

Develop a system that combines two images of the same size A, B into a hybrid image C obtained as a sum of a low-pass filtered A image and high-pass filtered B image

$$Output = A * f_{LP} + B * f_{HP}.$$

For better results, image content should be aligned. Please, provide at least two examples of hybrid images assembled by your program. You should experiment with several combinations of filters and parameters to get optimal results.

1. Use Gaussian filtering for both the low pass and high pass filtering operations.
2. Use a combination of Gaussian and Laplacian filtering in the design of these filters. Compare your results with the previous experiment and explain the differences.

The report shows the result of combining two images, one with the low frequency components, and the other image with the high frequency components. The first two experiments show the results of using low-pass and high-pass gaussian filters defined in the two equations. The last two experiments show the results of using low-pass gaussian filter, and Laplacian filter to get the high frequency components.

The Laplacian filter equation shown below is divided by (**5M**) where **M** is the number of rows. This division is found by experiments because once

the results of adding the low and high frequencies, the high frequency image was overtaking, and the low frequency image was suppressed.

$$H(u, v) = e^{-D^2(u, v) / 2D_0^2}$$

*Equation 1: Gaussian Low Pass Filter*

$$H(u, v) = 1 - e^{-D^2(u, v) / 2D_0^2}$$

*Equation 2: Gaussian High Pass Filter*

$$H(u, v) = - \left[ (u - M / 2)^2 + (v - N / 2)^2 \right]$$

*Equation 3: Laplacian Filter*

# Experiment 1

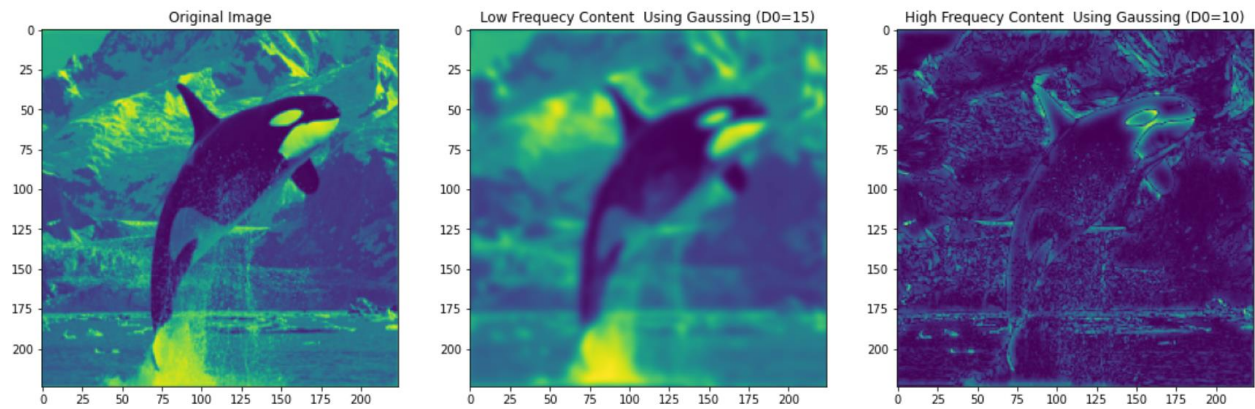


Figure 1

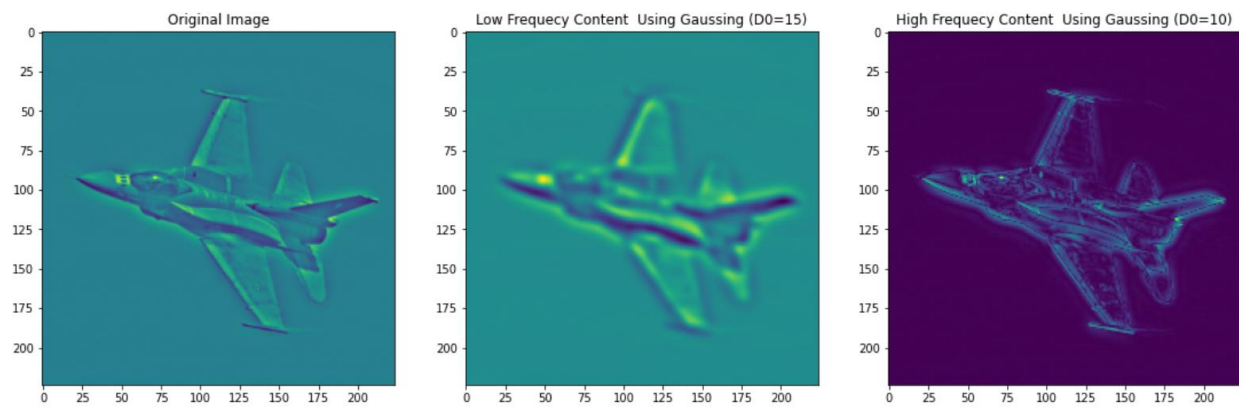


Figure 2

Hybrid Image, Experiment 1, Both Filters are Gaussian

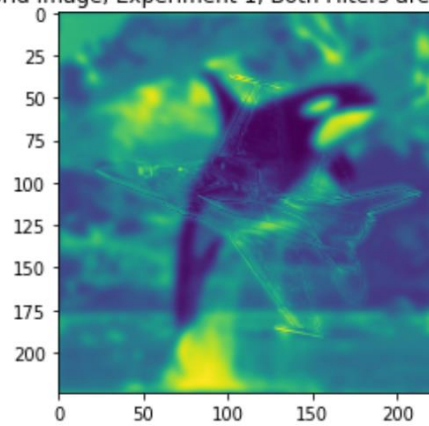


Figure 3

## Experiment 2

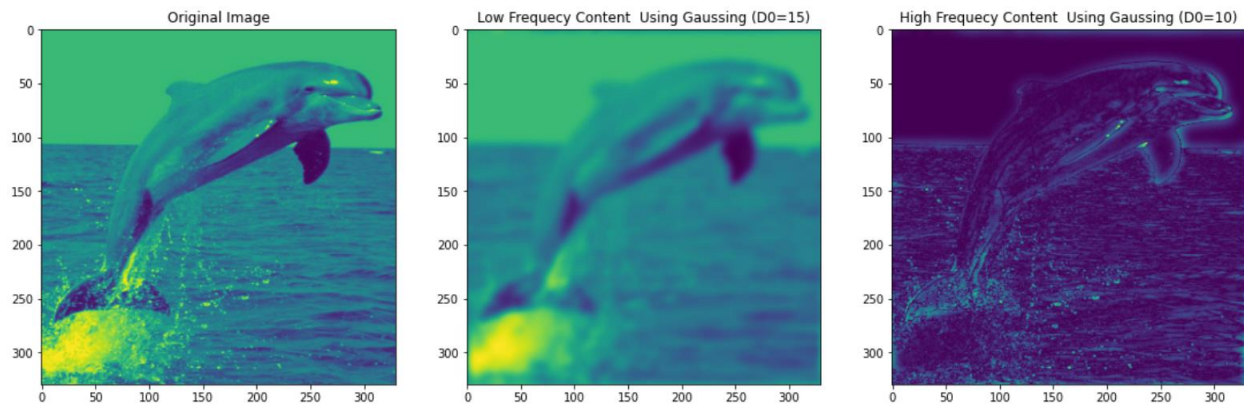


Figure 4

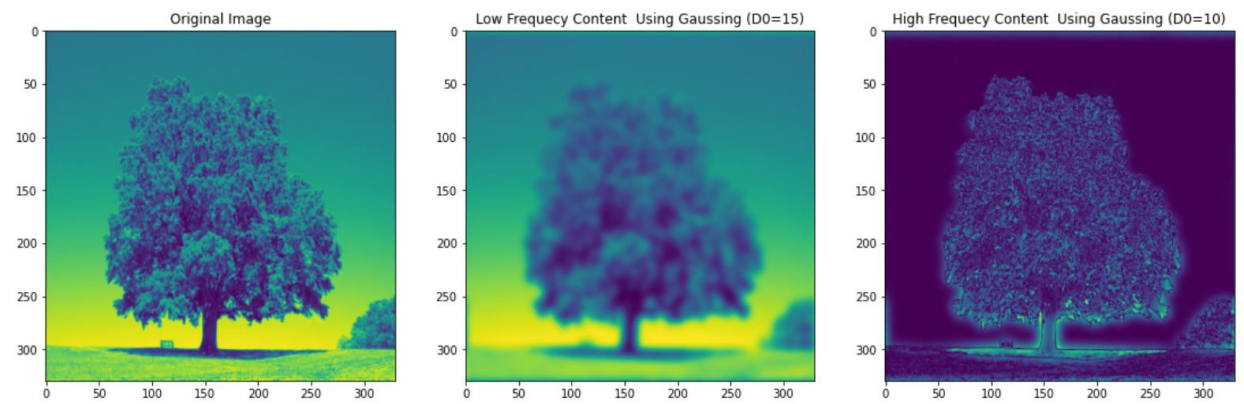


Figure 5

### Hybrid Image, Experiment 2, Both Filters are Gaussian

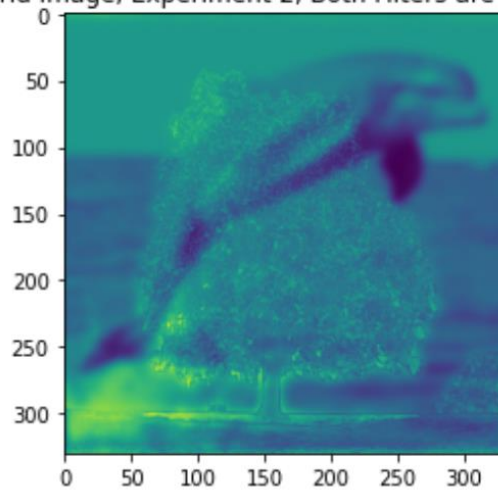


Figure 6

## Experiment 3

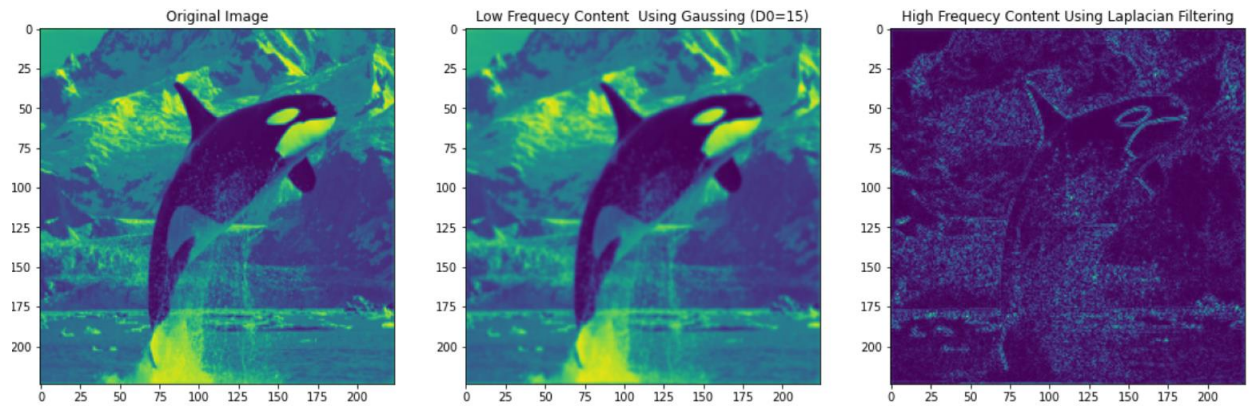


Figure 7

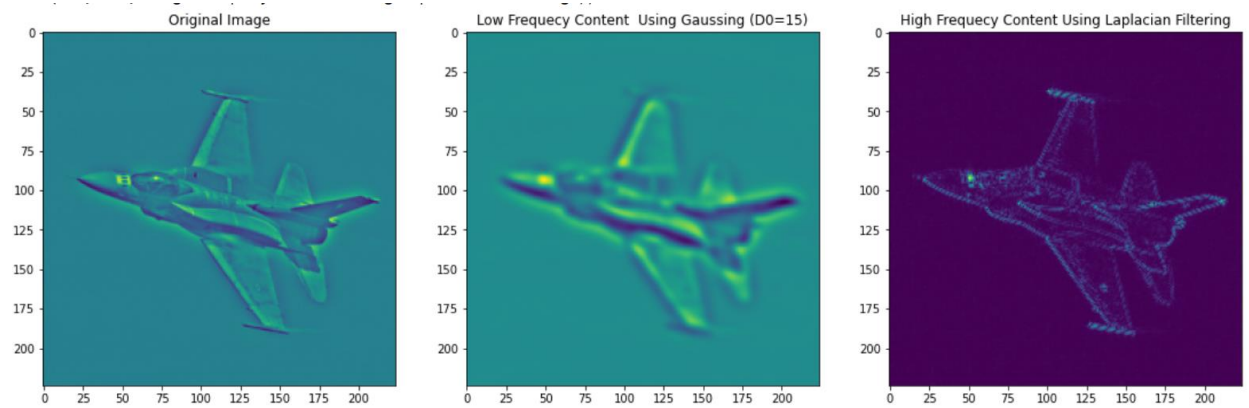


Figure 8

Hybrid Image, Experiment 3, One Filter is Gaussian, other Laplacian

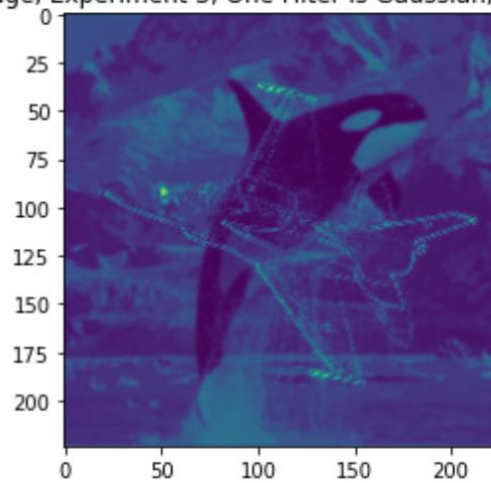


Figure 9



## Experiment 4

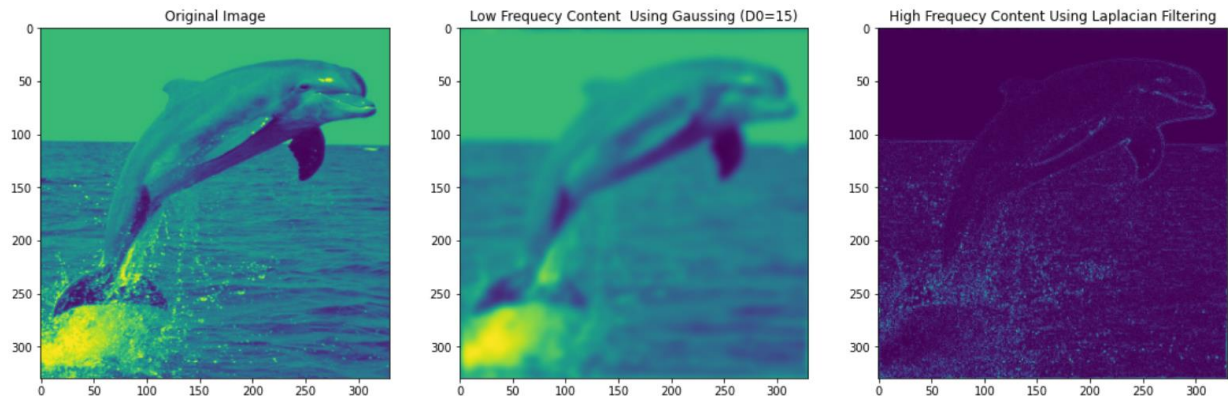


Figure 10

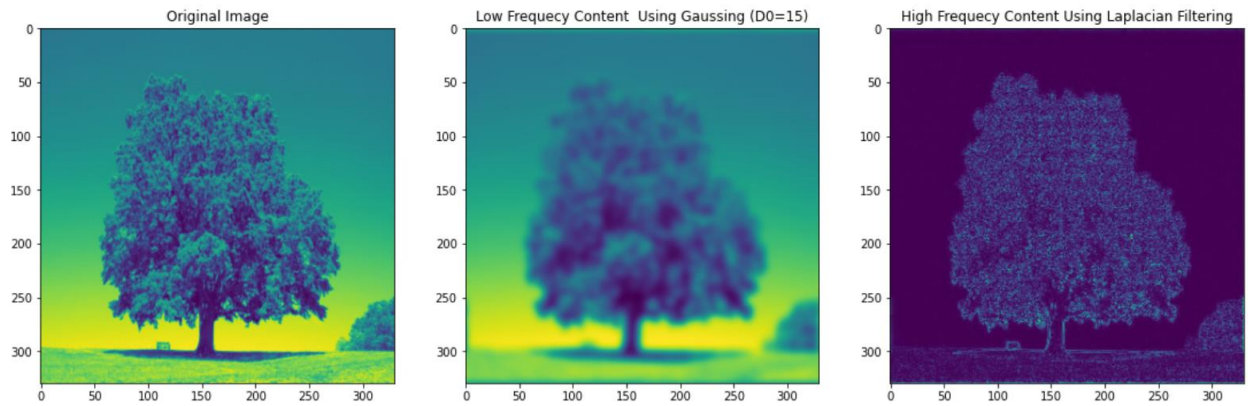


Figure 11

Hybrid Image, Experiment 4, One Filter is Gaussian, other Laplacian

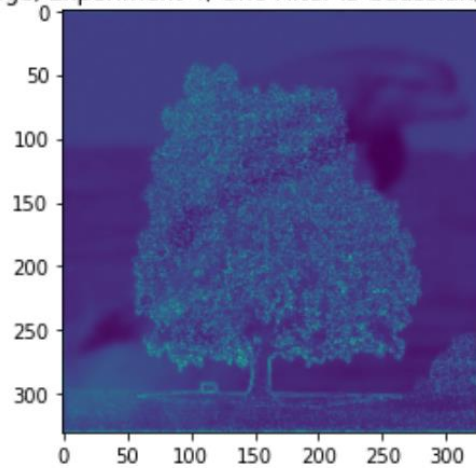


Figure 12

## Comparison between the Gaussian High-Pass Filter, and the Laplacian Filter.

The Laplacian filter seems better in filtering Low Frequency Content of the image as shown in Figure 13. But the Laplacian filter is stronger in a sense that it affect the overall image. Figure 14 shows the difference in output images, the image filtered with Laplacian filter has more presence from the high-frequency components as can be noticed from the change of the background color.

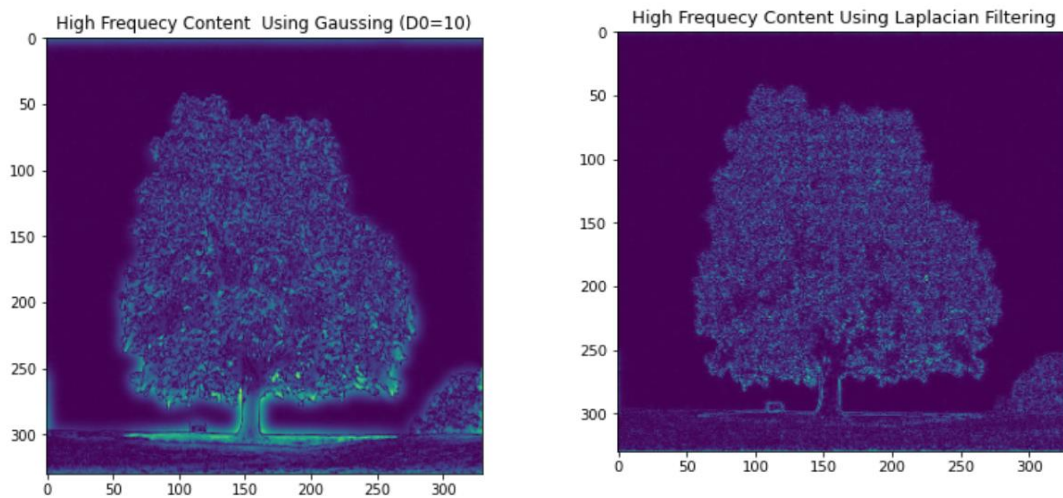


Figure 13

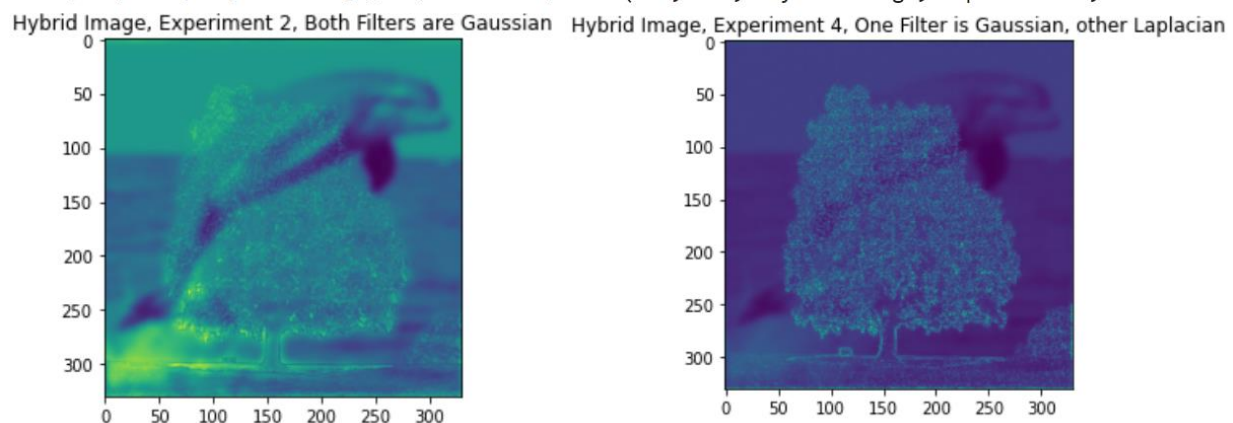


Figure 14