CS 415 Mini Project 1

1 Question Answering

Q1. (1) What is the goal of computer vision? (2) Please list three computer vision tasks (for example, face detection) and their respective applications. (3) What is a (digital) RGB image? (10 points)

Q2. (1) Please briefly describe the process of linear filtering. (2) What are the commonality and difference between (cross) correlation and convolution? (15 points)

Q3. Below are a 3x3 grayscale input image (left) and a 3x3 kernel (right). Please manually perform correlation and convolution. Zero padding should be used to make the size of the output image the same as that of the input image. (15 points)

$$\begin{matrix} 1 & 0 & 2 \\ 2 & 2 & 1 \\ 2 & 1 & 0 \end{matrix} \qquad \begin{matrix} 2 & 1 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{matrix}$$

2. Programming

The goal of this programming assignment is let you master the image filtering operations discussed in class. It is mandatory to use Python 3. OpenCV can be used for reading, writing, and displaying images.

P1. Implement the convolution operator. Directly calling a convolution or filtering function from any library is prohibited. You can use the linear filtering code in our code tutorial as a template (available in Blackboard) or build your own code from scratch. You are encouraged to implement your own Gaussian function. Please use padding to keep the image size unchanged. (25 points)

- Use convolution to apply mean, Gaussian (std=1), and sharping filters to lena.png.
- Try different kernel sizes: 3x3, 5x5, and 7x7.

P2. Implement the median filter (same requirement as P1). To keep the image size unchanged, you may simply ignore the pixels outside the input image when calculating the median value of a patch. (25 points)

- Apply both mean and median filters to art.png.
- Try different kernel sizes: 3x3, 5x5, 7x7, and 9x9.

P3. Self-study the filter2D function in OpenCV[1]. Use it to perform Gaussian filtering on lena.png with different kernel sizes (3x3, 5x5, and 7x7). Are the results the same as those obtained by your implementation in P1? (10 points)

3 Submission

Please follow the instructions below for submission.

- You need to upload two files to Blackboard: a PDF file and a .py file[2]. Do not compress them into a single ZIP file.
- The PDF file contains all your solutions to this homework. For Question Answering, you can either type answers or handwrite them and take a photo. For Programming, you need to include output of the program such as a processed image.
- The .py file contains all your code for the programming problems.

[1] https://www.askpython.com/python-modules/opencv-filter2d

[2] Using Jupyter Notebook and submitting a .ipynb file instead of a .py file are fine.