BBM 415
ASSIGNMENT-2 REPORT

Using Image Pyramid for Image Blending

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1. Introduction

a. Overview of Image Blending

Image blending is a pivotal technique in image processing, integral to creating visually compelling compositions. Its primary objective is to seamlessly combine multiple images or regions within a single image, ensuring natural transitions and harmonious integration.

The essence of successful image blending lies in the creation of cohesive and realistic compositions without apparent boundaries or visible artifacts. Achieving this seamless integration involves merging distinct images or regions, and managing their colors, tones, and textures to produce a unified, visually appealing output.

Methods like Laplacian pyramids provide a structured approach to achieving this seamless blending by decomposing images into multi-resolution representations and enabling controlled merging at different levels of detail.

b. Objective

The objective of this assignment is to leverage the Laplacian pyramid technique as an effective method for seamlessly blending images. Laplacian pyramids offer a structured approach to image blending by decomposing images into multi-scale representations, facilitating the creation of smooth and natural transitions between different image regions.

The primary aim is to implement an algorithmic approach that utilizes Laplacian pyramids to achieve seamless blending of images or masked image regions. By following a systematic process involving the construction of Laplacian pyramids for each input image and generating Gaussian pyramids for corresponding mask regions, the goal is to seamlessly merge these components at different pyramid levels.

<u>Seamless Transition</u>

Implementing a method that ensures smooth transitions between distinct image regions, reducing visible artifacts or discontinuities in the blended output.

Demonstration of Laplacian Pyramid Technique

Showcasing the efficacy of Laplacian pyramids in handling image blending tasks by effectively merging images or masked regions at multiple levels of detail.

Parameter Exploration

Experimenting with varying numbers of pyramid levels to evaluate their impact on the quality of the blended output. This exploration aims to determine the optimal number of levels for achieving seamless blending while maintaining computational efficiency.

Evaluation and Analysis

Assessing the performance of the implemented algorithm on different image types and discussing any encountered challenges or limitations.

Ultimately, the objective is to demonstrate the capability of Laplacian pyramids as a powerful tool for image blending, showcasing their ability to create visually appealing compositions with imperceptible seams.

2. Methodology

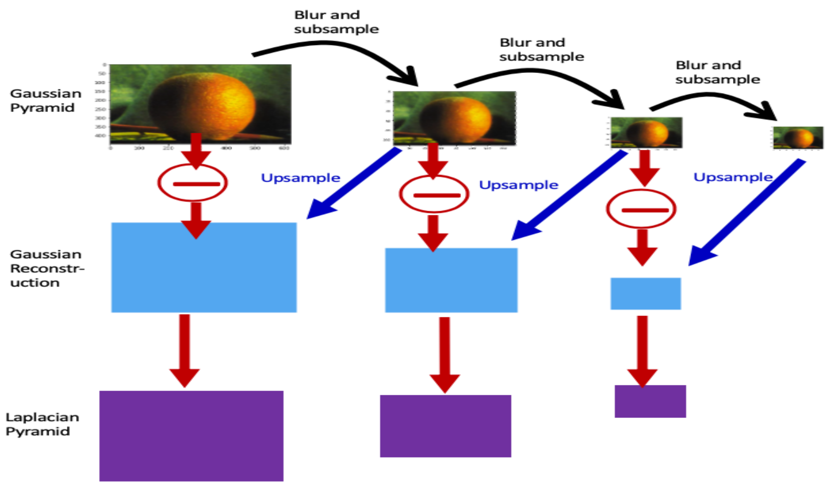
a. Data Collection

I divided the images I will use in this project into two different categories. While the first part contains image pairs, the second part contains only images to be used alone. In the first part, an object is selected from one of the image pairs and this selected object is added to the desired region of the other image. So I paid attention to color and scale similarities in these pairs of images to get better results. In the second part, since the selected object and the place where this object will be moved are in the same picture, I tried to choose images that would not look strange when there were two of the same object. Additionally, I included this image among my sample images to get results close to the Monolisa Table given as an example in the pdf where the assignment is explained.

b. Understanding Laplacian Pyramids

Laplacian pyramids are a multi-scale representation technique used in image processing and computer vision. They provide a hierarchical decomposition of an image into a series of levels or layers, each capturing different levels of detail. The pyramid structure resembles a stack of images, with each level representing a different scale of the original image.

The construction of a Laplacian pyramid involves two main steps: image Gaussian smoothing and subsequent downsampling, followed by the computation of the difference between the original image and the upsampled version of its smoothed counterpart. This process generates a series of images, each emphasizing different levels of detail, from coarse features in the lower levels to fine details in the higher levels.



Key Components of Laplacian Pyramids:

Gaussian Pyramid: Initially, the original image is repeatedly smoothed and downsampled to create a series of images at different scales, forming the Gaussian pyramid. Each level of the Gaussian pyramid represents a progressively downsampled and blurred version of the original image.

Laplacian Representation: The Laplacian pyramid is derived by taking the difference between each level of the Gaussian pyramid and an upsampled version of its smoothed counterpart from the previous level. This process results in a set of images capturing the residual details or high-frequency components at each scale.

c. Algorithm Overview

Masking and Alignment

Accurate selection and alignment of regions ensure precise blending, minimizing discontinuities and artifacts between different portions of the image.

Pyramid Generation

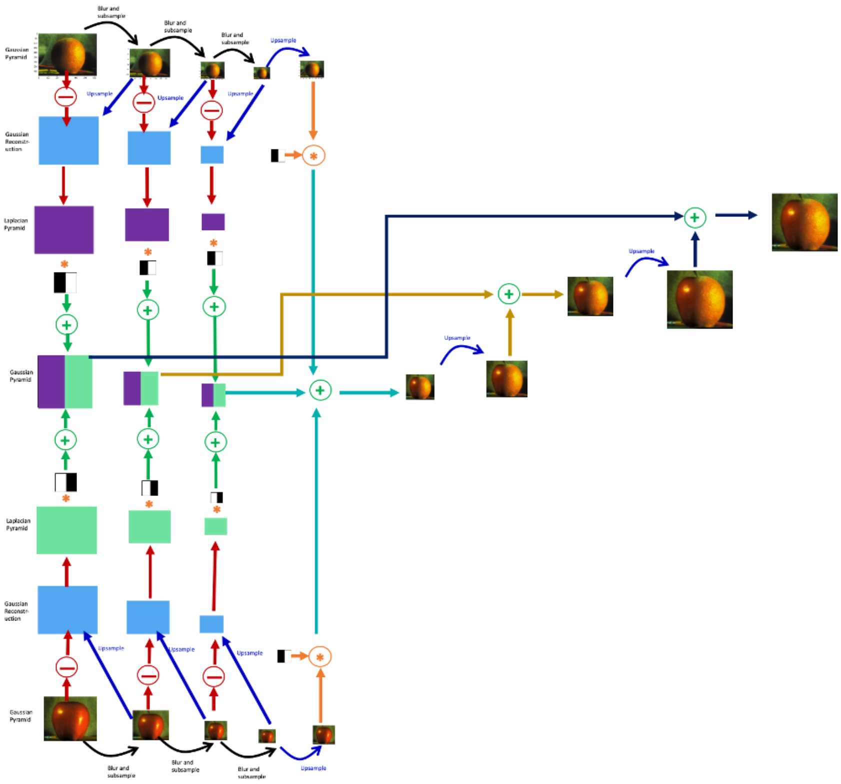
Creating Gaussian and Laplacian pyramids allows for multi-scale representation, preserving details at different levels. This preservation of detail facilitates controlled blending at various scales, contributing to smooth transitions and natural-looking merges.

Pyramid Blending with Mask

Utilizing the mask during pyramid blending ensures that the blending process is guided by the defined regions, enabling a controlled and seamless merge between images or regions based on the mask's influence.

Reconstruction for Final Image

The reconstruction step reintegrates the blended pyramid levels into a single image, ensuring a cohesive and visually consistent output by combining details from different scales in a seamless manner.



3. Results and Analysis

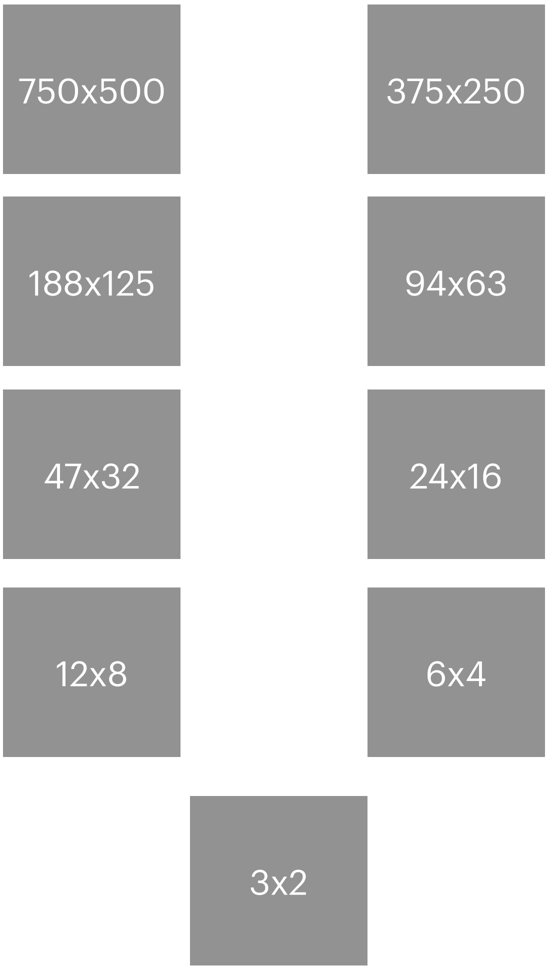
You can find the images you see side by side below in the Google Drive link I sent as files. I recommend you use it to examine it in more detail. Please review the images from the files.

a. Illustration of Key Steps

In this section of the report, I will show all the outputs for all steps in the algorithm of one of the images I used in my project. I used the images I named "sky" to show the details of the steps in the report.

I normalized the pixel values to the [0, 255] range so that we can see the images more clearly

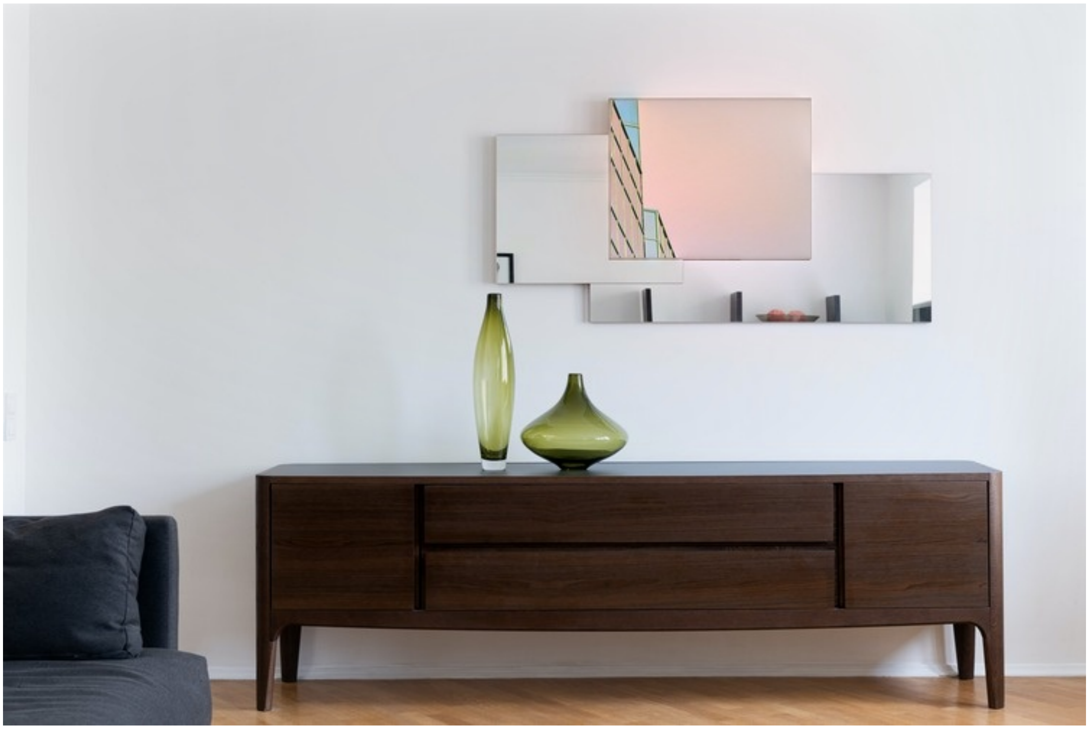
The images below start from 750x500 size and continue by halving the width and length until 3x2, as I showed an example below. To make the difference more visible, I equalized the sizes of all images in the report.



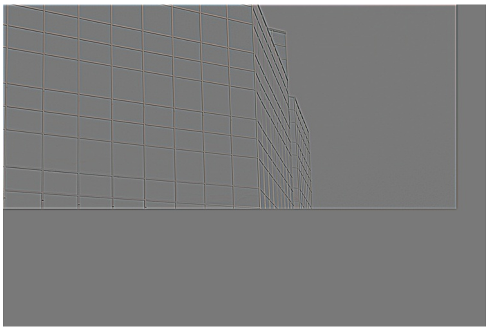
Original Images

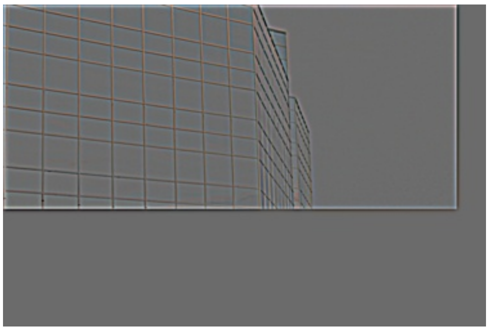
 

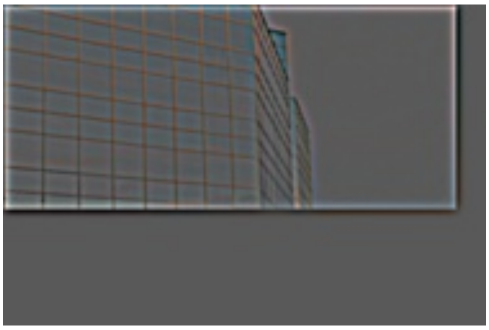
Result Image

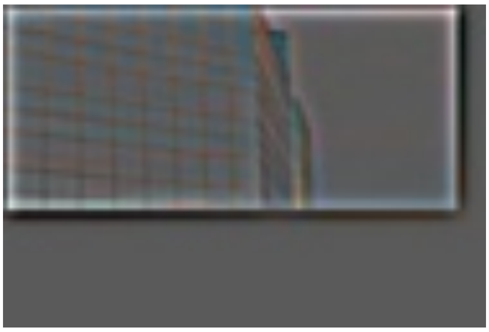


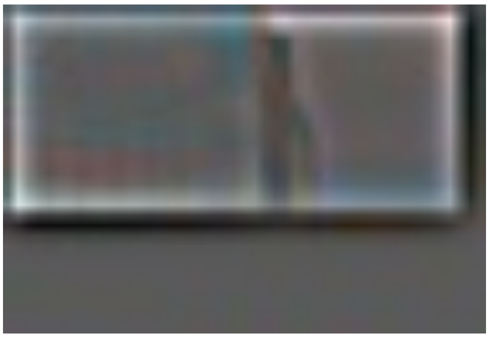
<u>Laplacian Pyramid Levels for the First Image in which I used the Object</u>

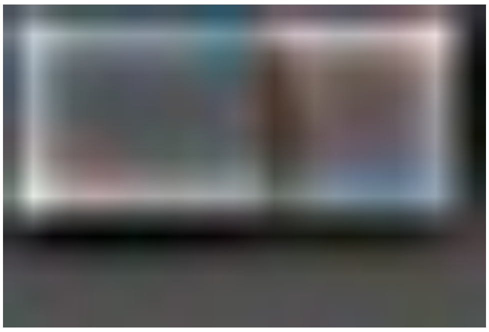






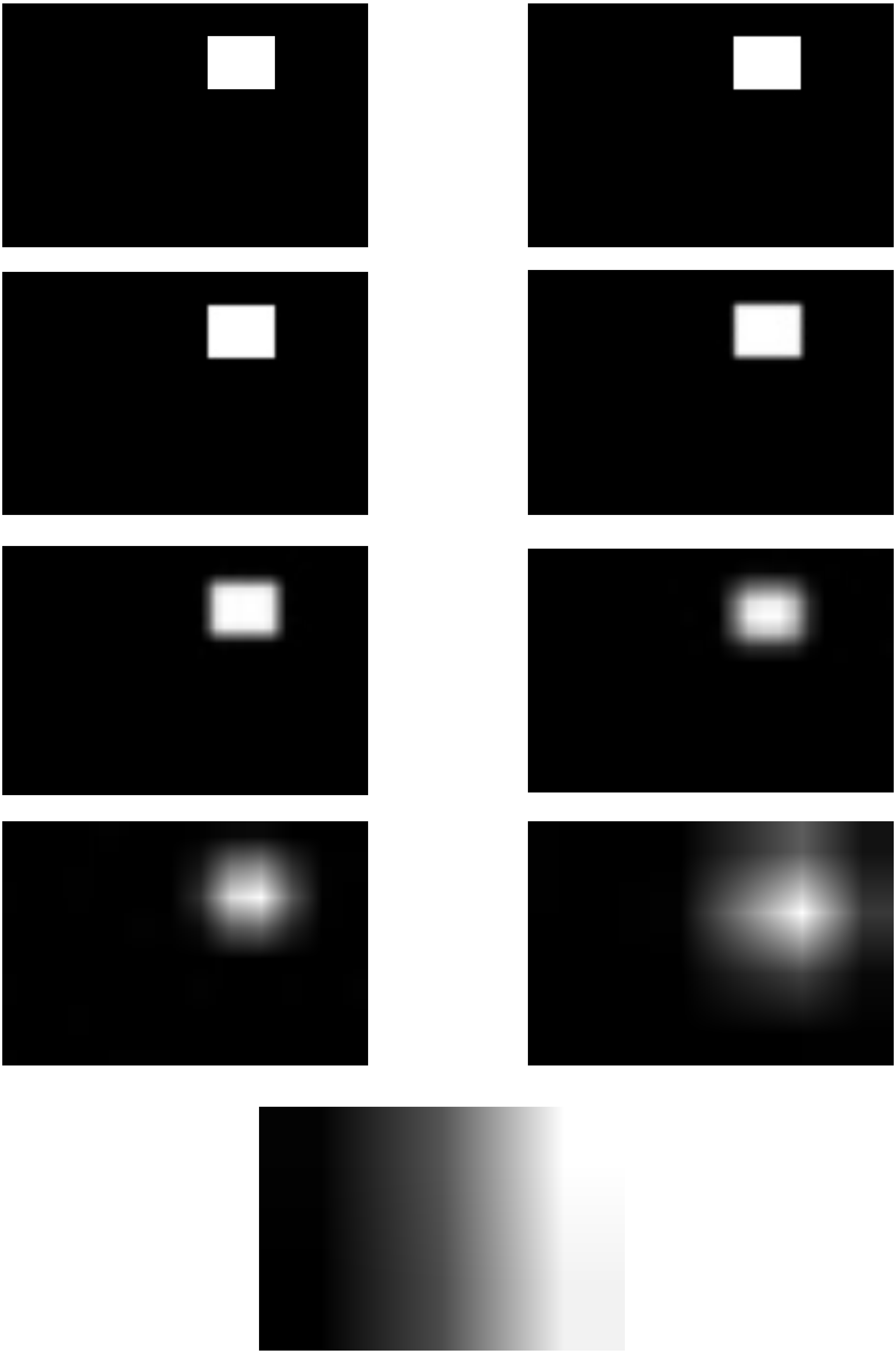






Laplacian Pyramid Levels for the Second Image I used for the Region Mask

Gaussian Pyramid Levels for the Region Mask

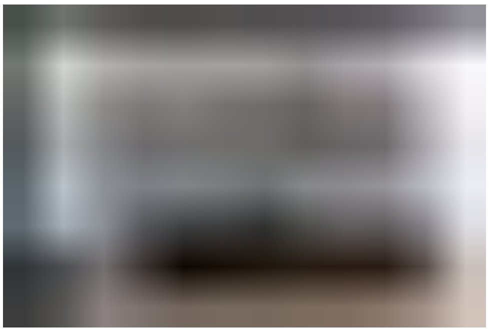


<u>Blended Images Levels using the Region Mask</u>

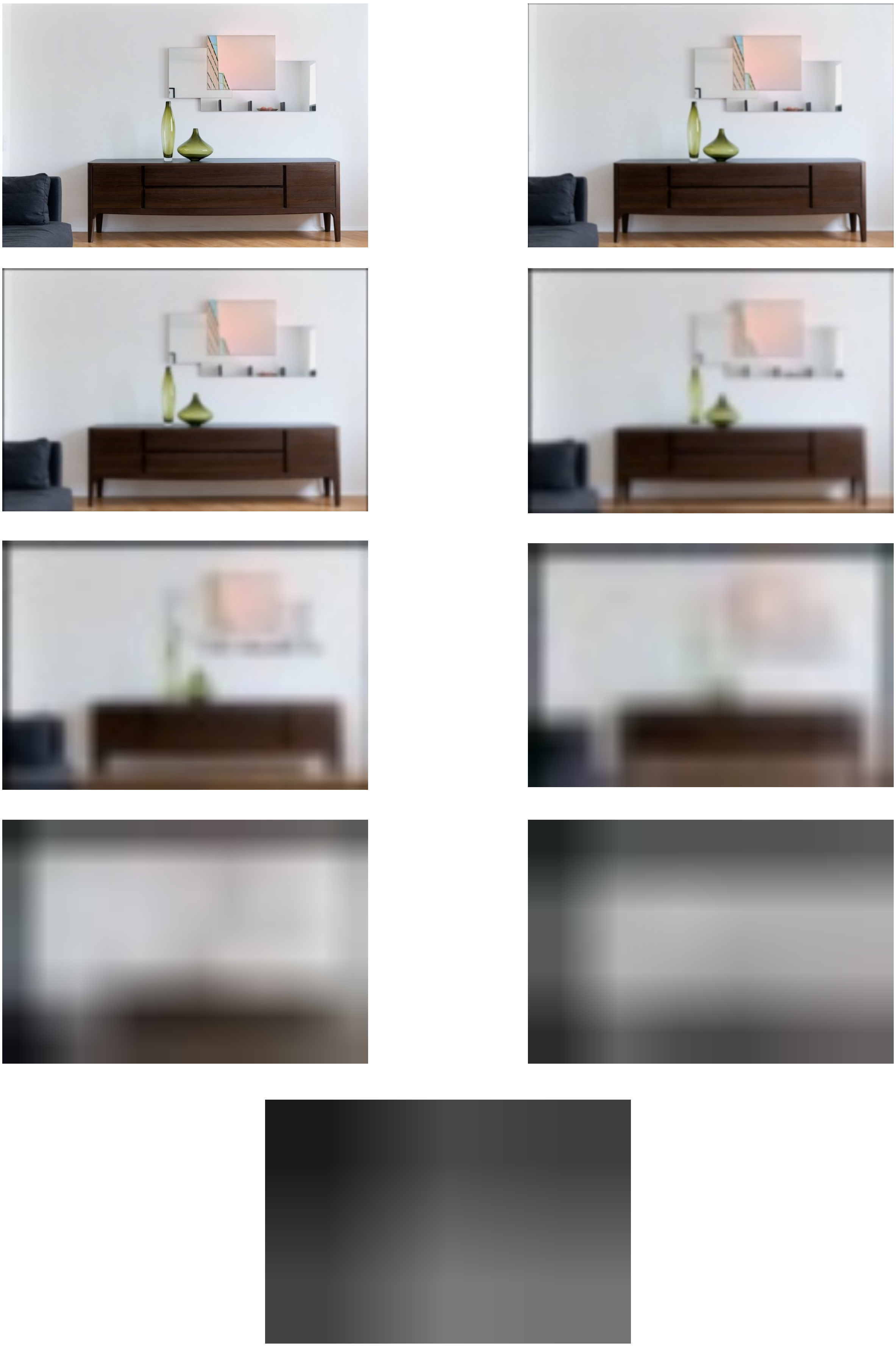








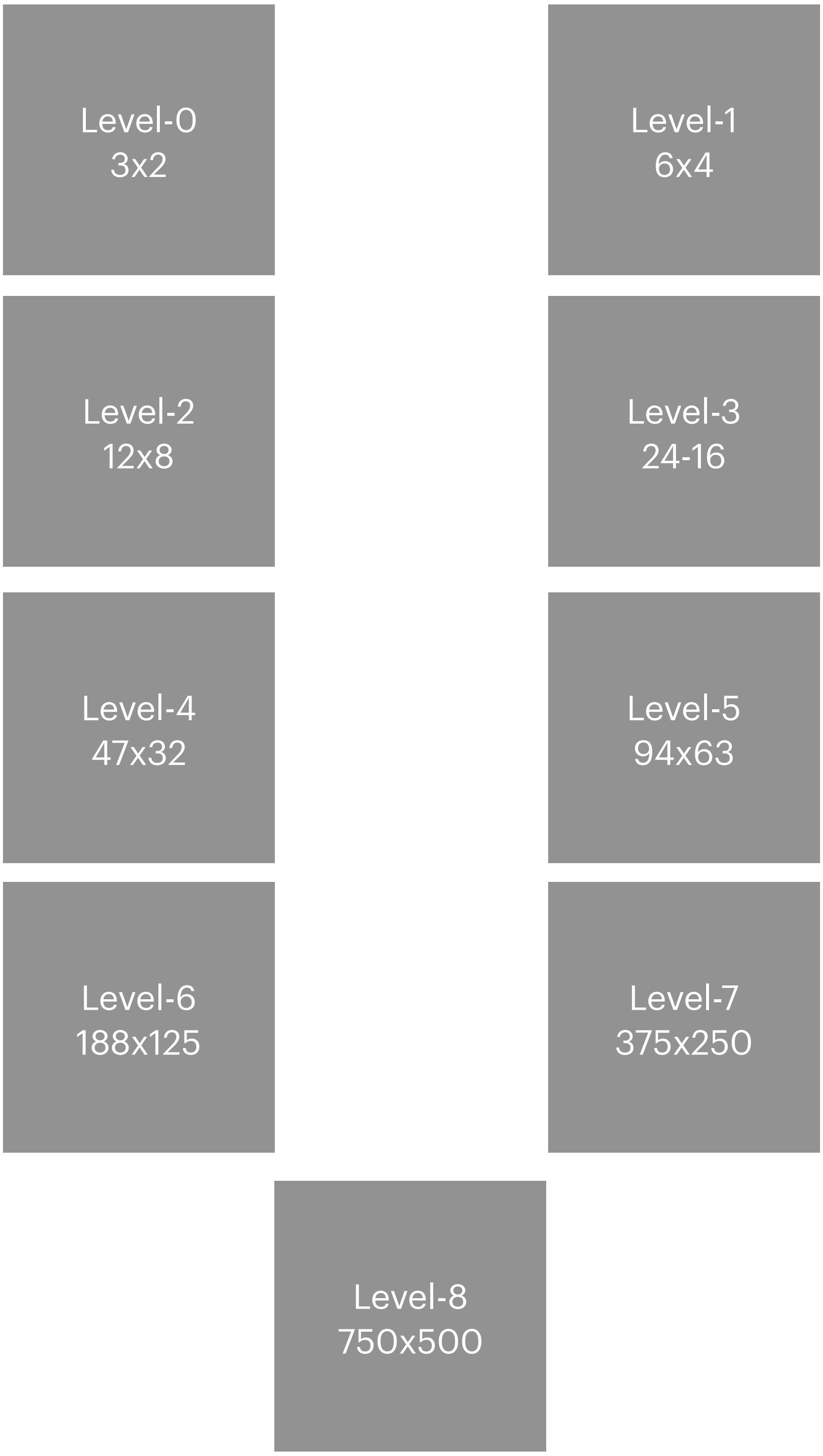
Collapse Images Levels



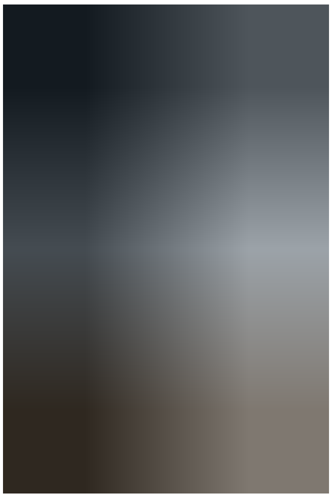
b. Impact of Pyramid Levels

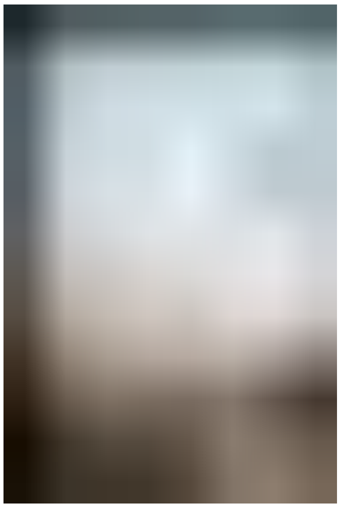
In this section of the report, I will show all my blended image results from the first pyramid level to the last pyramid level for all of my input image pairs.

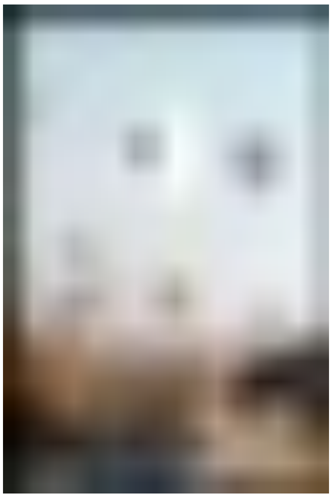
Note: Resolution and number of pyramid levels may vary in some examples. The following illustration is representative. Please see the images I sent via Google Drive for more detailed information and images.

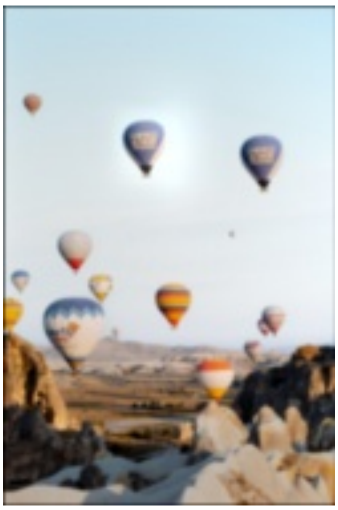


Baloon (2x3 - 500x750)

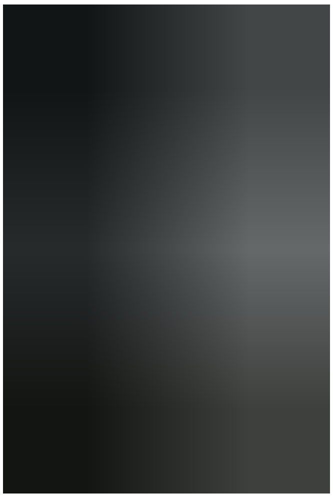


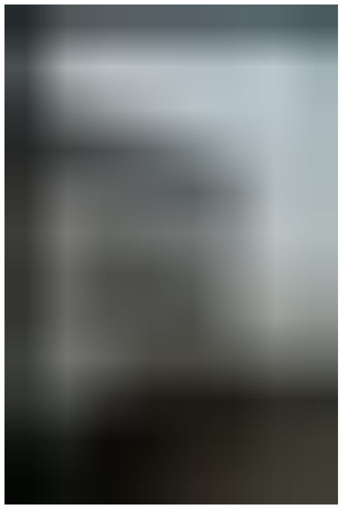
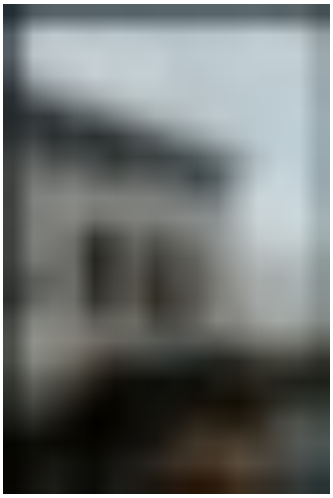






Bird (2x3 - 500x750)

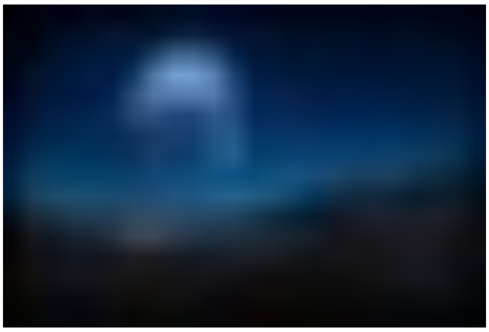




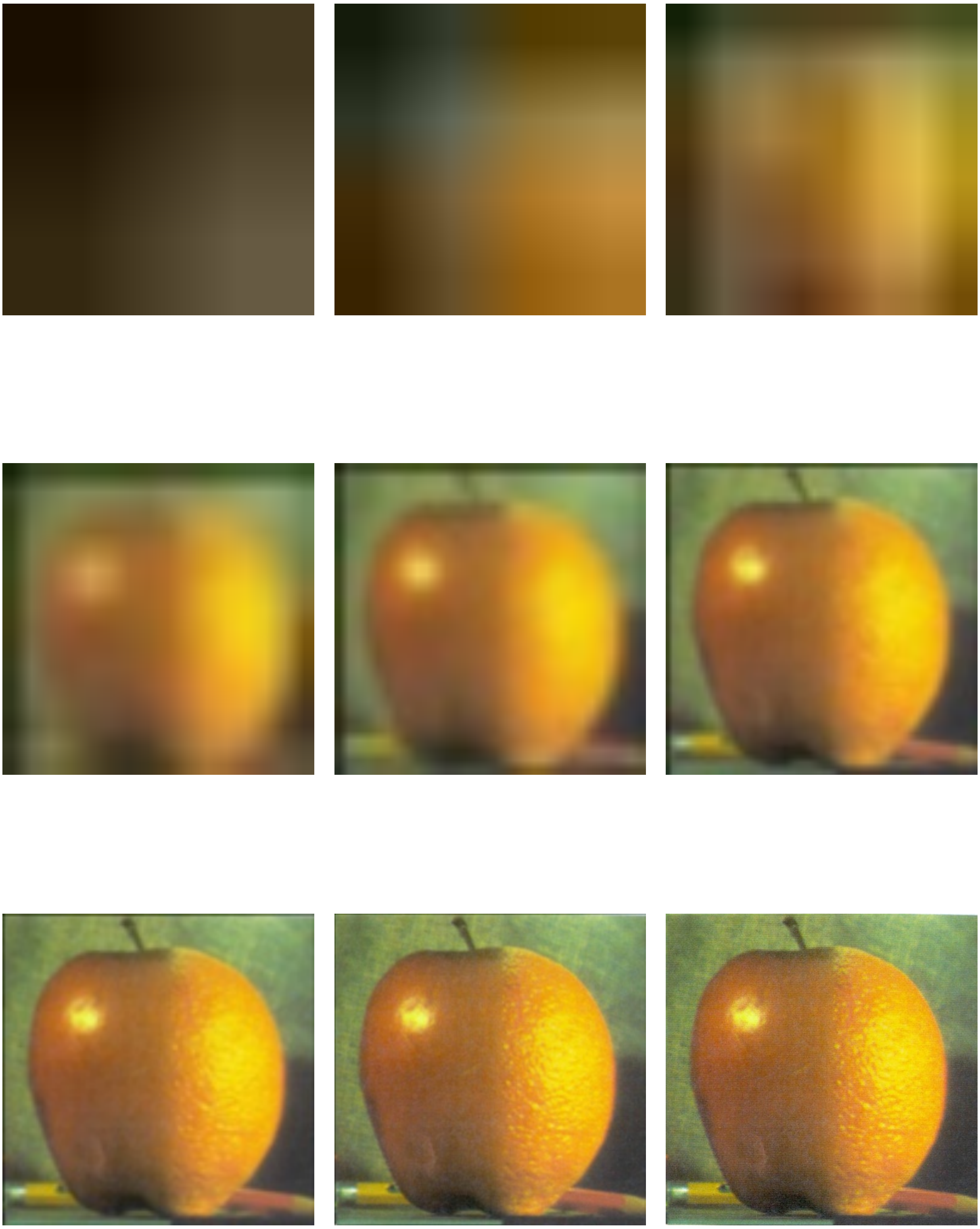

Fish (3x2 - 750x500)



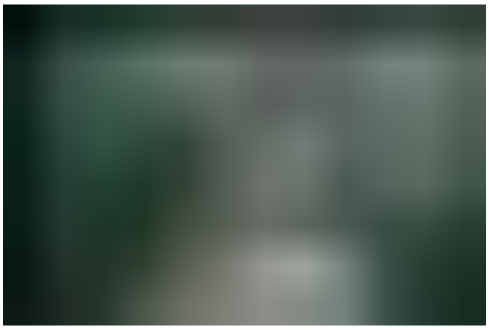
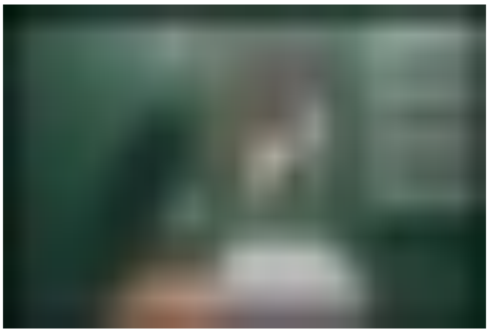


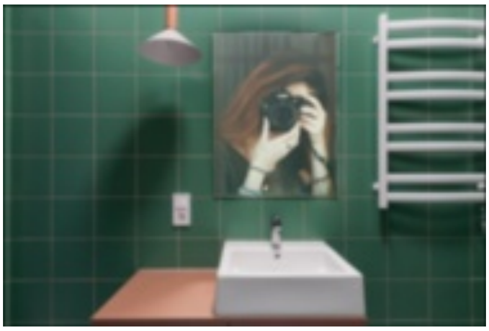

Fruit (2x2 - 512x512)



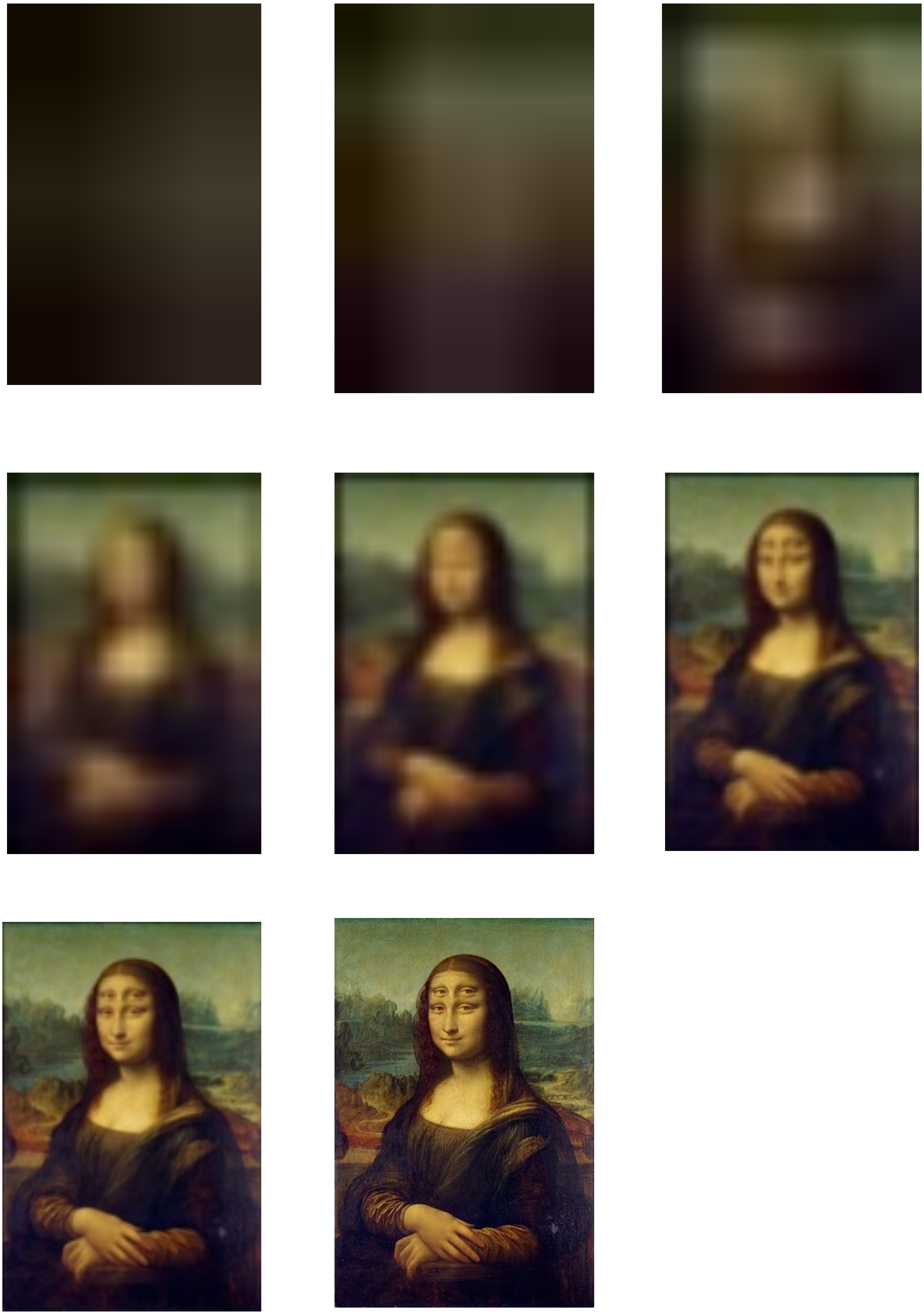
Mirror (3x2 - 750x500)



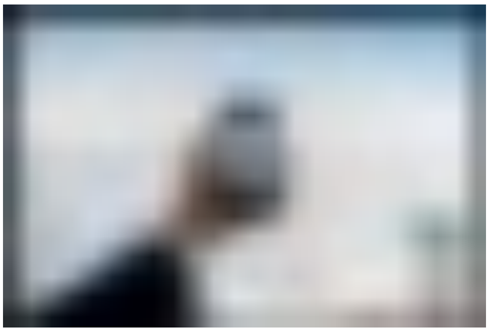
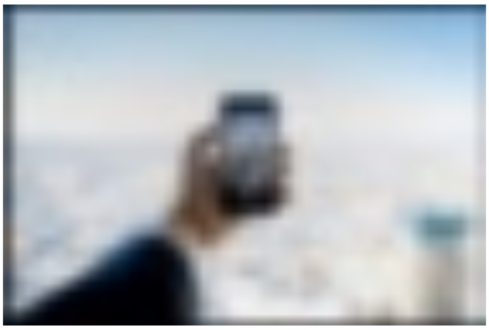



Monolisa (2x3 - 250x373)



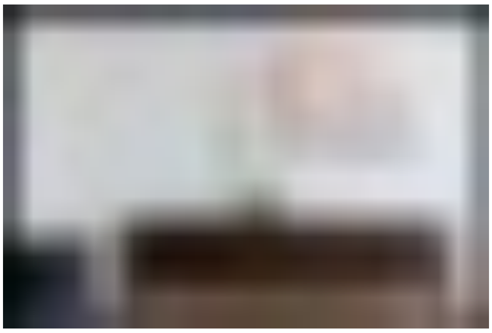
Phone (3x2 - 750x500)

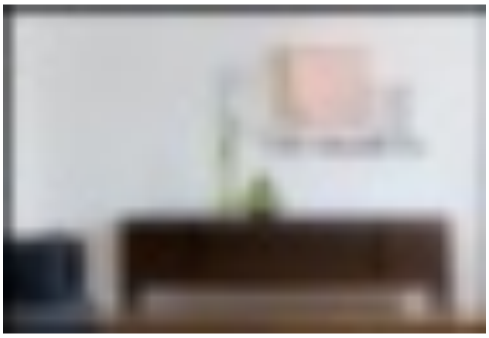


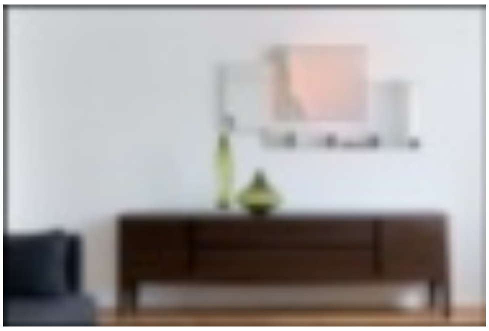




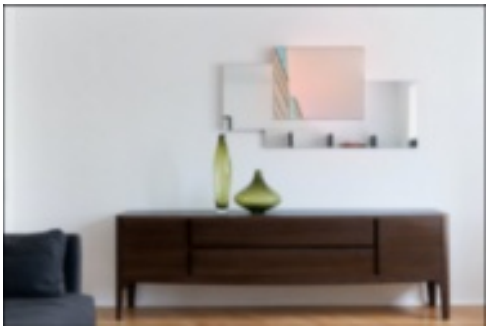


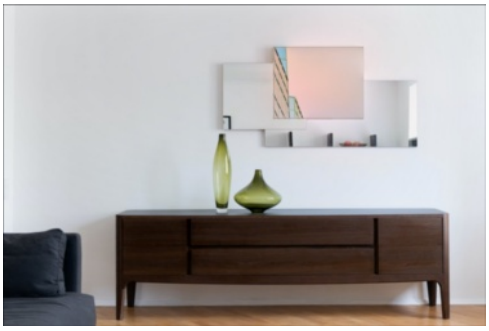
Sky (3x2 - 750x500)

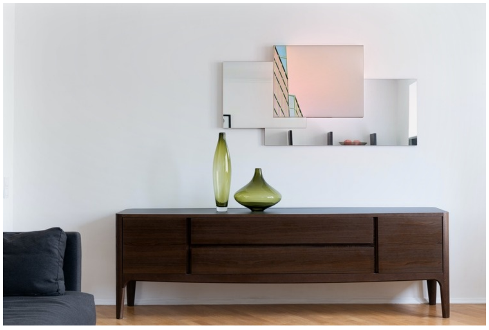




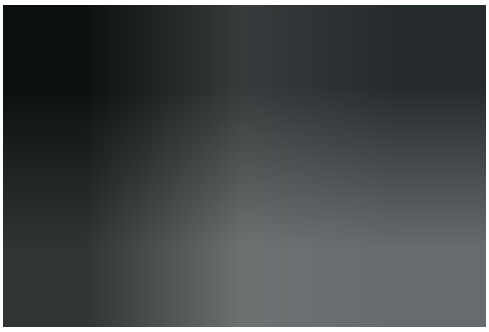


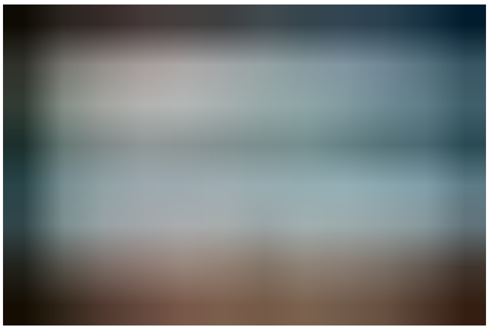


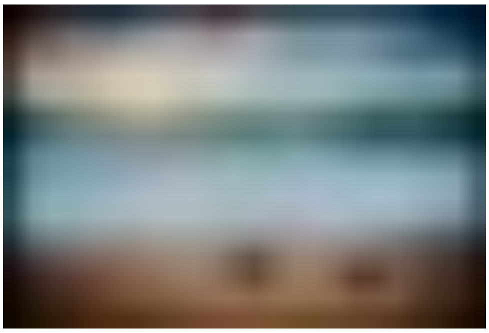


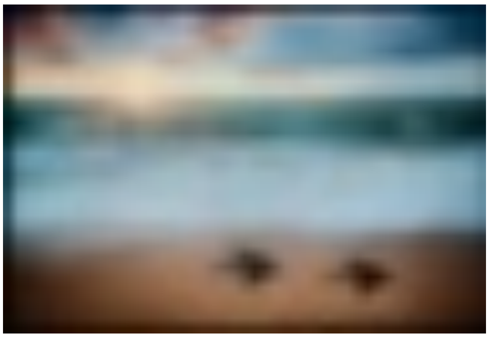


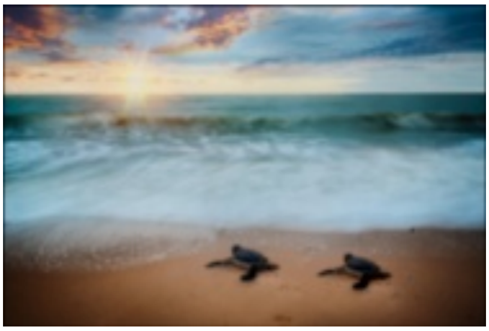
Turtle (3x2 - 750x500)











c. Criteria for Success and Evaluation

In this assignment, I tried to find photographs that I could use to test the success criteria I have collected under the main headings below. In the next topic, "Conclusion and Discussion", I will discuss how much the outputs of my algorithm meet these criteria.

I will use examples from the images I added above when testing whether the outputs of the algorithm meet the criteria.

<u>Seamless Integration</u>

The foremost criterion is the seamless blending of the selected regions from two images. The success lies in achieving a composite image without noticeable borders or artifacts where the merged regions meet.

<u>Natural Transitions</u>

The blended image should exhibit natural transitions between regions, ensuring that the composition appears visually coherent and realistic.

<u>Color Consistency</u>

Maintaining color consistency across the blended areas is essential. The colors from different regions should harmoniously merge without significant discrepancies.

<u>Detail Preservation</u>

The algorithm should retain important details from both input images during the blending process, ensuring that critical features are not lost.

<u>Flexibility and Adaptability</u>

The algorithm should be adaptable to various input images and masks, displaying consistent performance across different scenarios.

4. Conclusion and Discussion

a. Evaluation of Obtained Experiments

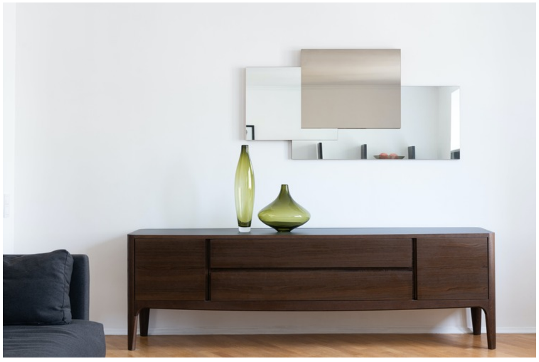
I think I got very successful results in every pair of images I found on the internet for this assignment. But of course, I could not achieve perfect results in some images. In this part of the report, I will use the images where I got very good results for each success criterion and the images where the blending process is noticeable as examples. Then I will examine why I got this result.

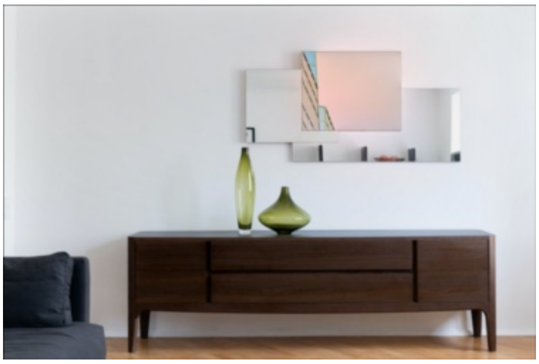
As expected in almost all images, I got the best result from the image I took from the last level, which contained the highest quality image in the reconstruction process. But there were also examples where I got better results in the penultimate level due to color incompatibility in some images.

Now let's take a look at all these examples:

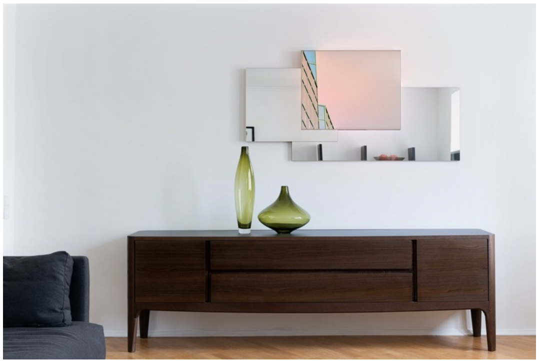
First, I would like to start with examples that pass all the criteria. It became almost impossible to understand that blending was done in these examples, which provided an almost flawless transition.

Now I will show an example that gives a perfect output again. But this time I will use the previous level, not the last level. Because if you look at the reconstruction levels of the image named "sky" above, you will see that there are slight defects in terms of Color Consistency in the last level. I think this is because the highest quality image shows the original colors of parts from two different images more clearly.





6th Level



7th Level

Now I will examine the examples where I did not get excellent results for the Natural Transitions success criterion. The common point of the 2 examples I will give now is that the place where I placed the image is too detailed. For this reason, I could not get perfect results in blending a new object into the detailed place I chose as the mask.