Hybrid Multi-Frequency Image Illusion

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***Abstract*—This report will outline the execution of the Hybrid Multi-Frequency Image Illusion technique and execute the process on the two images, where image filtering is used to obtain two images at distinct spatial frequencies. The illusion created has one image when it is looked at closely; and another look at it far away. The project examines manipulation in the frequency domain through the use of Gaussian filters to isolate high and low frequencies, giving results on the sensitivity of human sight and sensitivity in frequencies.**

***Index Terms*—Hybrid image, frequency, Gaussian filter, image processing, visual illusion.**

I. Introduction

Image combination(s), a synthesis of image processing and cognitive science, is an interesting interruption of image processes/images. They are created through the merger of the low spatial frequency components of an image with the high spatial frequency features of another image. Combined frequencies are perceived differently with the human visual system depending on the viewing distance.

It was first popularized by Oliva, Torralba and Schyns (2006) who were able to reveal how different frequency bands lead to distinct perceptual interpretations. The objective of this project is to reformat and derive the Hybrid Multi-Frequency Image Illusion with the help of computational filtering.

II. Methodology

This methodology involves three basic steps namely, preprocessing, frequency filtering and image combination. The translated in general the workflow is depicted in Fig. 1.

A. Preprocessing

Two grayscale images or colour images of the same size are picked. Every image is brought to the range of 0 to 1 and transformed to floating-point format, to manipulate the frequencies accurately.

B. Frequency Filtering

Image A is blurred using the Gaussian low-pass filter, which shows the low-frequency part of Image A, whereas Image B is modified by a high-pass filter is built by the difference between Image B and its low-frequency inversion:

$$I_{high} = I_B - G_\sigma(I_B) \tag{1}$$

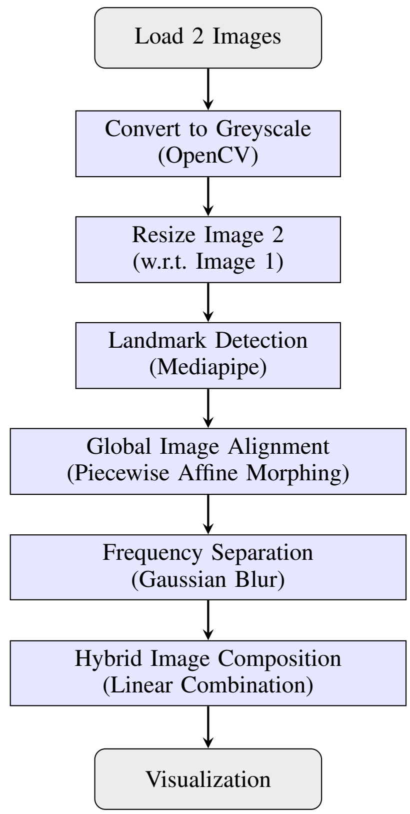

Fig. 1. Workflow of Hybrid Multi-Frequency Image Illusion: from image loading to hybrid composition.

C. Combination

The hybrid image H is constructed as:

$$H = G_{\sigma_L}(I_A) + k \times (I_B - G_{\sigma_H}(I_B)) \tag{2}$$

where σ_L and σ_H are the low and high-frequency cutoffs, and k is a scaling factor to balance contrast.

III. Results

It implemented it in Python and OpenCV. The resultant hybrid image that was constructed had a different visual effect at a close proximity to the image; at close see the high-frequency image captured dominating the visual perception and then with a distance vision the low-frequency image looked unusual.

Fig. 1 and Fig. 2 displayed above depict that the hybrid multi-frequency illusion was created using two source pictures, that is, two pictures of faces. The face, used as the low-frequency face following the application of a Gaussian, is represented in Figure 2 below: Face 1. Figure 2 in the appendix called face 2 is rendered as Face 2 and is considered to be the high frequency component since the fine detail and edges are highly brought out using high-pass filtering. The ultimate result, presented in Fig.3-hybrid depicts the hybrid image as a product of a linear combination between the low-frequency image and the high-frequency image. Face 2 details can prevail in the perception at the close observation distance whereas with the extension of the observation of the Face, there is an effect of winning the Face 1 image as the multi-frequency illusion.

Fig. 2. Face 1

Fig. 3. Face 2

Fig. 4. Hybrid Image

IV. Discussions

The illusion of human image hybrid helps to illustrate the rule that the human visual system attaches greater priority to low frequencies but at the further distance and high frequencies but at closer distance. The outcomes prove that the frequency separation should be properly balanced in order to avoid over-blending.

Furthermore, the state of lighting and the color difference contribute to the dominance of perception between the two images to a great extent. This phenomenon may be used in works of art design, protein concealment, and perceptual-driven compression methods.

V. Conclusion

The paper has achieved the necessary success in multi-frequency-based image illusion application with a hybrid, which is based on which frequency filtering effective with Smart Gaussianities is implemented in the current paper. The findings confirm the theoretical model of visual frequency perception and clearly show that it is applicable in practical use in computational art and visual communication. Future research can consider adaptive filtering on adaptive watching and real-time rendering of augmented reality systems.

References

[1] A. Oliva, A. Torralba, and P. Schyns, “Hybrid Images,” *ACM Transactions on Graphics*, vol. 25, no. 3, pp. 527–532, 2006.

[2] R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 4th ed., Pearson, 2018.

[3] OpenCV Documentation, “Image Filtering,” Available: https://docs.opencv.org