National Tsing Hua University

Department of Electrical Engineering

EE3662 Digital Signal Processing Laboratory, Fall 2018

Lab #6 Image Filtering and Hybrid Images

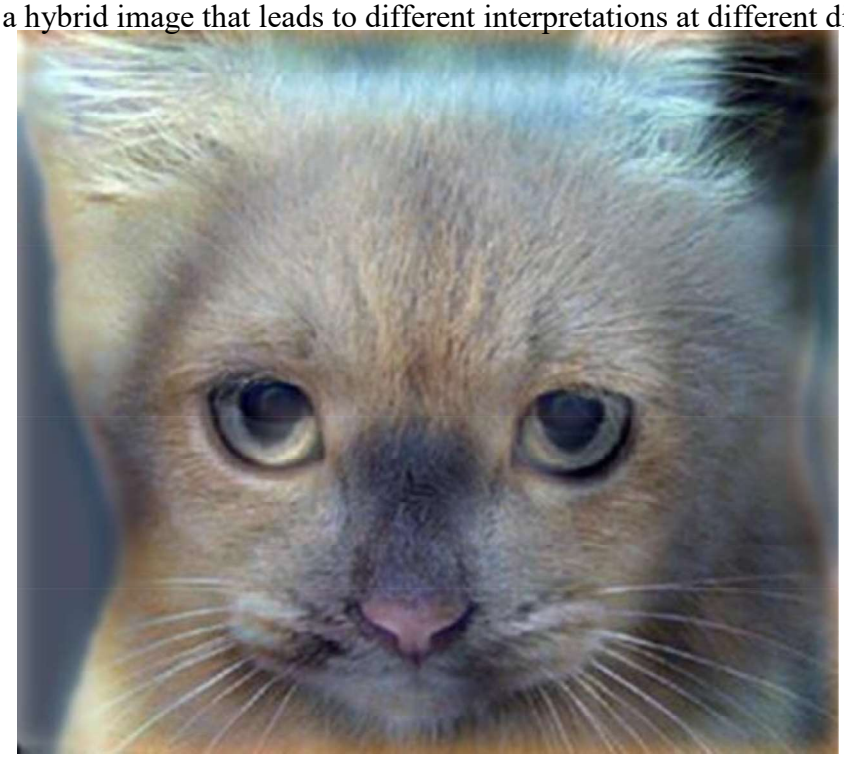
Assigned on Oct 22, 2018

Due by Oct 29, 2018

Overview

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 by Oliva, Torralba, and Schyns [1].

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



Details

I. In-class Demo

1. Image Filtering (50%)

Image filtering (or convolution) is a fundamental image processing tool. See chapter 3.2 of Szeliski and the lecture materials to learn about image filtering. MATLAB has many built in and efficient functions to perform image filtering, but you should write your own such function in this assignment.

You need to implement *my_imfilter()* which imitates the default behavior of the build in *imfilter()* function. As specified in *my_imfilter.m*, your filtering algorithm must

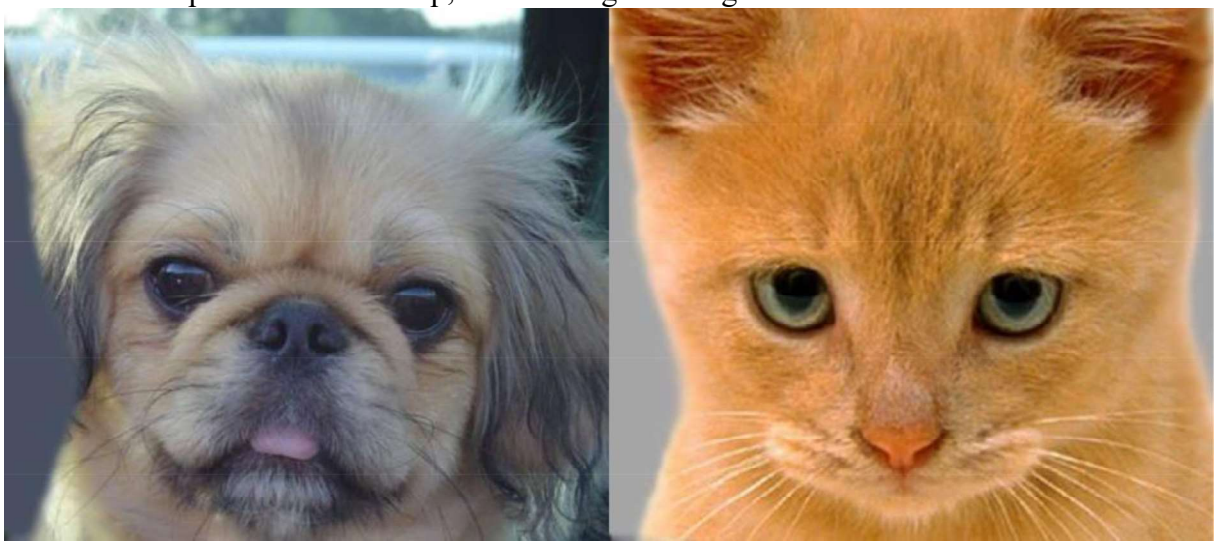
(1) support grayscale and color(RGB) images.
(2) support arbitrary shaped filters, as long as both dimensions are odd (ex.7x9 filter but not 4x5 filters).
(3) pad the input image with zeros or reflected image content, and return a filtered image which is the same resolution as the input image.

We have provided a script, *proj1_test_filtering.m*, to help you debug your image filtering algorithm.

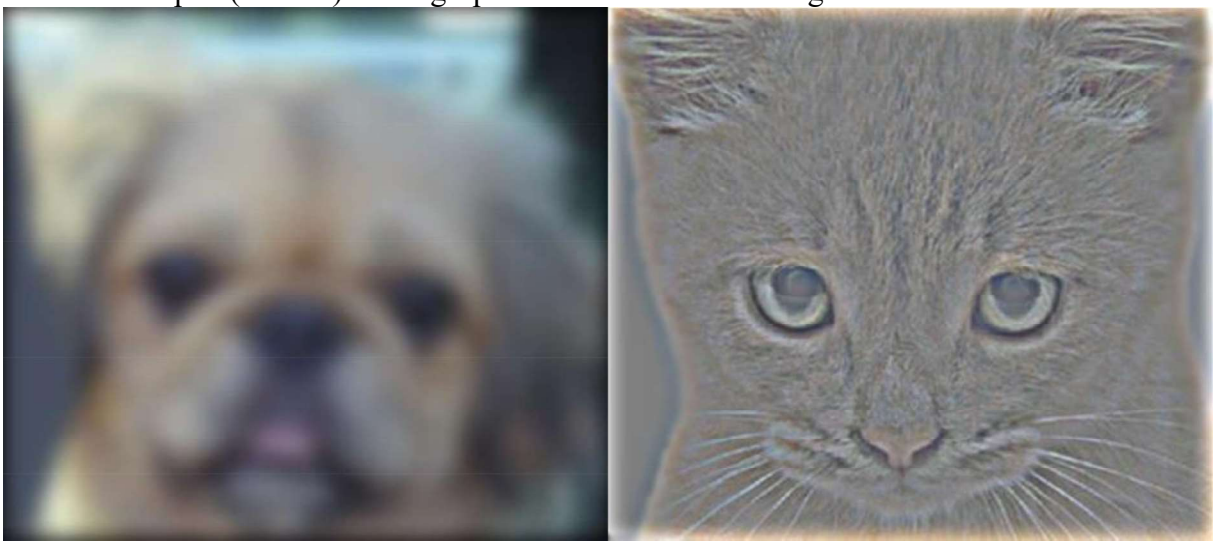
2. Hybrid Image (30%)

A hybrid image is the sum of a low-pass filtered version of the one image and a high-pass filtered version of a second image. There is a free parameter, which can be tuned for each image pair, which controls how much high frequency to remove from the first image and how much low frequency to leave in the second image. This is called the "cutoff frequency". In the paper it is suggested to use two cutoff frequencies (one tuned for each image) and you are free to try that, as well. In the starter code (*proj1.m*), the cutoff frequency is controlled by changing the standard deviation of the Gaussian filter used in constructing the hybrid images.

For example shown at the top, the two original images look like this:



The low-pass(blurred) and high-pass versions of these images look like this:



The high frequency image is actually zero-mean with negative values so it is visualized by adding 0.5. In the resulting visualization, bright values are positive and dark values are negative.

Adding the high and low frequencies together gives you the image at the top. If you're having trouble seeing the multiple interpretations of the image, a useful way to visualize the effect is by progressively downsampling the hybrid image as is done below:

The starter code provides a function, *vis_hybrid_image.m* to save and display such visualization.

Potential useful MATLAB functions: *fspecial(), padarray()*
Forbidden functions: *Imfilter(), filter2(), conv2(), nlfilter(), colfilt()*
(you can use for testing but not in your final code.)

II. Report

1. (5%) Write up with several examples of hybrid images.
2. (5%) Try different setting of the cutoff_frequency (ex:3,7,11) in proj1.m and explain what you observe (execute time, filter kernel size, blurred quality).
3. (10%) Explain why the high frequency images will be seen at close distance (larger one) while the low frequency images will be seen at far distance (smaller one)? (Hint: what's the meaning of high frequency signal and low frequency signal in an image?)

III. Deliverable and file organization

Directory	Filename	Description
LAB6/code/	*.m	All matlab script
LAB6/results/	*.png	Your result
LAB6/report/	report.pdf	Your report

When you submit your file, please organize your files according to the above table and compress your files to LAB6_10xxxxxxx.zip in ZIP format.

P.S 10xxxxxxx is your student ID.

IV. Reference

[1] http://cvcl.mit.edu/publications/OlivaTorralb_Hybrid_Siggraph06.pdf