

CSC 481 – Intro. To Image Processing

2024-25 – Winter Term

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Weekly Assignment 1: Digital Images

Objective

This assignment has multiple goals. First, it is meant to help students get familiar with image manipulation. Second, it will provide an opportunity for students to practice some of the concepts studied in the lecture.

Data

To complete this assignment, please pick 3 images of your liking. You should use:

- 1) A picture from any interesting landmark from your hometown. This can be a picture taken by you or from the internet. Please clearly indicate the source on your report.
- 2) A picture from any interesting landmark from Chicago. This must be a picture taken by you. If you are from Chicago, please pick a different picture from the first one.
- 3) A random picture of your liking different from the first two.

You will have to run your code with each of these images, and then you must display and briefly discuss the results in your report.

Part 1 – Getting familiar with image manipulation

Write code that will:

- (a) Read an image, convert it to grayscale if it is not already, and display the converted image
- (b) Calculate and report the size (total number of pixels) of the image.
- (c) Calculate and report the maximum pixel value.
- (d) Calculate and report the mean pixel value.

Change the pixel values of the image in the following way: all pixels' values less than the average calculated at (d) will be equal to 0 and all the others will be equal to 1. Display your binary image. Make sure your displayed image is black and white, not black and near black.

In addition, perform your thresholding on a color image, thresholding separately in each color channel. Combine the results into a single image for display. The resulting image should be a color image.

Part 2 – Image Interpolation

Write code that will, given an input image, reduce its spatial resolution (use a reduction of 1/10 to 1/20 in each dimension), and then return it to its original resolution. Use all of **nearest neighbor**, **bilinear** and **bicubic interpolation** to do this. For each input, your display should include at least 7 images: the original,

three reduced images and three restored images (one pair for each interpolation). Comment on the differences you see among the three restored images.

In addition to your commentary on the visual differences, perform image subtraction between the original image each of the three restored images and show the subtraction results for each method of interpolation.

Part 3 – Reducing the number of Gray Levels in an Image

Write code that reduces the number of gray levels in an image from 256 to 2, in integer powers of 2. **Do not use library functions to do this, implement in your code the pixel math necessary for the gray level reduction.** For each input image, your display should include 8 images (as we saw in class), the original and the 7 reduced intensity images. Strive to have your images not to display darker and darker as you reduce the number of intensities.

In addition, write code such that the desired number of gray levels does not have to be a power of 2. Show an example run of your code using a non-integer power of 2 (e.g. $2^{3.7}$) number of gray levels.

The Program

In this assignment, you will write a program that handles multiple operations. You can use any programming language of your preference, but Python is highly recommended. Your code should be properly organized and well-commented to clearly identify the correspondence between portions of the code and each part of this assignment. The code should compile and run on any properly configured programming environment without the need of making significant changes to it. In this sense, it is highly recommended to avoid the usage of absolute paths.

The report

You are asked to submit a written report showing the results for each part of the assignment. Use proper section headings and descriptions to clearly identify the results of each part. If I cannot easily find a match in the report for a required result, I might assume that this portion was not completed, and a score of 0 will be given by default.

For students working with Python, you are allowed to use Jupyter Notebooks. These allow you to combine code with the report in a single deliverable, which is perfectly acceptable for this course.

Delivery Instructions

You are given the freedom to use any programming language and IDE of your preference. You are also required to provide your own images, and to produce a written report. When done, **you should submit everything using a single Zip file.**

File names. The zip file that you submit should use “[Last Name(s)], [Given Name(s)].zip” as it appears in D2L. For example, “Kenny Davila Castellanos” (Davila Castellanos is two last names), would have to submit the homework with the name “Davila Castellanos, Kenny.zip”. Another student named “Kenny Mauricio Davila” (Mauricio is a middle name), would have to submit the homework as “Davila, Kenny Mauricio.zip”. Not following these instructions might lead to a penalty.

Policies

1. All general policies about Plagiarism and Cheating apply to this homework. If you plagiarize or receive code from other people, you will be caught and you will receive a score of 0, and a report of the academic integrity violation will be filed.
2. Please limit the usage of Chat-GPT and other code generators to ethical usage only. Submitting code that was directly generated by these tools is considered a form of plagiarism.
3. Do not post your solutions online and do not share them with anyone. It is your responsibility to safeguard your private data.
4. **Code that does not compile due to syntax and/or semantic errors will automatically receive a score of 0.** It is hard to assign partial credit when I cannot even run your code.
5. You can use any programming language of your choosing.
6. You must follow the delivery instructions.
7. Very late homework's without justification will receive a score of 0.
8. The homework description outlines very specific requirements. You are welcome to try other things and report your results. However, no amount of extra work can be used as a substitution of the actual requirements.
9. Do ask for help if anything is unclear, but do it in a timely manner (e.g., by e-mail, Discord or during the Office Hours).