SWS3026 Visual Computing

Tutorial 2: **Image Processing Basics**

Tasks:

1. Study OpenCV basic image manipulation operations
2. Study Numpy, Scipy, PIL and Matplotlib libraries
    a. https://docs.opencv.org/4.8.0/d6/d00/tutorial_py_root.html
    b. https://numpy.org/doc/stable/
    c. https://docs.scipy.org/doc/
    d. https://pillow.readthedocs.io/en/stable/
    e. https://matplotlib.org/stable/contents.html

Installation

A. Install Anaconda from: https://www.anaconda.com/download

   This will install most of the packages you need for this course, including Python, Jupyter, Pytorch, Numpy, Scipy, Scikit-learn, Pillow, Matplotlib.

   After installation is successful, run the Anaconda Prompt (see the Conda section on this page: https://docs.anaconda.com/free/anaconda/install/verify-install/). In the prompt window, type: **`conda list`**

   This will show all the installed packages and their version number.

B. Install OpenCV by following the instructions here: https://pypi.org/project/opencv-python/

   This uses the **`pip`** command, which was installed along with Anaconda.

Questions

Q1. Read the lecture notes 3_4_Convolution.pdf and 3_5_2dConvolution.jpg to understand the concept of convolution. Convolve the following "signals" A and B by hand. Then verify your answer by using Python code. (HINT "**`from scipy import signal`**" and use **`signal.convolve`**). The underlined number is the origin, ie. where t=0 or (x,y)=(0,0).

(a) $A = [\underline{2} \quad -1]$, $B = [\underline{-1} \quad 2 \quad 1]$

(b) $A = \begin{bmatrix} \underline{1} & 3 & 2 & -1 \\ 2 & 0 & 3 & 4 \\ -1 & 2 & 4 & 1 \\ 5 & -2 & 0 & 1 \end{bmatrix}$, $B = \begin{bmatrix} \underline{0} & 1 \\ 2 & -1 \end{bmatrix}$

Programming exercises:

Q2. Write a python script to open the *"lena.png"* file using OpenCV.

- Display the opened image in a new window named "Display Lena"
- Save the image to a new file named "lena_resaved.png"

Q3. Use PIL and Matplotlib libraries for this question.

Use *"lena.png"* to perform following operations and save the images:

- Crop a section from the image whose vertices are (100,100), (100,400), (400,100), (400,400). (hint: convert the cv2 image into PIL Image)
- Rotate the cropped image by 45 degrees counter-clockwise.
- Perform histogram equalization on lena.png. (hint: use **`ImageOps.equalize`** from PIL)
- Use matplotlib to plot the histogram figure for both original image and processed image. (hint: use **`histogram`**() function in PIL)
- Perform Max Filtering, Min Filtering, and Median Filter on lena.png. (hint: **`PIL.ImageFilter`**)
- Perform Gaussian Blur with sigma equal to 3 and 5. (hint: **`PIL.ImageFilter`**)

Q4. Colour space conversion. First, read this tutorial to understand the common color spaces:

https://medium.com/analytics-vidhya/image-processing-series-part1-colorspaces-836d2e3ca700

Use Python OpenCV functions to perform following operations on *"bee.png"* and save the images at each step.

- Read the image.
- Convert the image to HSV color space.
- Perform histogram equalization on V channel by **`cv2.equalizeHist`**().
- Convert the result image to BGR color space.
- Show the image by **`cv2.imshow`**() and save the image.