PROGRAMMING ASSIGNMENT 1

Due: March 26, 2014 (12:30pm)

The goal of this assignment is to create hybrid images using the approach described in the SIGGRAPH 2006 paper 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.

Problem 1: Frequency Domain Filtering

This part is intended to familiarize you with image filtering in frequency domain. You can find two sample images (of Derek Hoiem himself and his former cat Nutmeg) and some starter code that can be used to load two images and align them at http://www.cs.uiuc.edu/homes/dhoiem/courses/cp_fall2010/projects/hybrid/hybrid.zip. The alignment is important because it affects the perceptual grouping (read the paper for details). First, you’ll need to get a few pairs of images that you want to make into hybrid images. You can use the sample images for debugging, but you should use your own images in your results. Then, you will need to write code to low-pass filter one image, high-pass filter the second image, and add (or average) the two images (Figure 1). For a low-pass filter, Oliva et al. suggest using a standard 2D Gaussian filter. For a high-pass filter, they suggest using the impulse filter minus the Gaussian filter (which can be computed by subtracting the Gaussian-filtered image from the original). The cutoff-frequency of each filter should be chosen with some experimentation.

![Figure 1: The creation process of a hybrid image (taken from [1]).](image)

For your favorite result, you should also illustrate the process through frequency analysis. Show the log magnitude of the Fourier transform of the two input images, the filtered images, and the hybrid image. In Matlab, you can compute and display the 2D Fourier transform with:

```
imagesc(log(abs(fftshift(fft2(gray_image)))))
```
Try creating a variety of types of hybrid images (change of expression, morph between different objects, change over time, etc.).

**Problem 2: Laplacian Pyramids**

This part is intended to familiarize you with image pyramid processing, but otherwise the goal is the same. Download and install the pyramid image processing toolbox by Eero P. Simoncelli [2]. First, you will generate Gaussian and Laplacian pyramids for the input two images. Then, you will want to generate a hybrid images by adding multiple levels of the Gaussian and Laplacian pyramids. In this case, the cutoff-frequency for the low-pass and high-pass filters can be set choosing the last N and the first M levels, respectively. To get the best results, you need to select the best thresholds for each pair of images. For this part of your problem set, you can use `buildGpyr`, `buildLpyr` and `pyrBand` functions supplied in [2].

For your favorite result, you should also show the Gaussian and the Laplacian pyramids of the input images. In addition, show the Laplacian pyramid of the hybrid image as in Figure 2.

![Figure 2: (a) A hybrid image, (b) Output of a Laplacian pyramid revealing the components of the hybrid image (taken from [1]).](image)

As in the first part, try creating a variety of types of hybrid images (change of expression, morph between different objects, change over time, etc.).

**Grading**

The assignment will be graded out of 100 points:

- 0 (no submission), 20 (an attempt at a solution), 40 (a partially correct solution), 60 (a mostly correct solution), 80 (a correct solution), 100 (a particularly creative or insightful solution)

Note: Preparing good report is important as well as your solutions!
What to Hand In

You are required to submit all your report along with a short webpage in HTML. For that purpose, prepare a folder containing

- HTML/README.txt (text file containing details about your project)
- HTML/code/ (directory containing all your code)
- HTML/ (directory containing all your documents, including your images)
- HTML/data/ (including your data images)
- HTML/result/ (including your result images)
- HTML/index.html (html report)

Archive this folder as pset1.zip and email to my email address (aykut@cs.hacettepe.edu.tr).

Each student must individually do the coding and prepare detailed HTML report which contains a brief overview of the problems, details of your implementation and results with your observations. If your implementation failed to give a satisfactory results, provide a brief explanation of the reason(s).

Late Policy

You may use up to five extension days (in total) over the course of the semester for the three PSets. Any additional unapproved late submission will be weighted by 0.5.

Academic Integrity

All work on assignments must be done individually unless stated otherwise. You are encouraged to discuss with your classmates about the given assignments, but these discussions should be carried out in an abstract way. That is, discussions related to a particular solution to a specific problem (either in actual code or in the pseudocode) will not be tolerated. In short, turning in someone else’s work, in whole or in part, as your own will be considered as a violation of academic integrity. Please note that the former condition also holds for the material found on the web as everything on the web has been written by someone else.

References