Lab 2 – Basic Image Processing Techniques and Application of OpenCV to Color Processing

Goals:

- *Introduction to basic image processing operations.*
- *Getting familiar with OpenCV library. Basic processing of color images.*
- *Getting familiar with different color spaces.*

Introduction

In this lab we will study basic image-processing operations: image resizing and rotation.

We will analyze the effects of resizing and rescaling on image quality and the methods to improve the quality and avoid artifacts.

We will get familiar with different color spaces while using Application of OpenCV to Color Processing.

OpenCV library

OpenCV is an open source computer vision library, written in C and C++. One of the main goals of OpenCV is to provide a simple-to-use computer vision infrastructure that helps people to build sophisticated vision applications quickly. Among the tools provided by OpenCV are image transformations, histograms, video tracking, 3D vision algorithms and machine learning.

The OpenCV library is available for download from [1] *. In the downloaded package you'll find a tutorial, comprehensive documentation and many useful examples. Also, the OpenCV documentation can be found online at OpenCV homepage [2]. OpenCV programming in Python can be studied using Ref [3].

** OpenCV already installed in Google Colab, use 'import cv2'.*

Preliminary report

Part 1 – Basic Image Processing Techniques

1. Study the python functions **resize, rescale** and **rotate** from skimage.transform library. Give a short explanation about each of the input argument for these functions. Give a short explanation about each of the interpolation methods (*order* input) that can be used as an input argument for these functions (nearest-neighbor, bilinear, biquadratic, etc.).
2. Why do rotate methods need interpolation? Give a short explanation.
3. What problem may occur when down-scaling an image? How is it possible to overcome this problem? Refer to the help of **resize** function and explain how the solution to the above problem is used in **skimage.transform.resize** function.

Part 2 - Color Spaces

1. Give the definition of histogram. What is histogram used for?
2. Assume a grayscale image. What is histogram equalization and what is it used for?
3. What is the mathematical formula for RGB to grayscale conversion? Explain the weighting on the formula.
4. Give a short description of RBG, CMYK, HSV and LAB color spaces. Explain the meaning of each letter in these abbreviations. Give examples for common uses for each of these color spaces. (Hint: the information about color spaces can be found in many digital image processing books, e.g., in [9].)
5. What are the RGB and HSV values for the colors black, white, gray, red, green, blue, cyan, magenta and yellow? Write all values in one chart.
6. what are the complementary colors of red, green, and blue?
7. Study the OpenCV function **cvtColor** from the cv2 library. Write a command that converts an image, given in BGR color space, to HSV color space. Write a command that performs the backwards conversion (i.e., from HSV to BGR).
8. Study the OpenCV functions **split** and **merge** from cv2 library. Write a command splitting an HSV image into its 3 components (H, S and V) and merging them again to a single HSV image.

Find a grayscale image and a color image to be used in the lab and send it to your email.

Description of the experiment

Open the Google Colab notebook supplied for Lab2 and follow the instructions in the 2 sections:

1. Basic Image Processing Techniques - Resizing (Scaling) and Rotation.
2. Color Space Conversion

Final report

Part 1 – Basic Image Processing Techniques

Submit the results of the demonstrations from Jupyter Notebook with the image of your choice. Answer all questions and give the relevant examples as instructed in this part.

Note - RMS calculation:

$$RMS = \left[\frac{1}{MN} \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} \left[\hat{f}(i,j) - f(i,j) \right]^2 \right]^{\frac{1}{2}}$$

where f is the original image and $\hat{f}$ is the output of shrinking and then expanding the image by the same factor.

Part 2: Color Spaces

Submit the results of the demonstrations from Jupyter Notebook with the image of your choice. Answer all questions and give the relevant examples as instructed in this part.

Pay attention to all submission guidelines in the lab1 manual file.

Submit a single PDF file with all your answers.

Verify that the PDF contains all your content.

References

1. Install: https://pypi.org/project/opencv-python/
2. Documentation: https://docs.opencv.org/master/index.html
3. Tutorial: https://docs.opencv.org/master/d6/d00/tutorial_py_root.html
4. A. K. Jain, *Fundamentals of Digital Image Processing*. Prentice-Hall, Inc., 1989 (Library Dewey number 621.368 JAI).
5. http://www.scipy-lectures.org/advanced/image_processing/
6. http://scikit-image.org/docs/dev/index.html
7. https://opencv-python-tutroals.readthedocs.io/en/latest/index.html
8. https://pythontic.com/image-processing/
9. R. C. Gonzalez, R. E. Woods, *Digital Image Processing.* Pearson Education, 2008, Third Edition. Chapter 6 (Color Image Processing).