HW7 Report

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Introduction

This program applies the thinning operator to an binary image. The overall process includes:

Preprocess. Binarize it with threshold=128, and then down-sample the source image using 8x8 block size with the topmost-left pixel's value

Main Process. Compute the Thinning Operator (4 connected) of the binary image.

Usage

Place the source image and main.py under the same directory. Run the following command in the terminal.

```
python3 main.py -s <source>
```

Parameters

    `-s <source>` : the file path of source image, default = `lena.bmp`

Thinning Operator

The Thinning Operator is a combination of *Yokoi Operator*, *Pair Relationship Operator*, and *Connected Shrink Operator*. The operation is comprised of the following steps:

1. Apply the *Yokoi Operator* to the input binary image to generate an image of Yokoi connectivity numbers.

2. For each pixel starting from top-left to bottom-right:

2-1. Apply the *Pair Relationship Operator* to this Yokoi image with Yokoi connectivity number = 1 chosen to be the masked value m. If the pixel satisfies the pair relationship condition, it receives an output $y = p$.

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

$$y = \begin{cases} q, & if\ \sum_{n=1}^{4} h(x_n,\ m) < 1\ or\ x_0 \neq m \\ p, & if\ \sum_{n=1}^{4} h(x_n,\ m) \geq 1\ and\ x_0 = m \end{cases}$$

2-2. Apply the *Connected Shrink Operator* to the input pixel, and get the output $f = True/False$ that indicates if the pixel is removable or not.

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

$$f(a_1, a_2, a_3, a_4,\ x) = \begin{cases} True, & if\ exactly\ one\ of\ a_n = 1,\ n = 1\sim4 \\ False, & otherwise \end{cases}$$

2-3. Remove the pixel if both conditions of 2.1. and 2.2. are satisfied.

3. Repeat **1.** and **2.** until no changes are made to the image.

4. The result is saved as `thinning.bmp` (64x64 pixels) as shown below.