PROJECT 1

IMAGE FILTERING AND HYBRID IMAGE

ABSTRACT

Image filtering and processing is considered the first step in any computer vision project. In this project, different types of filters are tested on different images, and then applied in a real-world project. This project is combing two different images in one hybrid image.

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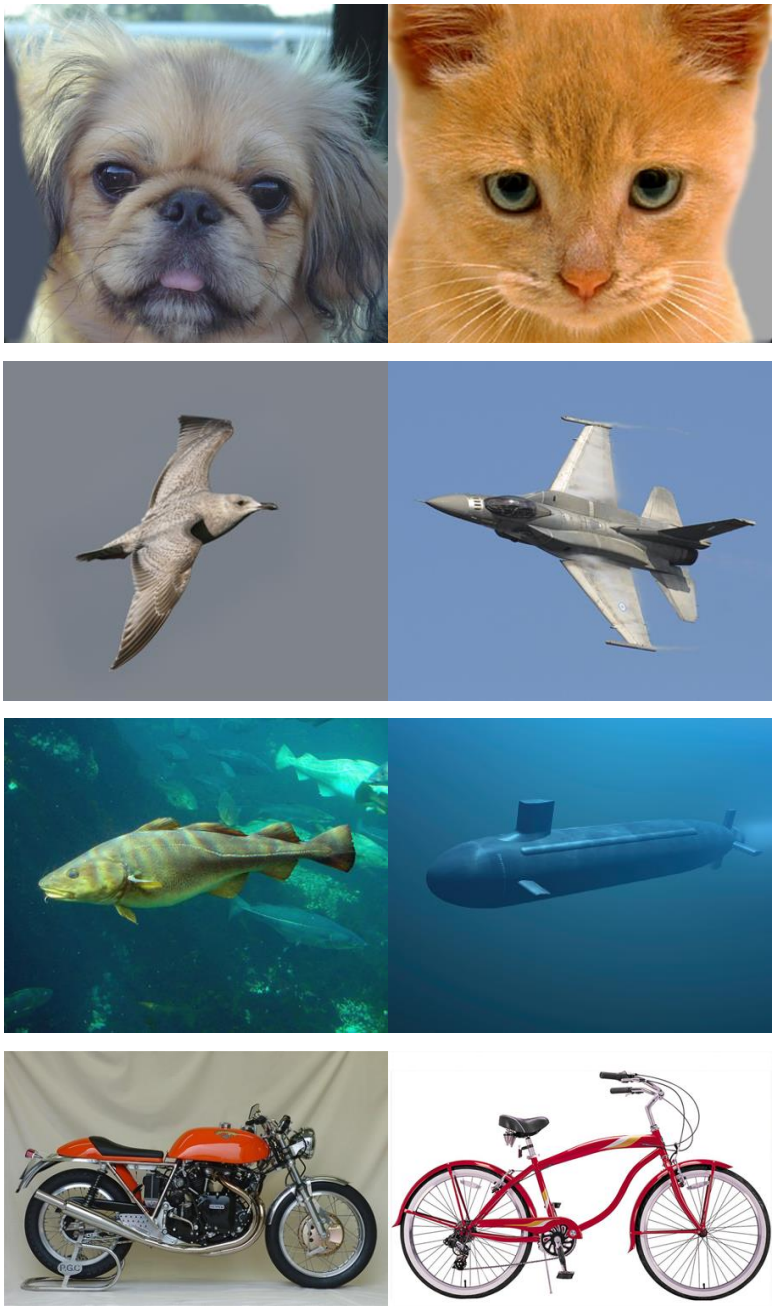
CIE552 – Computer Vision

Contents

1. Dataset

The dataset is simply 8 images that can be considered as 4 pairs of images as following:

1. Dog and Cat
2. Motorcycle and Bicycle
3. Plane and Bird
4. Fish and Submarine



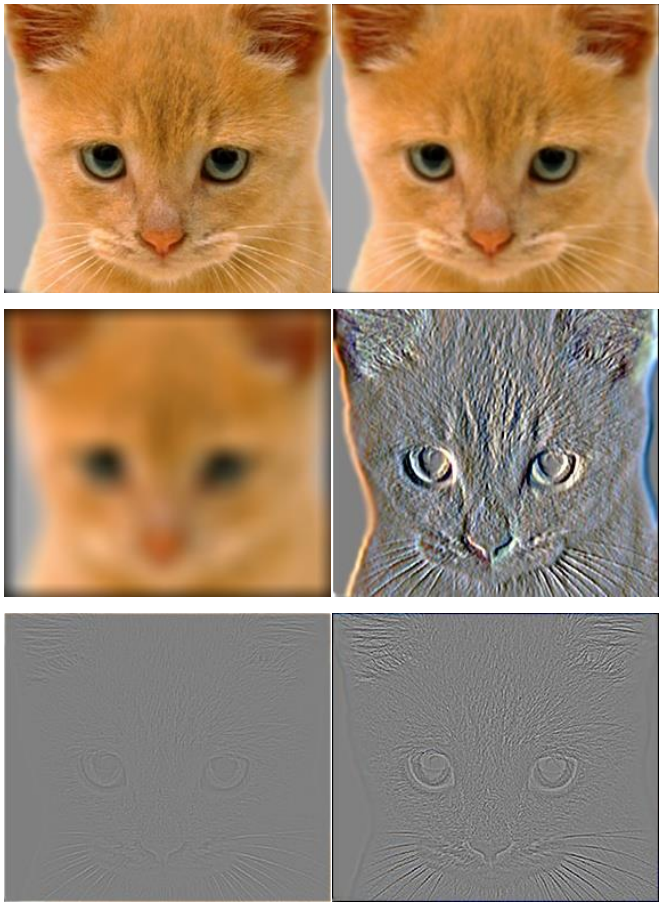
2. Image Filtering

1. Filters used

There are 5 different filters used in this part as following:

1. Identity filter: which basically output the same image.
2. Small blur filter: which removes the high frequency components from the image.
3. Large blur filter: which does the same as small blur filter but more aggressively.
4. Sobel filter: which is meanly used for edge detection.
5. Laplacian filter and high pass filter: which does the opposite function of the blur filter as it passes the high frequencies.

The output of each filter on the cat image is as following:



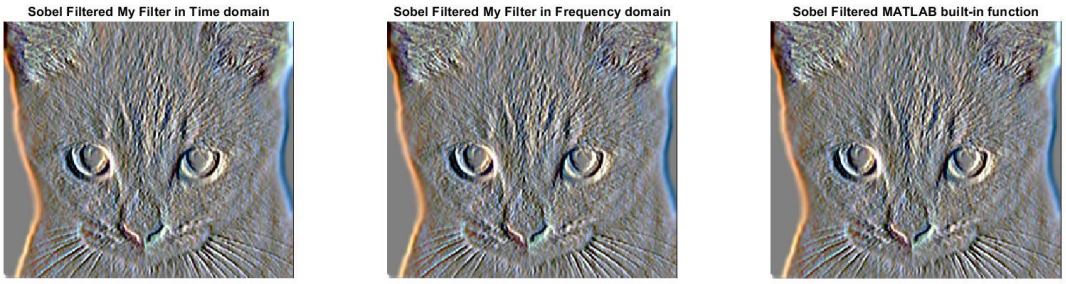
2. Algorithm

1. Get the dimensions of the filter and the image.
2. If the reminder of the rows or the columns with 2 is equal to zero, throw an error.
3. Pad the image using *padarray* function with the size equal to the ceil of both the number of rows/2 and the number of columns/2, in both directions.
4. Assign the last index of both the rows and the columns to be the number of rows of the filter – 1 “row_index_end” and the number of columns – 1 “column_index_end”.
5. convolution_row_index = 1, and the same with columns.
6. For rows = 1: number of rows in the image
    1. For columns = 1: number of columns in the image
        1. Make a small image that will be convoluted which has boundaries equal from the number of the current row to number of the current row + last_index_rows, the same with columns, and for all channels (either gray or color image are supported).
        2. For each channel
            1. Compute the convoluted image (the output) by using the index of the rows as the convolution_row_index, the same with columns, and loop over the channel.
            2. The output should be computed by getting the sum both times (in rows and columns) of the element wise multiplication between the small image and the filter.
    2. Restart the convolution_column_index to be 1.
    3. Increment the convolution_row_index by 1.

7. The output of this nested loop should be the convoluted image.

3. FFT vs time vs built-in

The following plot compares the output of the built-in MATLAB function with the implemented time-based function and with the FFT-based function (bonus).



It is pretty clear that the output is exactly the same.

3. Hybrid Image

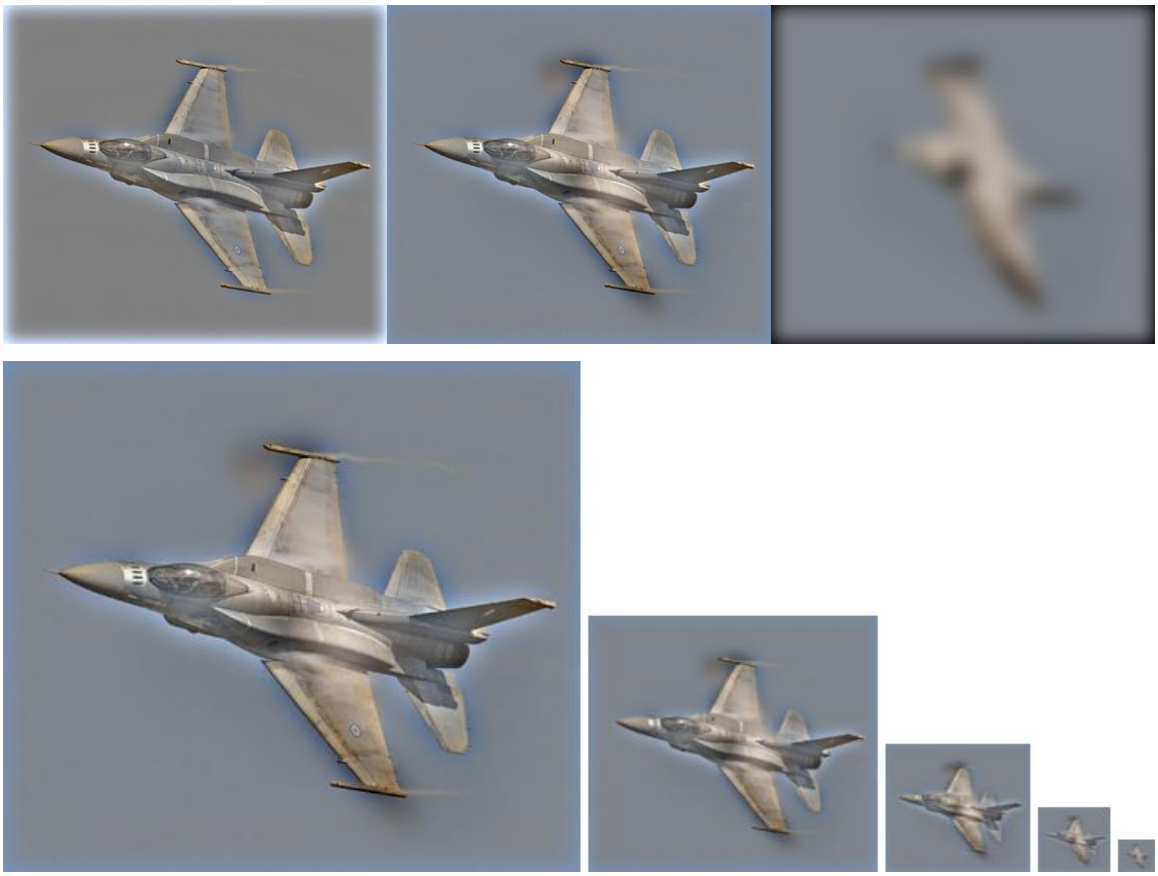
1. Results

Hybrid images can be constructed by using 2 images with respectable shapes and using a low pass filter on one image and a high pass image on the other one.

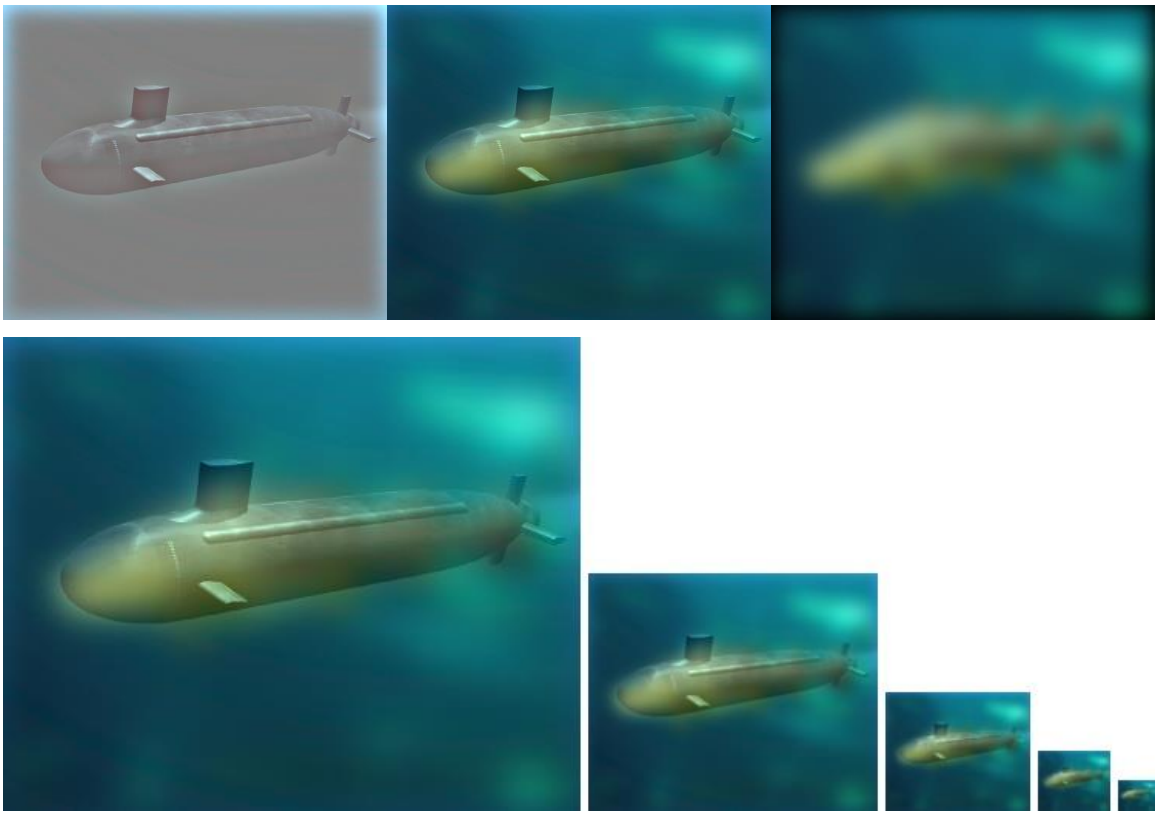
The four pairs are constructed as following:

1. Cat-Dog pair:

2. Bird-Plane pair



3. Fish-Submarine pair



4. Motorcycle-bicycle pair

2. Algorithm

1. Use the large blur filter on the first image to get the low frequencies of the first image.
2. Use the large blur filter on the second image and subtract it from the second image to get the high frequencies.
3. Add the two processed images together to get the hybrid image.