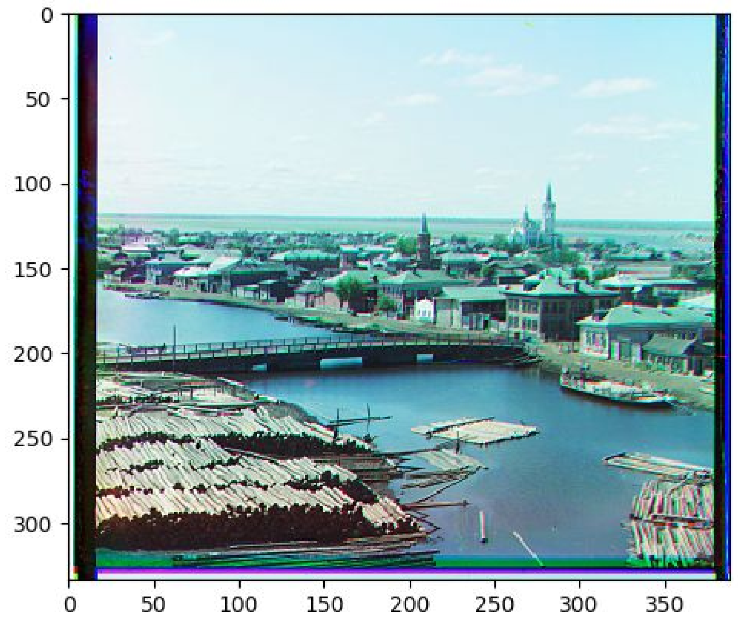
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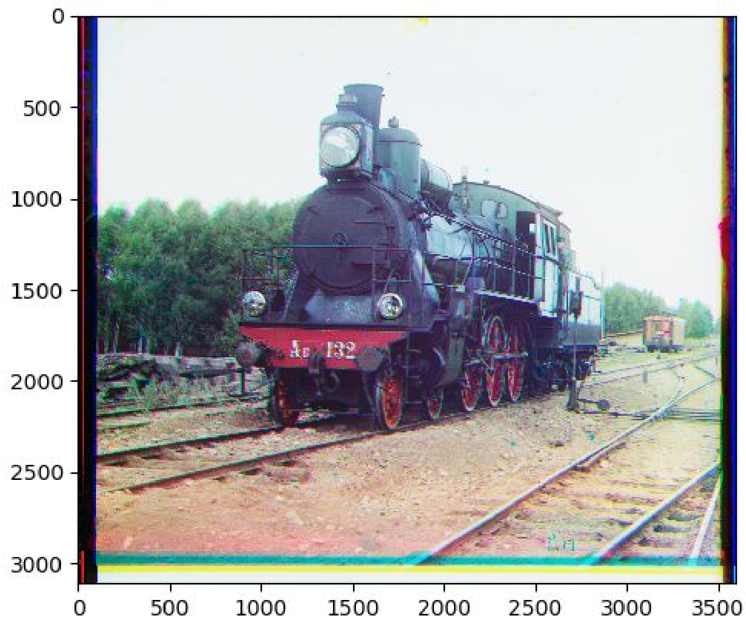
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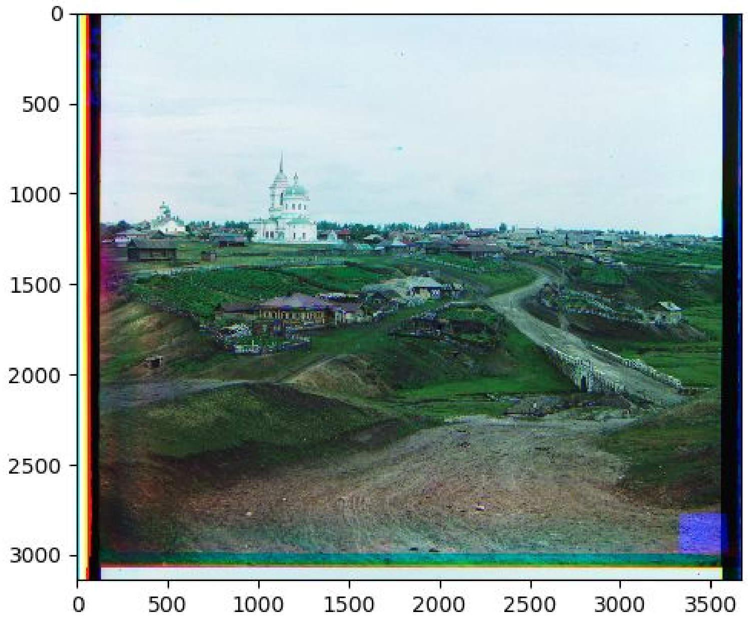

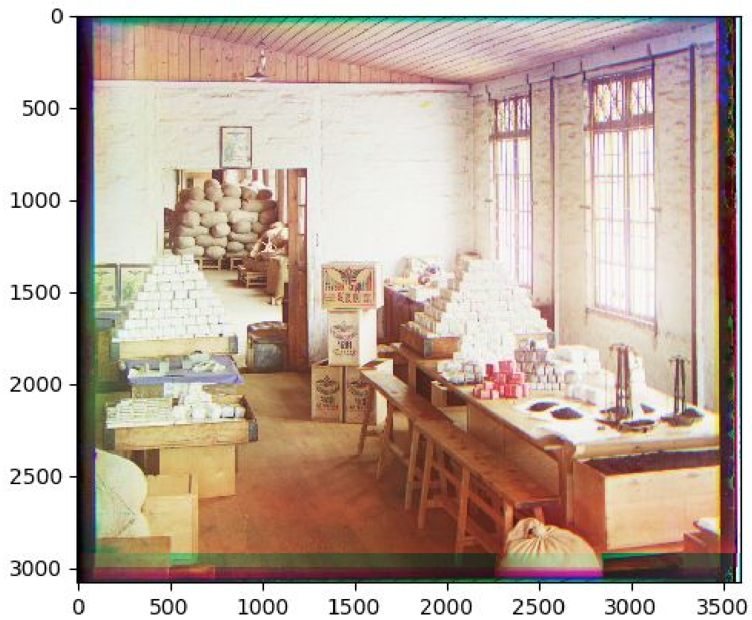

4. Discussion (difficulties and solutions)

   Task1:

   For different input pairs, we need to find their best match cutoff frequency.And it is difficult for human eyes to tell which cutoff frequency is better when the cutoff frequency has little change. Therefore, it takes time to choose the best cutoff frequency.

Task2:

At first,we found that the outputs of “Spectrum of Laplacian pyramid” is too bright,all with pixel value 0, then we found that normalization is one good solution to resolve this problem. After normalized the pixel value to 0~255, outputs then become normal.

Task3:

For bigger size tif input image, it takes lots of time to get our result. We then found that we can reshape the input image before doing the alignment of R,G,B image. If we reshape the input image’s height and weight to 1/10 of the original image, we can speed up 100 faster than before. Meanwhile, their are white/black border in the input image, so we have to decide the best “border clipping ratio” for each input image. However, we have good results in the end.

5. Conclusion

This homework assignment is related to the frequency of images. Below is the summary for three tasks.

1) Fourier transformation can map the image from spatial domain to frequency domain, by multiply the filter function in frequency domain, it can derive the same result as convolution in spatial domain. In addition, the low pass filtering can smooth the image and the high pass filtering can do the edge detection. By these two filters, we can get a tricky image by summing up a low-pass version image and the other high-pass version image. As we mentioned in the implementation procedures, the distance between observer and the image is quite important. If we observe this image close, we can see the image for the high-pass filter, but if we stand far away from this image, we can see the image for the low-pass filter.

2) We learned how to do subsampling and upsampling images from this task. To prevent the occurence of aliasing, before subsampling the image, it’s necessary to filter the image. By subsampling the image, we get the Gaussian pyramid which is the collection of images from high resolution to low resolution. In addition, we can derive Laplacian pyramid from Gaussian pyramid by subtraction and upsampling.

3) In this problem, we show that even the input image is very big, we can first subsampling the image and than find the align of the small image. Finally we can get the x and y translation of the R and B to G quickly, since the image is small, and restore the origin RGB image.

6. Work assignment plan between team members

謝秉瑾 : main code

謝宗祐, 吳承翰 : partial code, report, test data