Project 1:Image Filtering and Hybrid Images
CS 143: Introduction to Computer Vision

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Introduction

The goal of this assignment is to write an image filtering function and use it to create hybrid images using a simplified version of the SIGGRAPH 2006 paper[1] by Oliva, Torralba, and Schyns. Hybrid images are static images that change in interpretation as a function of the viewing distance.

The basic idea is that high frequency tends to dominate perception when it is available, but, at a distance, only the low frequency (smooth) part of the signal can be seen.

By blending the high frequency portion of one image with the low-frequency portion of another, you get a hybrid image that leads to different interpretations at different distances.

Concept

A hybrid image is a picture that combines 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(Oliva *et. al.*). As for this project, we are encouraged to firstly write our own image filtering function, then create several hybrid images(see Figure 1) using our own filtering function.


Figure 1: A hybrid image superimposed by a dog image and a cat image. You will see a cat face from very close while recognizing a doglike face from far away.

Methods

Convolution versus correlation

The built−in function `imfilter(A,h)` in MATLAB will filter the image matrix *A* with filter *h* using correlation method(sum of element-wise dot product) by default. However, the typical convolution computation differs from correlation method by rotating the filter by 180 degrees before computation. Obviously, both approaches give the same output if and only if the filter is symmetric by y-axis. Figure 2 shows how to compute convolution of the red entry with respect to its neighbors.


sobel filter
(non-symmetric by y-axis)
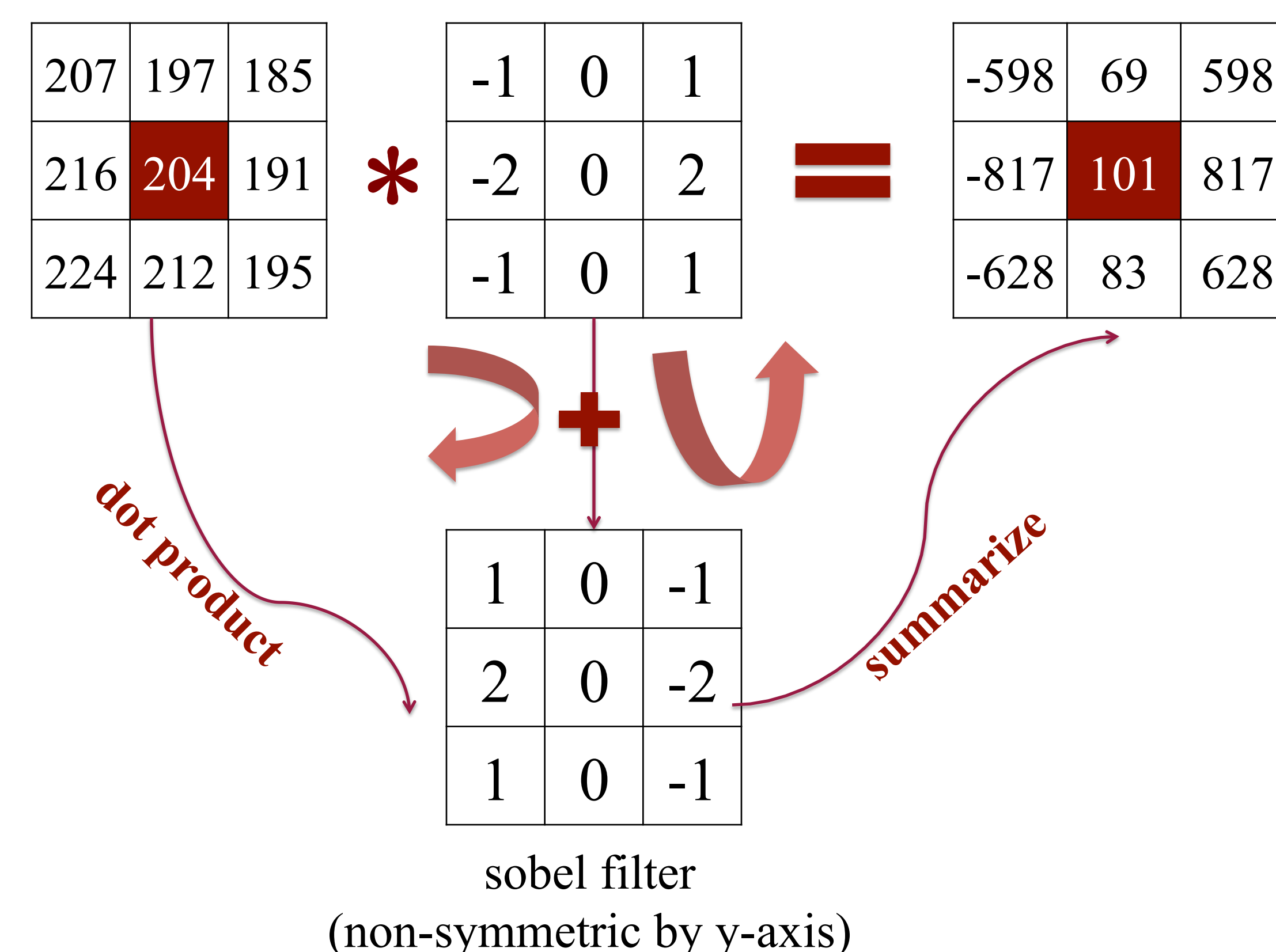
Figure 2: Convolution process

My version of `imfilter(A,h)` matches every checkpoint image well except for the sobel filter. Here is the difference: Edge colors are opposite to each other, especially the orange and blue lines on left side, since the corresponding grayscale values are opposite.
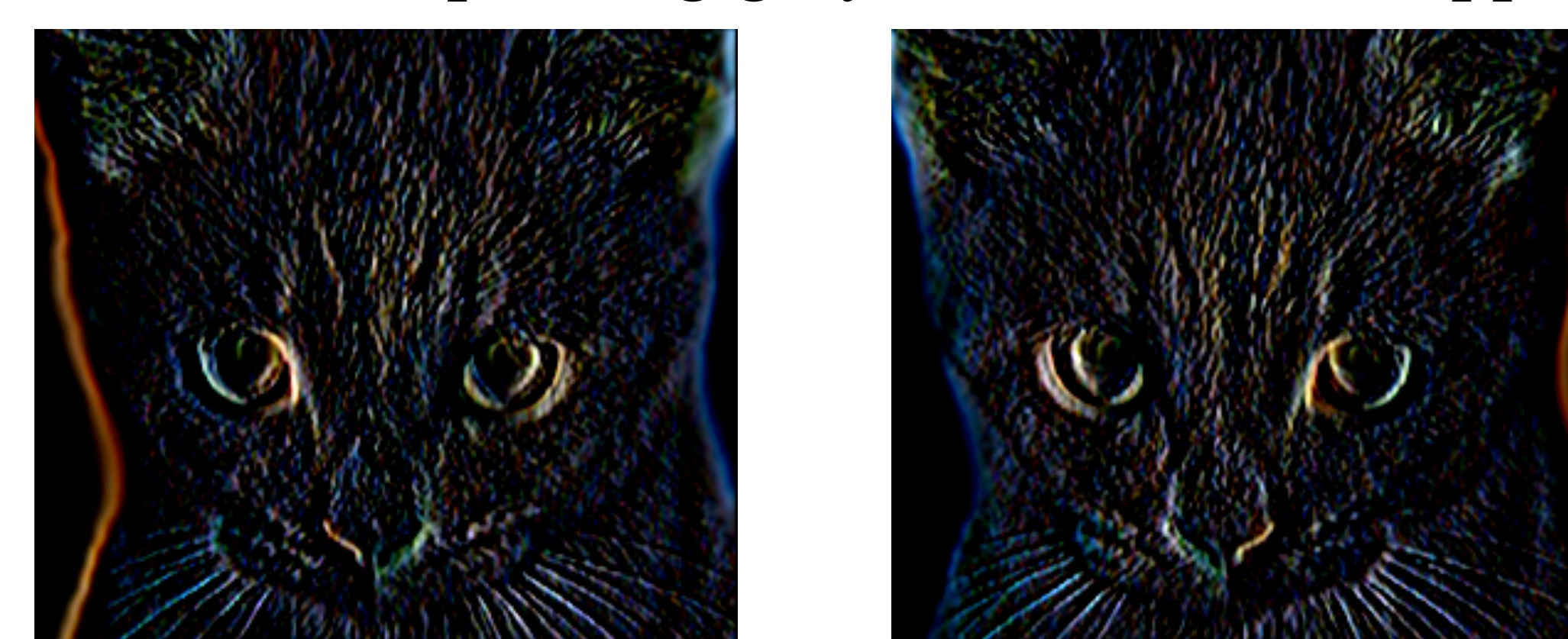
Figure 3: Differences between convolution and correlation

Results
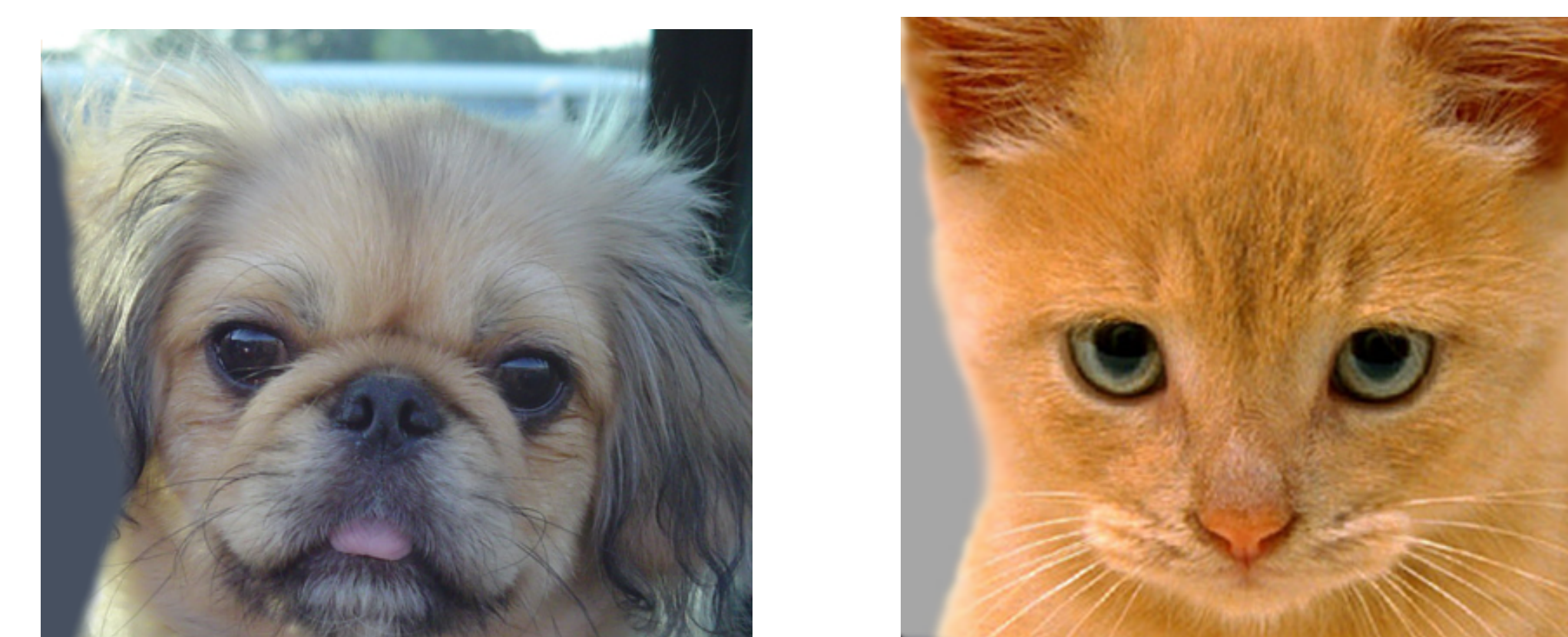
Fig. 4（**a**）: Original images

Fig. 4（**b**）: Frequency extraction: low frequency. from dog image, high frequency extracted from cat image.

Fig. 4（**c**）: Adding high and low frequencies together and downsampling the hybrid image(for easier recognition purpose).

Fig. 5（**a**）: From Marilyn to Einstein

Fig. 5（**a**）: From Einstein to Marilyn

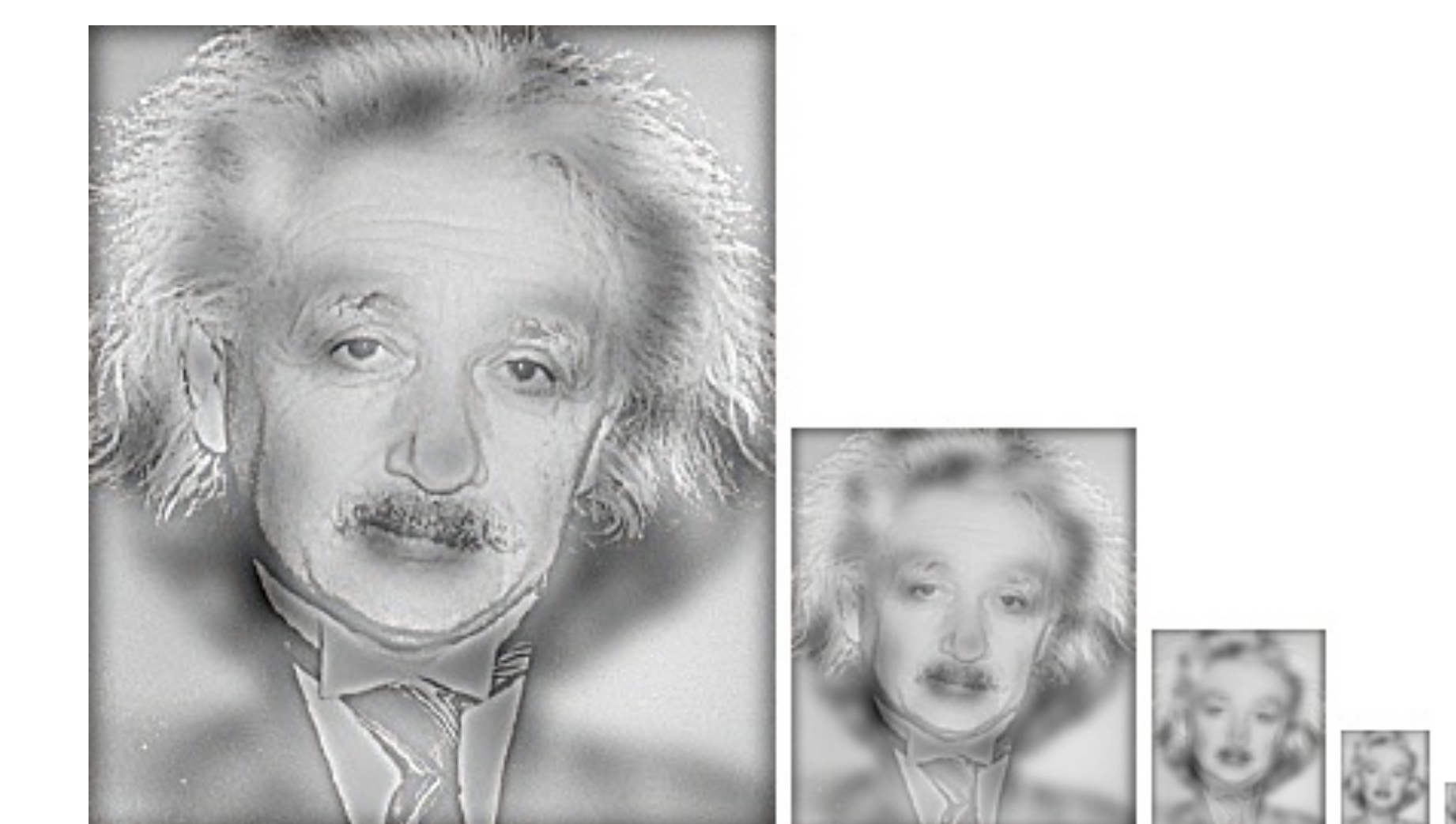**Fig. 6**: From two-eye minion to one-eye minion

Disclaimer

The content of this project comes from Brown's CS 143: Introduction to Computer Vision, Fall 2013, taught by Prof. James Hays. All right reserved to Computer Science Department, Brown University. The author is a fanatic self-learning learner in the field of computer vision. All references have been credited.
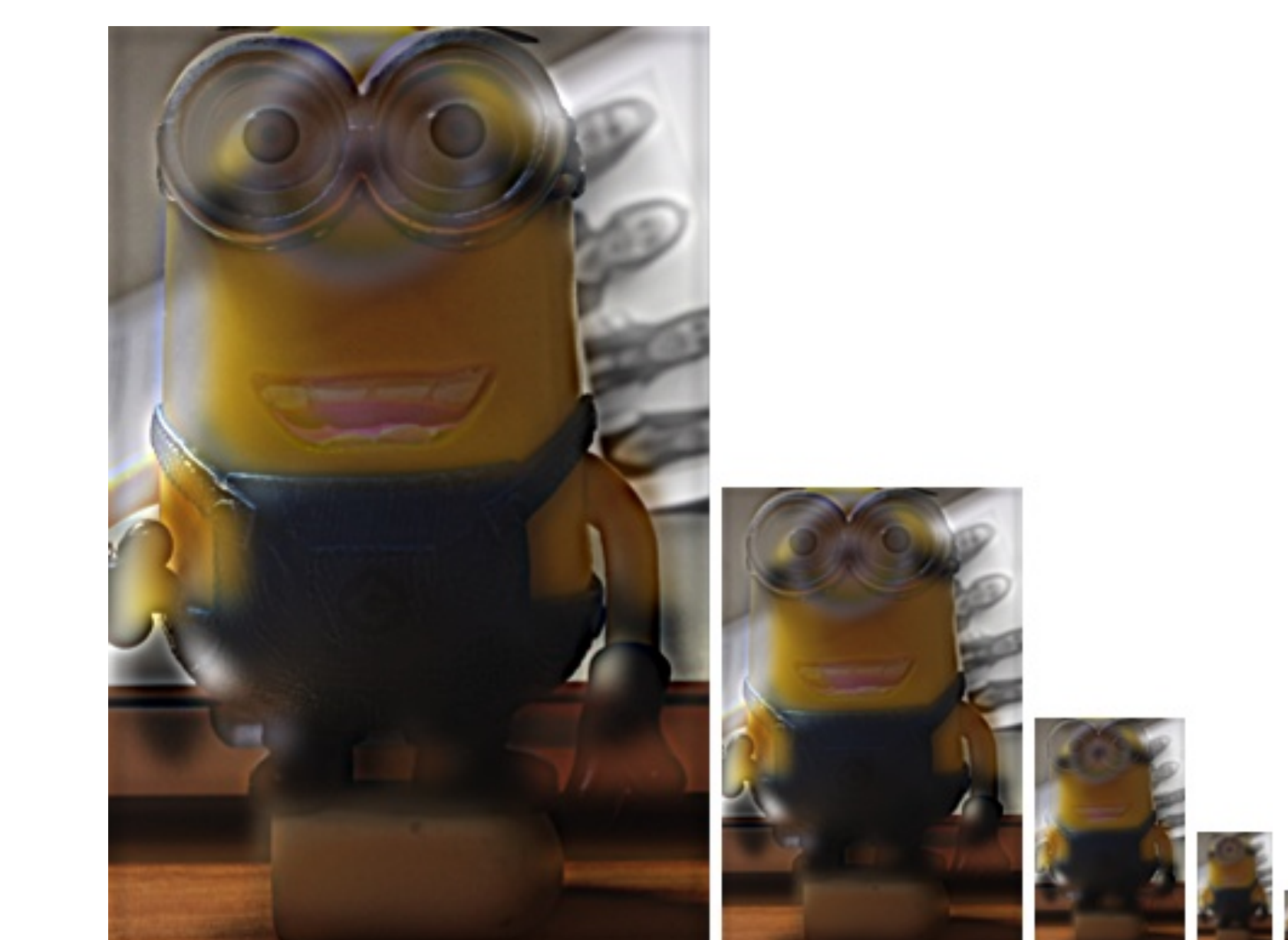Project description URL:
http://cs.brown.edu/courses/csci1430/proj1/

References

1. Oliva, Aude, Antonio Torralba, and Philippe G. Schyns. "Hybrid images." ACM Transactions on Graphics (TOG). Vol. 25. No. 3. ACM, 2006.
2. Feifei Li. "Pixels and Filters." Stanford CS131 lecture slides, URL:http://vision.stanford.edu/teaching/cs131_fall1314/lectures/lecture4_pixels%20and%20filters_cs131.pdf, last visited Jan 27th, 2014.