Chennai Mathematical Institute
Computer Vision
January 31, 2020

Assignment 2: **Image Pyramids and Image Mosaics**

Due Date: Friday, February 14, 2020 @ 6:00PM

Note: You may use the functions you built in Assignment 1 or ones provided in the package you are using for padding and/or convolutions. However, ***you may not use a packaged function down-sampling, up-sampling*, *or generating the pyramids.***

1. Write a function to construct an image pyramid. Your function should take as input:
    a. An image (color or grayscale)
    b. A separable filter
    c. Desired number of levels in the pyramid

2. Specialize the function above to generate Gaussian pyramids.
    a. Use a 5x5 window for your convolution.
    b. You can use the binomial kernel $1/16[1, 4, 6,4,1]$.
    Note: See the algorithm outlined in [1] for an efficient implementation of the down-sampling function.

3. Build the Gaussian pyramid for the two of the images provided (one grayscale and one color) for up to 5 levels.

4. Construct a function to generate the interpolated, up-sampled image given an image. The up-sampled will have twice as many rows and columns of the input image and 4 times as many pixels.
    Note: See the function EXPAND in [1] for suggestions on an efficient implementation.

5. Write a function to build the Laplacian pyramid from a Gaussian pyramid by computing the difference between the image at each level and the up-sampled image from the level above. Note that at the highest level of the pyramid, the Laplacian and Gaussian images are identical.

6. Build the Laplacian pyramids for the two images from task 3, using the Gaussian pyramids you have created.

7. Reconstruct the original images by summing the Laplacians, recovering the image at each level by adding the Laplacian (at that level) to the up-sampled version of the Gaussian at the level above.

8. How does the reconstructed image compare with the original? Measure the pixel-wise intensity difference and provide your observations.

Extra Credit:

Write a program that takes as input two color images of the same size and produces a blend of the two images (say A and B) by combining the left half of image A with the right half of B. The process works as follows:

1) Construct Laplacian pyramids LA and LB images A and B respectively.
2) Construct a third Laplacian pyramid LS by copying pixel intensity values from the left half of LA to the corresponding pixels of LS, and the pixel values in the right half of LB to the right half of LS. Nodes along the center line of LS are set equal to the average of corresponding LA and LB nodes. More details are in [2], page 226.
3) Obtain the merged image S by expanding and summing the images Laplacian pyramid L_s.

Note: It is convenient to have the image dimensions be 2^N+1, where N denotes the number of levels of the pyramid. So, crop or pad your images to get the right size.

References:

[1] "The Laplacian Pyramid as a Compact Image Code" by Peter J. Burt and Edward H. Adelson, IEEE Transactions on Communications, April 1983.

[2] "A Multiresolution Spline with Applications to Image Mosaics" by Peter J. Burt and Edward H. Adelson, ACM Transactions on Graphics, October 1983.