

Introduction – Image processing with Python

EE551

Week 1 – Image Processing in Python

Ref. chapters 1 & 2, Gonzalez & Woods

2023

Image Processing tools in Python

- There are multiple image processing packages available in Python
- In this module, we will use the following:
 - openCV
 - Pillow (Python Image Library)
 - Scikit-image
 - Matplotlib
 - Numpy (for data manipulation)
- Most of these packages offer the same basic functionality (e.g. image read/write etc). However, some have particularly useful features not easily available in other packages

Image Processing tools in Python

- All code examples in this module will be presented in Jupyter Notebooks
- All example code implementations will be shared via Jupyter notebooks
- Each lecture slide deck will have an accompanying Notebook

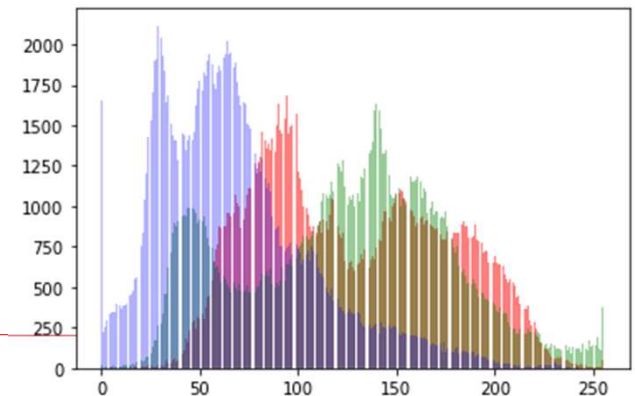
Basic image properties

- As a first analysis step, it is always worth understanding the properties of the image data you are working with. Fundamental properties include:
 - Image size/resolution – vertical and horizontal size in pixels
 - Colour format – greyscale, RGB, HSV, LAB etc?
 - Pixel data format – uint8, uint16, float?
 - File format – png, bmp, jpg?



Image statistics

- Understanding the basic statistics of an image is also very useful. Statistics can be used in the following ways:
 - As a initial step for thresholding
 - To debug image quality issues (e.g. low contrast)
 - To debug colour issues e.g. a white balance issue can be debugged by looking at the relative stats of red, green and blue stats



Colour spaces

- A colour space is a mathematical representation of how image colours are described. We will cover multiple colour spaces and their uses in this module. As an introduction, some common colour spaces are:
 - Greyscale – one colour channel representing image lightness (i.e. from dark shades to light shades)
 - RGB – each colour is represented as a mixture of red, green and blue components
 - HSV – each colour is represented as a mixture of Hue, Saturation and Value (a greyscale representation)
 - LAB - each colour is represented as a mixture of lightness, red-green and blue-yellow combinations



Colour spaces - examples

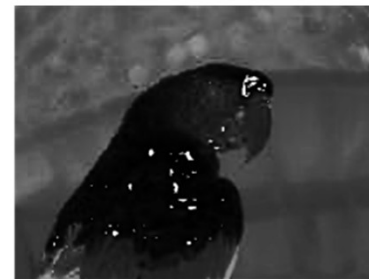


Input Image

R,G,B colour channels



h



s



v



H,S,V colour channels



Basic image manipulations - Image Cropping

- Cropping refers to selecting a region from an image and discarding the rest of the image
- Generally speaking, there are two ways the crop area is defined, depending on the package used:
 - Define top left coordinate, width and height
 - Define top left and bottom right coordinate
- Often a pre-processing step, to remove redundant information



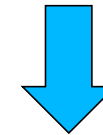


Basic image manipulations - Image Resizing

- Image resizing involves changing the size (in pixels) of an image
 - Downscaling – taking a large image and reducing to lower size
 - Upscaling – taking a smaller image and increasing to a larger size
- The quality of the output image is largely dependent on the interpolation scheme used



107*105 pixels



720*540 pixels





Basic image manipulations – Geometric operations

- Geometric operations change the fundamental shape of the image. Examples include
 - Rotation
 - Affine transformation
 - Perspective manipulations
 - Radial distortion manipulations





Basic image manipulations – Pixel manipulations

- Pixel level manipulations involved change the values of the pixels themselves
- Pixel level operations include
 - Addition, subtraction
 - Blending images
 - Tone mapping
 - Colour adjustments e.g. saturation adjustment



Basic image manipulations – Pixel manipulations

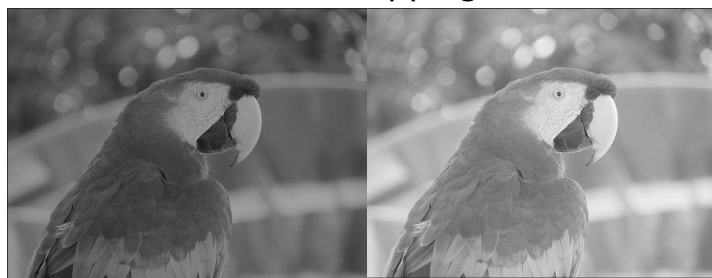


Difference image

Alpha blending



Tone mapping



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Colour saturation

Basic image manipulations – Adding noise

- Multiple types and levels of noise can be added to images
 - Gaussian
 - Poisson
 - Salt and Pepper
 - White noise
- Some denoise filters are better at removing certain types of noise than others. Adding noise to images is an important part of the test and validation step
- Counterintuitively, noise can also improve image quality in certain cases
 - Dithering
 - Half-toning



Basic image manipulations – Adding noise

Gaussian noise with sigma=0.1



Gaussian noise with sigma=0.25



Salt and Pepper noise with amount=0.1



Salt and Pepper noise with amount=0.25



Gaussian noise with sigma=0.5



Gaussian noise with sigma=1



Salt and Pepper noise with amount=0.5



Salt and Pepper noise with amount=1



Questions?
