

Homework 6

Write a program which counts the Yokoi connectivity number on a downsampled image(lena.bmp).

The requirements above are accomplished by Python. All the histograms are created by matplotlib package, and all the processed images are exported by cv2 package. In the beginning, I use 128 as a threshold to binarize the image.

Downsampling

For the requirement, I wrote the downsampling function to transform the 512x512 image into 64x64. The input of this function is 3d image array and the size set of reduction kernel. In the function, the reduction kernel will cover the image and take the topmost-left pixel in each kernel corresponded to the input image as the downsampled image. The return is the downsampled 3d image.

Yokoi connectivity number labeling

For labeling the Yokoi connectivity number, I wrote the Yokoi and h_fun function. The h_fun function has four inputs, and the first input is the center pixel while other three inputs are the angle neighbor pixels. The expression below is the formula of my h_fun.

$$h(b, c, d, e) = \begin{cases} \text{return } 1 \text{ (q condition), if } b = c \text{ and } (d \neq b \wedge b \neq e) \\ \text{return } 10, \text{ if } b \neq c \\ \text{return } 0, \text{ otherwise} \end{cases}$$

In the Yokoi function, the boundary of the image is augmented by one 0 pixel for the convenience of detecting the neighbor pixels. It would take the neighbor pixels from four corner sides respectively as the inputs for h_fun function and sum the returns from four corner sides of each pixel. If there is any q condition around the center pixel, the summation mod 10 will be the label for the pixel. If the center pixel is not equal to the first neighbor pixel, the h_fun function will return 10 for the summation. However, when all the neighbor pixels are 1, the summation from h_function will be 0 and the pixel label will be 0 as the summation mod 10 is 0. And if the summation equals to 40, it means that the center pixel is isolated, the label for the center pixel will be 0. After detecting all the pixels, the Yokoi function will return 2d array of the labelling.

At last, the print_label function is used to print all the labels of the downsized image. In this function, when it detect label 0, it will print a space to make the result clean.



Figure 1. The left one is the Yokoi connectivity number of the image. The right one is the downsized binary image.