Image Processing – 67829 – Exercise 3

Due Date: 04.12 at 23:59

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1 Task

In this exercise, you will need to perform image blending using different images which you choose. We encourage you to experiment with the capabilities of these blending techniques and see if you can come up with new types of blends and ideas.

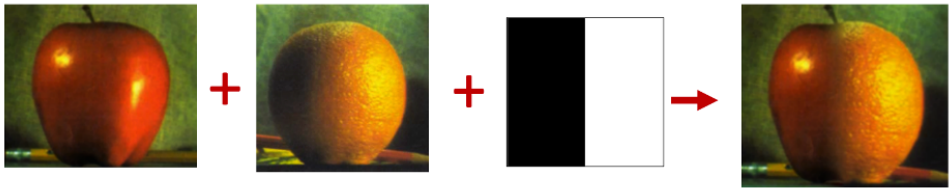
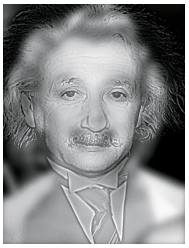


Image Blending



Hybrid Images

1.1 Image Blending

Given two images and a mask, blend the images seamlessly.

1.2 Hybrid Images

Given two images, create a third image such that, when viewed up close, the first image appears, and when viewed from afar, the second image appears.

Note 1: This exercise is meant to be fun and allow you to explore the possibilities of image processing and manipulation even with simple algorithms such as the ones you will use here. Be creative, try to test the limitations of the methods and see if you can bend them to your will.
Note 2: Your should not use library functions that trivialize the exercise, e.g., functions that perform blending or implement pyramid construction. You should implement these on your own.
Note 3: Your solution needs to be based on the material you've learned in class, do not use neural networks or generative image editing models.

2 Submission

- Submission instructions are given in the "Submissions Guidelines" document published on the course web page (here). Please read and follow them carefully. Any updates to those guidelines will be posted in the news forum, so be sure you follow the forum.
- You are required to submit code that can run on the CS computers and a "requirements.txt" file with all the pip dependencies you've used in your solution that can run on the CS computers.

3 Report Guidelines

In addition to the code, you should submit a report describing your solution. We provide an English and Hebrew Google Docs template (you need to copy it to use it). In case you choose not to use it, please maintain a similar structure (font size, same sections, same number of pages, etc.).

Note: you can have more or less figures than the placeholders shown in the template.

The report should be no longer than 5 pages and include the following sections and topics:

1. **Introduction**
   (a) In your own words, state the goal of the exercise. What core image processing concept (not a specific tool) is central to solving it? Briefly explain why this concept is crucial for achieving seamless blends or hybrid images.
2. **Algorithm & Implementation**
   (a) **For each blending algorithm (Image Blending & Hybrid Images)**:
      i. **Description:** Clearly describe the steps involved in your algorithm. Elaborate on the underlying image processing concepts learned in class and use visualizations from your blending images to illustrate.

ii. **Implementation Details:**

A. Describe your implementation, specifying which parts were written from scratch and which utilized existing library functionalities. List libraries used and justify your choices.

B. Detail any necessary hyper-parameters, thresholds, or design choices, explaining their impact.

C. Discuss challenges faced during implementation and how they were addressed.

(b) **Comparison:** Explain the fundamental differences and similarities between the Image Blending and Hybrid Images algorithms in terms of their goals and how they achieve them.

3. **Results**

(a) **Successful Blends:** Present one successful blending result for Image Blending and one for Hybrid Images. For each, briefly explain your choice of input images, masks (for image blending), and key parameters. **Unsuccessful Blends:** Present one example of an unsuccessful Image Blending result and one for Hybrid Images. These should be perceptually flawed (e.g., visible seams, ghosting, jarring transitions), even if technically executed. Explain the perceived reasons for the failure (e.g., image content mismatch, mask issues, parameter choices). *Note: Avoid presenting trivial technical failures such as blending with a single-valued mask, etc.*

4. **Analysis**

(a) **Pyramid Analysis:** Select one successful blend and one unsuccessful blend (from your results). For each, visualize multiple levels of its **Gaussian** and **Laplacian** pyramids.

- Compare what you observe in the pyramids of the good blend versus the bad blend.
- Discuss how the information content (e.g., details, broad structures) differs across pyramid levels for each, and how these differences explain the success or failure of the blend.
- Explain the role of each pyramid (Gaussian for low-pass, Laplacian for high-pass/detail) in achieving the desired blending effect.

(b) **Frequency Domain Analysis:** Using the same successful and unsuccessful blends, visualize their 2D Fourier Transforms (magnitude spectra).

- Compare these two Fourier Transforms. Discuss what specific differences you observe in the frequency domain that correlate with the visual quality of the blends.
- Explain how the presence or absence of certain frequency components (e.g., strong high frequencies at seams, or smooth low-frequency transitions) contributes to a seamless vs. flawed result.

5. **Conclusion**

(a) Summarize your key findings and insights from the exercise, particularly those highlighted in your analysis of good vs. bad blends. Summarize your key findings and insights from the exercise, particularly those highlighted in your analysis of good versus bad blends. Briefly reflect on the creative aspects of the exercise and any interesting ideas or new types of blends you explored.

Your final submission should be:

1. A PDF named ”ex3.pdf”.
2. A tar file a python file named ”ex3.py”, a requirements.txt file with your dependencies, and **all of the images you've used including inputs, outputs, and masks**. Place the images in an ”inputs” and ”outputs” dirs and make sure to clearly name the files. To create a tar file you can run the following command: `tar -cvf ex3.tar ex3.py requirements.txt ./inputs ./outputs`

Note: The PDF and tar should be submitted to the respective submission in the Moodle.

4 Grading

Your exercise will be graded based on a manual inspection of your report (and code).

Good luck and enjoy!