ECE501 : Digital Image Processing

9 - Hybrid Multi-Frequency Image Illusion

Course Instructor:	Dr. Mehul Raval
Group Number:	8
Group Members:	Aashaka Ashara
	Bansari Jani
	Manasvi Gondalia
	Aaryan Sheth

Abstract

This project aims to merge two different images such that the final image appears to be one image from certain angle and the other image from a different angle. We aim to do a study of how it is possible to create hybrid multi frequencies image illusions by mixing two images with different frequency bands. The method exploits the image processing techniques to extract the low-frequency content of one image with the high-frequency features of another and combine them into one hybrid image.

Figure 1: An example of what final image should be like.

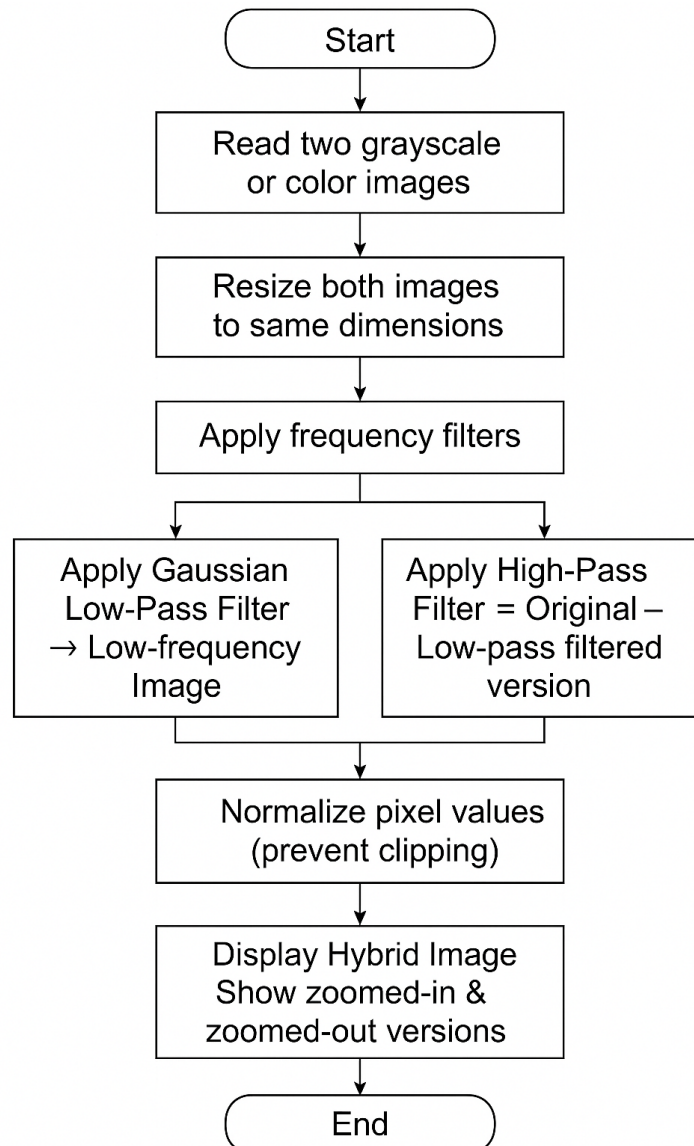# Contents

1 What We Have Done

We have learned about hybrid images, their principles, and their broad application. Hybrid images combine the low spatial frequencies of one picture with the high spatial frequencies of another picture, producing an image with an interpretation that changes with viewing distance. The visual effect of a hybrid image relies on spatial frequency (low frequencies convey coarse structure seen from afar, high frequencies convey fine details seen up close), multiscale processing (the visual system analyzes low and high frequencies through separate pathways), and viewing distance (distance or blurring determines whether low- or high-frequency information dominates perception). We have determined the categories of the frequency components that are to be employed and defined the step-by-step procedure that is necessary to build a hybrid image.

A perception change occurs when the human visual system concentrates on the high-frequency details when the person is close to the object and when focusing on the low-frequency contents in the image when viewed at a distance. The execution is frequency filtering with Gaussian or Fourier-based techniques, source image alignment and display of the resulting hybrid illusion. There are medical diagnostic uses, computer vision, art and industrial inspection applications of this approach. It is anticipated that there will be an illustration of the changing perception as the viewing distance changes, and showcasing the scientific and artistic capability of frequency-based image manipulation.

2 What We Aspire to Do

Our intention is to be successful in creating a hybrid image through the identified process. The desired result is to develop a picture resembling the one given with the low and high frequency components effectively merged together to show the illusion.

3 Flowchart

```
        ┌──────────────┐
        │    Start     │
        └──────┬───────┘
               │
               ▼
     ┌──────────────────┐
     │ Read two grayscale│
     │  or color images  │
     └────────┬──────────┘
              │
              ▼
     ┌──────────────────┐
     │ Resize both images│
     │ to same dimensions│
     └────────┬──────────┘
              │
              ▼
     ┌──────────────────┐
     │Apply frequency filters│
     └────────┬──────────┘
```

Start

Read two grayscale or color images

Resize both images to same dimensions

Apply frequency filters

Apply Gaussian Low-Pass Filter → Low-frequency Image

Apply High-Pass Filter = Original − Low-pass filtered version

Normalize pixel values (prevent clipping)

Display Hybrid Image Show zoomed-in & zoomed-out versions

End

References

[1] A. Oliva and P. G. Schyns, "Hybrid image illusion," in *The Oxford Compendium of Visual Illusions*, pp. 763–766. [Online]. Available: http://olivalab.mit.edu/Papers/Oliva-Schyns_Hybrid-Image-Illusion-Chapter.pdf

[2] P. Sripian and Y. Yamaguchi, "Hybrid image of three contents," *Visual Computing for Industry Biomedicine and Art*, vol. 3, no. 1, 2 2020. [Online]. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC7099537/

[3] "View of Hybrid motion illusions as examples of perceptual conflict | Journal of Illusion." [Online]. Available: https://journalofillusion.net/index.php/joi/article/view/7084/13847

[4] A. Oliva, A. Torralba, P. G. Schyns, and A. for Computing Machinery, "Hybrid images," Tech. Rep., 2006. [Online]. Available: https://dellaert.github.io/19F-4476/misc/oliva-siggraph-2006.pdf