LAB 8: DUE 2 FEBRUARY, (BETTER BY 26 JANUARY)

Poisson image editing enables seamless compositing. The reference on the topic is Perez et al.'s article, "Poisson image editing," published at Siggraph 2003 and available at http://dl.acm.org/citation.cfm?id=882269
Given a background (target) and a new foreground (source), as well as a binary mask, we seek to replace the target region inside the mask by the con- tent of the source. Below, we show a target (water), a source (bear), and the corresponding mask.

Task 1: Naive Compositing (10 pts)

Implement a function naiveComposite(bg, fg, mask, y, x) that simply copies the pixel values from an image fg into a target bg when mask is equal to 1. fg is assumed to be smaller than bg and has the same size as mask. y and x specify where the upper left corner of fg goes in the source image bg. In python you should be able to do it without a for loop, using multiplications between images and the mask or 1-mask, and using the slicing operator :.

Task 2: Poisson Gradient Descent (40)

Write a function Poisson(bg, fg, mask, niter) implements gradient descent to solve for Poisson image compositing. bg, fg, and mask are assumed to have the same size. Your code will be a more or less direct implementation of the math in the supplementary material.

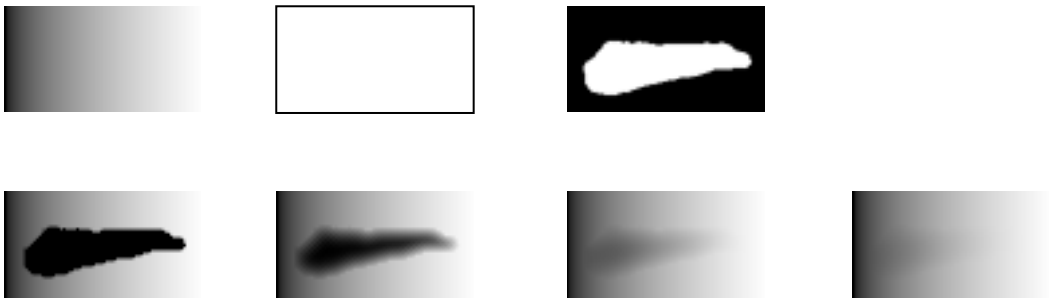
Implement a Laplacian operator and a dot product for images functions.

The Laplacian operator is a convolution of the image with [[0, -1, 0],[-1 , 4, -1],[0, -1, 0]]. The dot product is the sum of all elements in a element wise multiplication (images, of course, need to be same size).

In a nutshell, first compute the constant image b by applying the Laplacian operator to the image fg. Initialize x with a black image and iterate: compute the residual r by applying the Laplacian to your current estimate and subtract it from b. Then solve for alpha using the dot product you have implemented for images. Finally, update your estimate of x.

Besides replacing the matrix-vector operations by their image implementation, the other special thing you need is to make sure that pixels outside the that mask have values from bg and are not updated. For this, first initialize the pixel in x outside the masked area by copying those in bg. See below for examples of x, and in particular x_0. You can do all this easily with array subtractions and multiplications. Next, you need to multiply your residual by the mask as soon as you compute it. This way, your updates will only consider pixels inside the mask.

Test this function on the small inputs because it is slow to converge. I highly recommend the provided testRamp which seeks to paste a flat source into a background composed of a greyscale ramp. Input and in the first row, and x0, x50, x100, x200.



Task 3: Poisson Conjugate (50)

Write a function PoissonCG(bg, ,fg, mask, niter)) that implements the above conjugate gradient algorithm to solve Poisson image editing. The specifications are the same as for gradient descent. Similarly, x_0, r_i and d_i need to be masked appropriately. Note how much faster the conjugate method converges.

Extra

Have fun with it. Try your own pics, etc. Read about Conjugate Gradient Descent.
http://www.cs.cmu.edu/~quake-papers/painless-conjugate-gradient.pdf

Deliverables

Naive Compositing image. Task 2: 50, 100, and converged composited. Task 3: Final Bear composite, and your composite