

The American University in Cairo

Department of Computer Science and Engineering

CSCE 4603 – Fundamentals of Computer Vision

Dr. Mohamed Moustafa	Assignment 1 [10%]	Spring 2021
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Assignment released February 21st, and due by March 7th

1. Implement the following transformations to input grayscale images:
 - a. translate, scale, and rotate around an **arbitrary point** of the image. Rotation angle can be any arbitrary value in the range -90 to +90. Your program should allow for combined transformations. [3 pts]
 - b. the following gray level transformations: [2 pts]
 - i. n^{th} power.
 - ii. histogram equalization.

Your program should expect as input a grayscale (8 bits/pixel) image, desired transformation(s), and the transformation(s) parameter(s) (e.g., the n in n^{th} power, the scaling factor, and the rotation angle, etc...).

2. Implement the following image 2D filters for input grayscale images
 - a) Smoothing (choose any averaging or median filter) [1 pt]
 - b) Gradient filter [1pt]
 - c) Sharpening filter [1pt]
3. A 2D filtering mask is said to be separable if it can be written as the product of two 1D masks. For instance, the box filter:

$$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \text{ can be decomposed as } \frac{1}{3} \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} \text{ and } \frac{1}{3} [1 \quad 1 \quad 1]$$

- a) Find at least one more separable filter from what we have studied. [1 pt]
- b) Develop a program that performs the following to any input grayscale image:
 1. 2D spatial filtering using the 2D filter.
 2. 2D spatial filtering using the two decomposed 1D filters.
 3. Compare the execution speed of 1) and 2) for many filter sizes, e.g., 3x3, 5x5, 7x7, and 11x11

You are expected to deliver:

- a) source code of your program.
- b) short report describing your work the original images and the output of each transformation. [1 pt]

You can use OpenCV (or any other image manipulation platform) to help you open the input image and save the transformed image in any of the standard image formats. However, you should perform all transformations on your own.

Bonus

Implement a pinhole camera and take pictures with it to use in the transformations above. Provide snapshots of your home-made camera setup + images taken with it.[1 pt]