CS 91R: The Computational Image

Assignment 2: Filtering

DUE February 12th at 11:55 PM

1 Part One: Implementation

As part of a p5 sketch, implement the following filters using convolution. Each filter should be written as a function that takes a `p5.Image` and returns a new `p5.Image`. Use your grayscale conversion from last lab. **I'll do some demos in the beginning of lab so be there on time!**

1.1 Blur Two Ways (using the box and gaussian kernels)

$$\frac{1}{25}\begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix} \qquad \frac{1}{256}\begin{bmatrix} 1 & 4 & 6 & 4 & 1 \\ 4 & 16 & 24 & 16 & 4 \\ 6 & 24 & 36 & 24 & 6 \\ 4 & 16 & 24 & 16 & 4 \\ 1 & 4 & 6 & 4 & 1 \end{bmatrix}$$

1.2 Horizontal Sobel

The resulting values may be negative, so either add an offset or use the absolute value.

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

1.3 Vertical Sobel

The resulting values may be negative, so either add an offset or use the absolute value.

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

1.4 Sobel

Combine the magnitude of the gradient from the horizontal and vertical sobel: `sqrt(sq(x) + sq(y))`.

2 Part Two: Evaluation

Reimplement your blur filter as two one-dimensional filters. Compare the computation time spent with the standard k^2 filter and the $2k$ implementation that exploits the linear separability of the filter. You can use `millis()` to calculate the run-time of the filtering operation. Write about it in `refelection.md`.

$$\frac{1}{25}\begin{bmatrix}1 & 1 & 1 & 1 & 1\\1 & 1 & 1 & 1 & 1\\1 & 1 & 1 & 1 & 1\\1 & 1 & 1 & 1 & 1\\1 & 1 & 1 & 1 & 1\end{bmatrix} = \frac{1}{25}\begin{bmatrix}1\\1\\1\\1\\1\end{bmatrix}\begin{bmatrix}1 & 1 & 1 & 1 & 1\end{bmatrix} \qquad \begin{bmatrix}-1 & 0 & 1\\-2 & 0 & 2\\-1 & 0 & 1\end{bmatrix} = \begin{bmatrix}1\\2\\1\end{bmatrix}\begin{bmatrix}-1 & 0 & 1\end{bmatrix}$$

3 Part Three: Have fun!

Use your filters to display the webcam's images in a creative manner. Some possible ideas:

- use a sequence of filters in some creative way;
- filter RGB images;
- use the blur idea on the hue (or S or V) in another color space;
- use different filters in different parts of the image;
- use a sequence of filters overlayed using an alpha layer on the original image.
- combine multiple images by adding/averaging/compositing them:
  - `nimg.pixels[i] = 0.5 * img1.pixels[i] + 0.5 * img2.pixels[i]`

4 Learning Objectives

- filter images using convolution;
- implement blurring using linear separability;
- evaluate the run-time of similar algorithms.