3460:435 Algorithms

Project 3 --- Dynamic Programming

Images are often viewed on different devices with different resolutions and viewing space. To accommodate limited space, one can resize the image using techniques such as cropping. However, cropping alters the image and is not always desirable. Your third programming assignment is to implement a dynamic programming algorithm called seam craving for image resizing. This project is to be done in C++.

Here is a link to the paper on seam carving published on SIGGRAPH2007 http://www.faculty.idc.ac.il/arik/site/seam-carve.asp (paper and video).

Seam carving changes the size of an image by removing the least visible pixels in the image. The visibility of a pixel can be defined using an energy function. Seam carving can be done by finding an one-pixel wide path of lowest energy crossing the image from top to bottom (vertical path) or from left to right (horizontal path) and removing the path (seam).

$$e(\mathbf{I}) = |\frac{\partial}{\partial x}\mathbf{I}| + |\frac{\partial}{\partial y}\mathbf{I}|$$

e(i,j) = |v(i,j)-v(i-1,j)|+ |v(i,j)-v(i+1,j)|+ |v(i,j)-v(i,j-1)|+ |v(i,j)-v(i,j+1)|,

v(i,j) = pixel value at (i,j). For the boundary cases, the difference = 0 if one of the pixel is outside of the given image.

The cumulative minimum energy M for all possible connected horizontal seams for each entry (i,j) can be calculated as the following

$$M(i,j) = e(i,j) + \min(M(i-1,j-1), M(i-1,j), M(i-1,j+1))$$

Similarly the cumulative minimum energy for vertical seams can be calculated also.
Note: When you process the image remove the lowest-energy vertical seams first before you remove the horizontal ones.

For this project, the image to be resized is in pgm (portable gray map) format. The pgm image file requires 4 entries followed by the greyscale values (some files include comments lines starting with the character #). The four entries are: the literal "P2", an integer representing the x dimension, an integer representing the y dimension, and an integer representing the maximum greyscale value. There should be x times y number of grey-level values after these 4 numbers. Part of a sample plain pgm image (40 columns × 42 rows) bug.pgm is shown below.

```
P2
# Created by IrfanView
40 42
255
192 192 192 192 192 192 192 192 192 192 192 192 192 192 192 192 192 192
192 192 192 192 192 192 192 192 192 192 197 197 197 191 192 192
...
```

The image of bug.pgm 

Your program should provide all the necessary functionalities, including:

(1) Allow the user to provide the image file name through the console (**command line)**.
(2) Allow user to specify #s of horizontal and vertical seams to be removed through the console (**command line)**.

(3) Save the processed image in a pgm file named: original_image_file_name_**processed**.pgm

To remove 10 vertical and 5 horizontal seams from image.pgm (this is only an example name), we are going to run your program using the following command:

- **"a.exe" image.pgm 10 5**

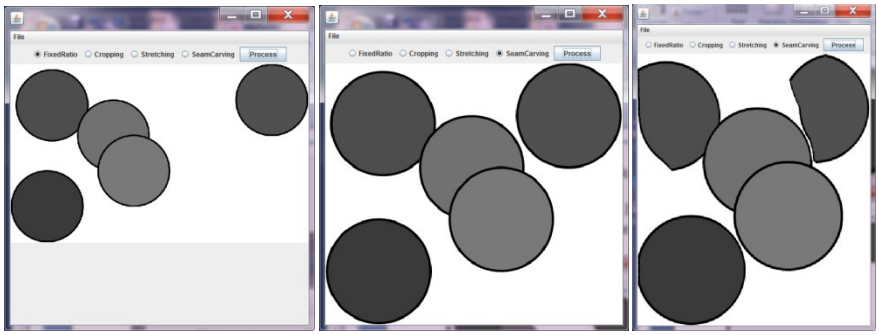
Your processed file should be saved as **image_processed.pgm**

Here is an excel seam carving calculator (SeamCarvingCalculator.xlsx). You should use it to double check your program before you submit your program!

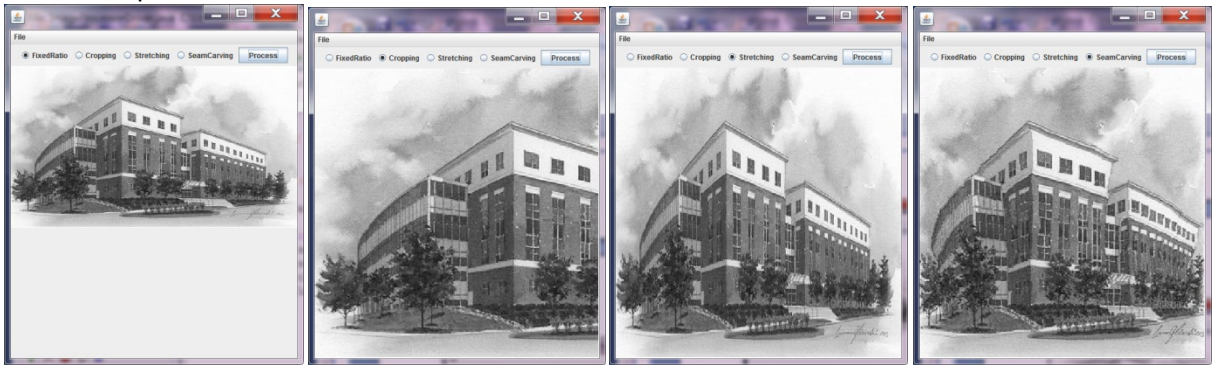
What to submit.

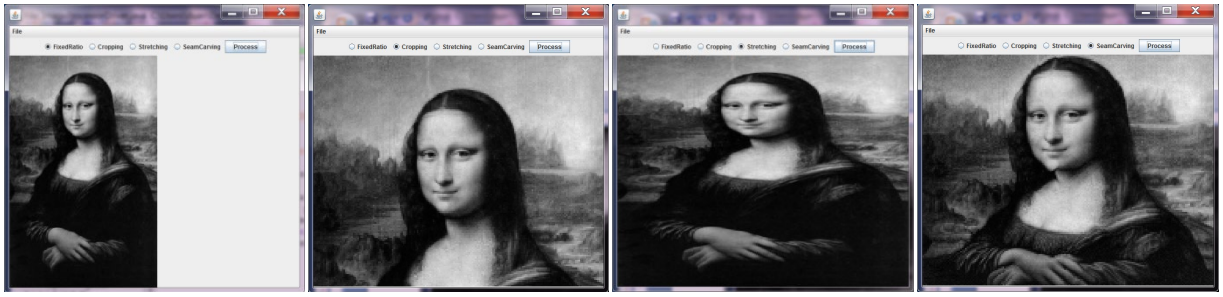
1. Grading sheet: testCases. Grade your project with the 4 test cases (three for the balls and one for CAS), check the cases that matches with my output; enter an X for the ones that do not match.
2. Submit your source code (upload to brightspace). Make sure to test your code on more than one set of data. DO NOT submit programs that are not *reasonably correct*! To be considered *reasonably correct*, a program must be completely documented and work correctly for sample data provided with the assignment.
3. A text file named readme.txt. You should use this file to give the reader a very clear description on how to run your code, a high-level explanation of your source code and point to anything unusual or notable about your program.
4. **Two processed images** from Buchtel.pgm:
    a. Buchtel_processes_100_0.pgm, "a.exe Buchtel.pgm 100 0", remove 100 vertical seams & 0 horizontal seam
    b. Buchtel_processes_50_20.pgm, "a.exe Buchtel.pgm 50 20", remove 50 vertical seams & 20 horizontal seam

Here are some examples:



More examples:





Source code submission instructions. Follow these steps:

1. Create a folder named jsmith_1 (but use your first initial and last name).
2. Place just the source files inside the folder.
3. Right-click on the folder and choose Send To... Compressed Folder (or use some other Zip utility to archive the entire folder). The goal is to create a zip archive named jsmith_1.zip (your initial and name) that contains the folder which contains the source files for your project.
4. Drop this single zipped file to the drop box.

Please pay attention to the naming conventions for the submission files. These must be followed exactly in order to receive credit. Invalid submissions will need to be resubmitted with a penalty assessed.

Be sure to electronically submit your working solution before the due date! Do not submit non-working programs. The electronic submission time will be used to assess late penalties (if applicable).

Graduate students:
Read the original paper and submit one page summary of the paper.