

Computer Vision I: Homework 7

Department: CSIE Student ID: d11922016 Name: Jia-Wei, Liao

November 15, 2022

1 Problem description

Write a program which does thinning on a downsampled image (lena.bmp).

2 Yokoi connectivity number

The h function in yokoi connectivity number represent how the center pixel connects to the neighborhood pixels in 2×2 block. 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, which is defined by

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

The f function 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 Pair relationship operator

The h function in pair relationship operator is to find the edge of image, which is defined by

$$h(a) = \begin{cases} 1, & \text{if } a = 1, \\ 0, & \text{otherwise.} \end{cases}$$

The pair relationship operator use 4-connected neighborhood. The output of (i, j) -th element is

$$y_{i,j} = \begin{cases} q, & \text{if } \sum_{n=1}^4 h(x_n) < 1 \text{ or } x_0 \neq 1, \\ p, & \text{otherwise.} \end{cases}$$

4 Connected shrink operator

The h function in connected shrink operator is to find the corner in image.

$$h(b, c, d, e) = \begin{cases} 1, & \text{if } b = c \text{ and } d \neq b \text{ or } e \neq b, \\ 0, & \text{otherwise.} \end{cases}$$

The output of connected shrink operator is defined by

$$f(a_1, a_2, a_3, a_4, x) = \begin{cases} g, & \sum_{n=1}^4 a_n = 1, \\ x, & \text{otherwise.} \end{cases}$$

5 Thinning operator

Algorithm Thinning Operator

- 1: **Input:** A binary image I
 - 2: **Initial:** A thinning image T
 - 3: **while** T does not change **do**
 - 4: $Y \leftarrow \text{YokoiConnectivityNumber}(I)$
 - 5: $P \leftarrow \text{PairRelationshipOperator}(Y)$
 - 6: $T \leftarrow \text{ConnectedShrinkOperator}(Y, P)$
 - 7: **end while**
 - 8: **return** T
-

6 Experiment result



Figure 1: Thinning image

7 Summary

In this homework, we use the Yokoi connectivity number algorithm, pair relationship operator, connected shrink operator to compute the thinning image of 64×64 binary image.