Lab 2: Image Processing
CPV301

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White patch

Find the max value of each channel (R, G, B) in the image.

Then value of each channel of each pixel in the balanced image equal to the corresponding pixel in the original image divide by the max value of that channel:

$$balanced[x, y, channel] \longleftarrow original[x, y, channel]/channel\_max$$

Gray world

Find the mean value all channel of all pixel and the mean value of each channel (R, G, B) in the image.

Then value of each channel of each pixel in the balanced image equal to the corresponding pixel in the original image multiply by the mean of all pixel then divide by the mean value of that channel:

$$balanced[x, y, channel]$$

$$\longleftarrow original[x, y, channel] * image\_mean / channel\_mean$$

Ground truth

Similar to gray world but we do not use the mean of the whole image but the mean of the specific patch.

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Histogram Equalization

This method usually increases the global contrast of many images, especially when the image is represented by a narrow range of intensity values. Through this adjustment, the intensities can be better distributed on the histogram utilizing the full range of intensities evenly. This allows for areas of lower local contrast to gain a higher contrast.

Histogram equalization accomplishes this by effectively spreading out the highly populated intensity values which are used to degrade image contrast.

Reference: Histogram Equalization - OpenCV

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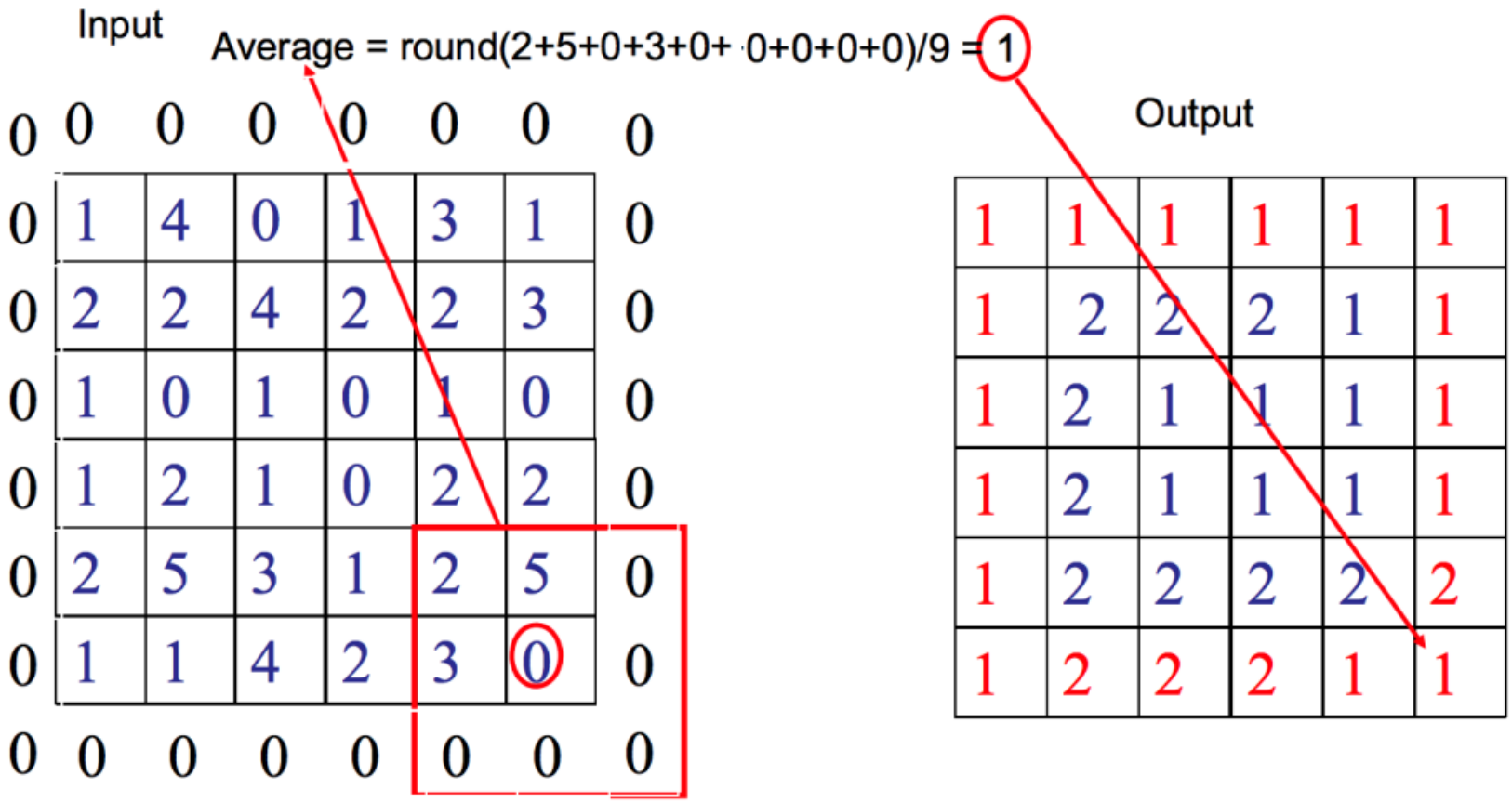
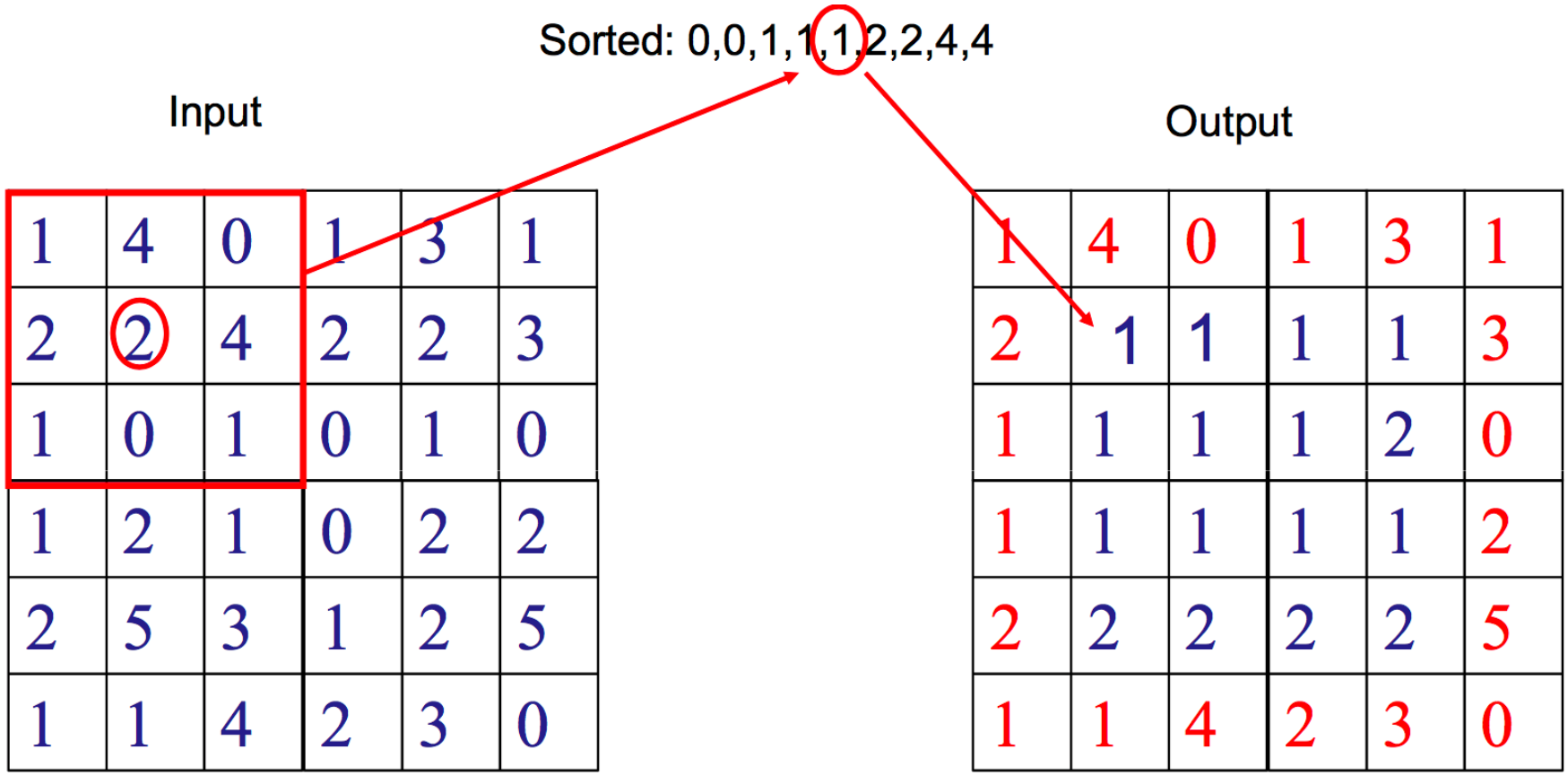
0-Padding

To prevent from reducing the size of the image after filtering when use convolution, we need to add the 0-padding to the image.



Median filter

For each patch with the size of the given kernel, we choose the median value (the middle value after sorting) to create the new pixel.



Convolution

In convolution, the value of an output pixel is computed as a weighted sum of neighboring pixels. The matrix of weights is called the convolution kernel, also known as the filter.

Convolution uses the kernel to highlight a particular feature of an image.

$$(f * g)(t) \stackrel{\text{def}}{=} \int_{-\infty}^{\infty} f(\tau)\, g(t-\tau)\, d\tau$$

Mean filter

Kernel of the mean filter is the matrix of all 1-entry divide by its size.

For example the 5×5 kernel:

$$\frac{1}{25}\begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

Gaussian filter

Each entry of the Gaussian kernel is calculated by the following formula:

$$G^s(x, y) = \frac{1}{2\pi s^2} \exp\left(-\frac{x^2 + y^2}{2s^2}\right)$$

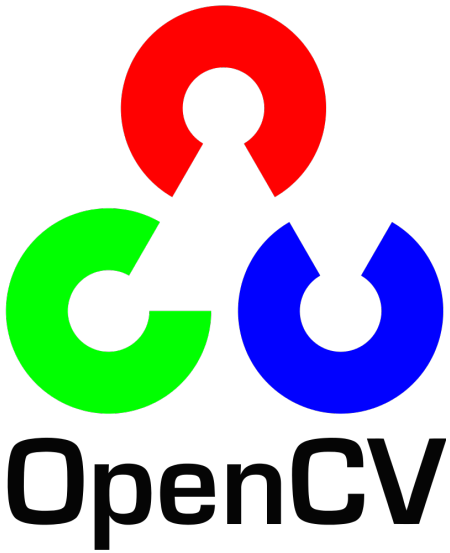
Where (x, y) is the coordinates of that entry, and the coordinates of center of the kernel is $(0, 0)$.

Dependencies

Tkinter is the library be chosen to design GUI for this app. It is the standard GUI library for Python. Tkinter provides a fast and easy way to create applications.

Dependencies

NumPy is imported for mathematical calculations, matrices operations. And OpenCV is used for loading and exporting images.



Algorithms implementation

All algorithms are implemented from scratch using the formulas that are presented in the previous slides.

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First view

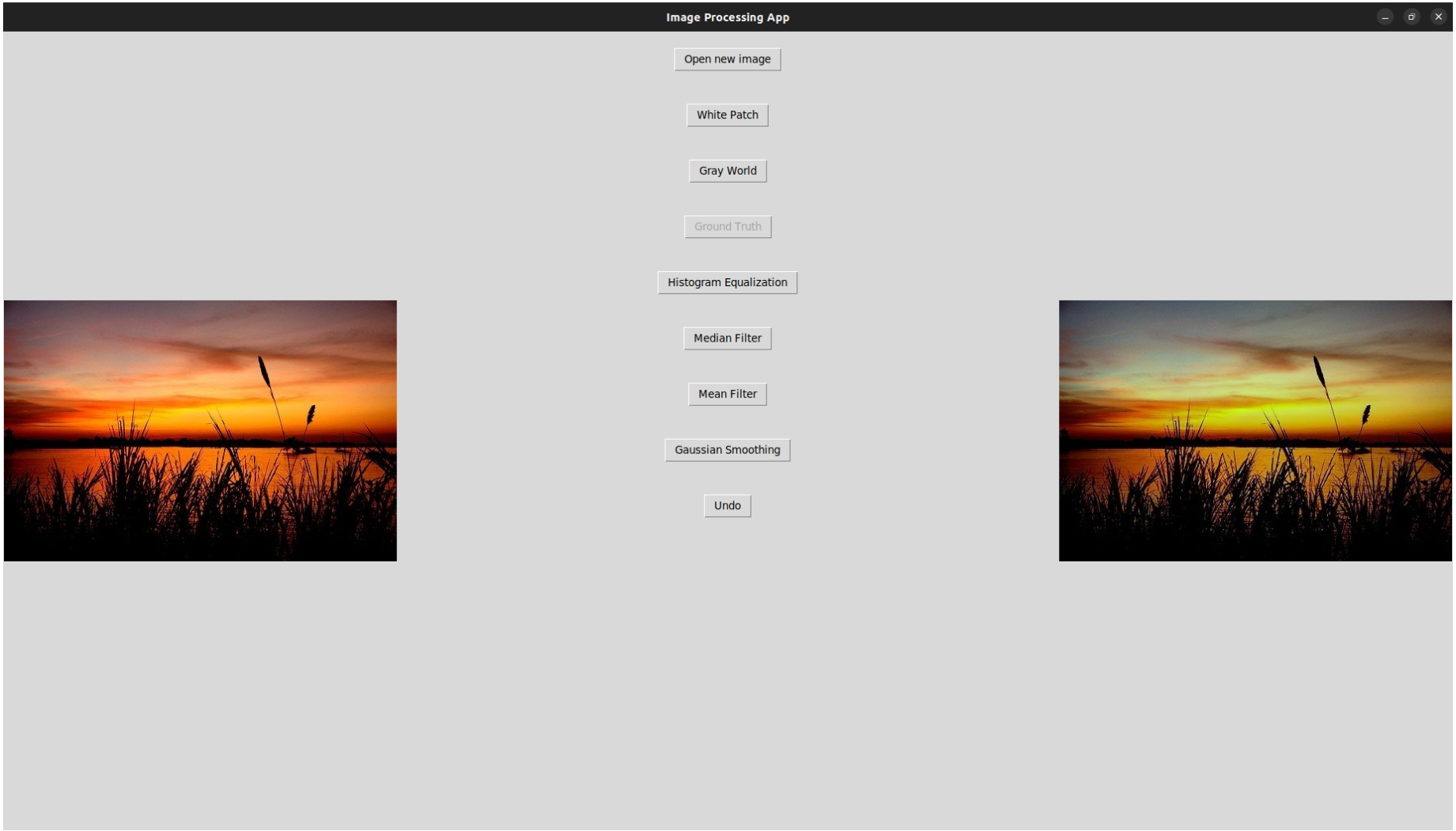


Image Processing App
Open new image
White Patch
Gray World
Ground Truth
Histogram Equalization
Median Filter
Mean Filter
Gaussian Smoothing
Undo

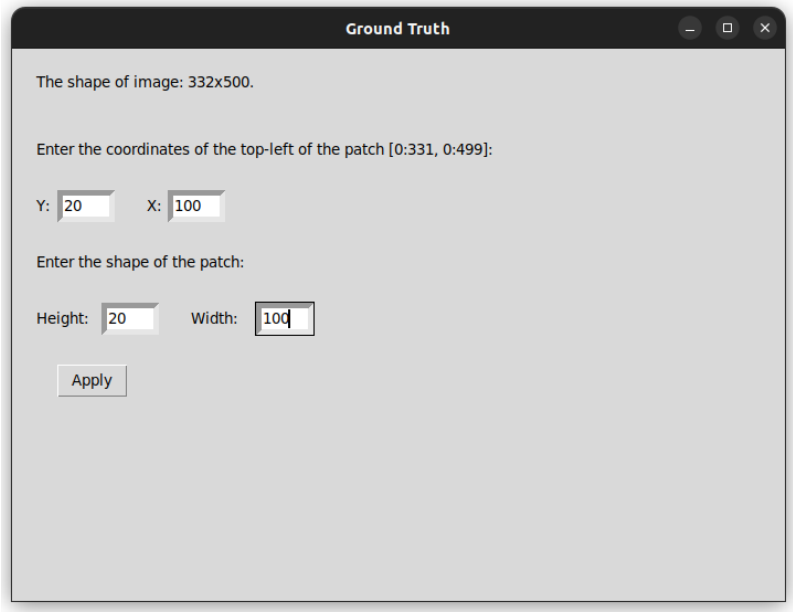
GUI Overview

After loading image, we can perform many effect on it. Each effect can only be used once, after using that button it will be disabled. For example, in the image in the previous slide we used the white balance: ground truth technique.

Coefficients input

For some effects: ground truth, median filter, mean filter, Gaussian smoothing, we need to input the coefficients.

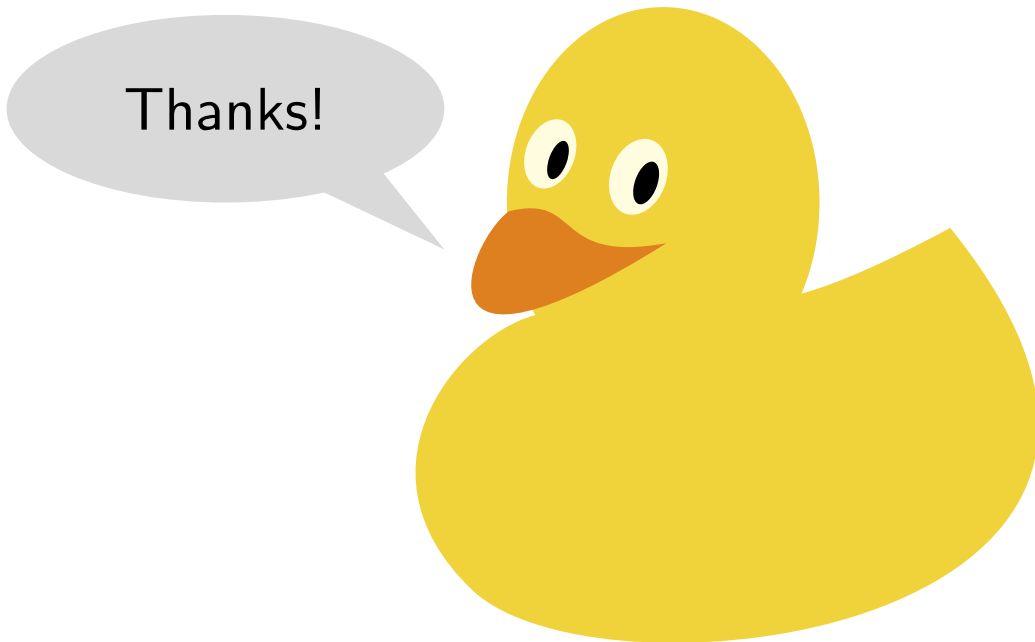
For example, this is coefficients input windows for ground truth:



All the fields are handled input error.

Source code

https://github.com/hoanghai1803/CPV301/tree/main/lab2


Thanks!