Computer Vision I: Homework 6

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1 Problem description

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

Hint:

1. Binarize the benchmark image Lena as in HW2 by 128.
2. Using 8×8 blocks as a unit, take the topmost-left pixel as the down-sampled data, Down-sample Lena from 512×512 to 64×64.
3. Count the Yokoi connectivity number.
4. Result of this assignment is a 64×64 matrix. Please align the matrix within 1 single A4 page (using 4-connected).

2 Yokoi connectivity number

Our goal is to determine the connective numbers of each pixel by the given binary image. There are six types of labels of connective numbers, shown in Table 1. For convenience, we denote the corner neighborhoods corresponding to 8 directions of each center pixel in Table 2.

Label	Type
0	Isolated
1	Edge
2	Connecting
3	Branching
4	Crossing
5	Interior

Table 1: Label of connective numbers.

x_7	x_2	x_6
x_3	x_0	x_1
x_8	x_4	x_5

Table 2: Neighborhoods of center pixel.

We defined the function h to represent how the center pixel connects to the neighborhood pixels in 2×2 block.

$$h(b,c,d,e) = \begin{cases} q, & \text{if } b = c \text{ and } d \neq b \text{ or } e \neq b, \\ r, & \text{if } b = c \text{ and } d = b \text{ and } e = b, \\ s, & \text{if } b \neq c \end{cases}$$

where r express when all pixels of the region are 255, q express when the main axis is 255, but one of the neighborhoods is 0, and s expresses other cases. We calculus the h value of 4 main axis (x_1, x_2, x_3, x_4) as the following.

$$\begin{aligned} a_1 &= h(x_0, x_1, x_6, x_2), \\ a_2 &= h(x_0, x_2, x_7, x_3), \\ a_3 &= h(x_0, x_3, x_8, x_4), \\ a_4 &= h(x_0, x_4, x_5, x_1) \end{aligned}$$

Finally, we defined function f to determine the connectivity number. If all the neighbors are equal to r, it represents the interior, so the label is 5. Otherwise, the label is the number of q.

$$f(a_1, a_2, a_3, a_4) = \begin{cases} 5, & a_1 = a_2 = a_3 = a_4 = r, \\ n(\{a_k \mid a_k = q\}), & \text{otherwise} \end{cases}$$

3 Experiment result

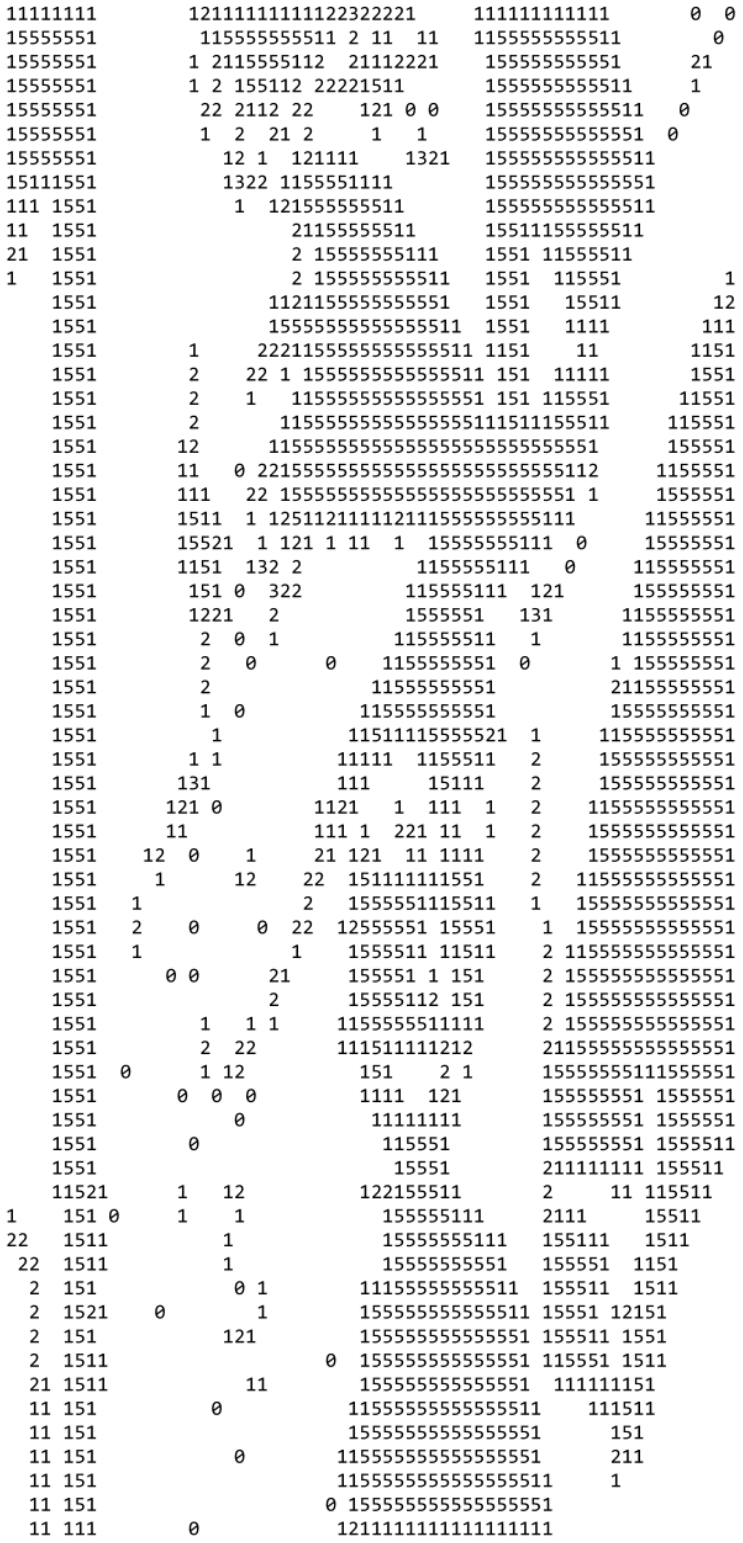

Figure 1: Yokoi connectivity number

4 Summary

In this homework, we use the Yokoi algorithm to calculus the connectivity number, which is a nonrecursive symbolic neighborhood operator method to classify the pixel into six type labels. As we have shown in Figure 1, this figure doesn't have label 4.