Computer Vision I: Homework 9

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

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1 Problem description

Write programs to generate the following gradient magnitude images and choose proper thresholds to get the binary edge images:

1. Robert's operator (threshold: 12)

2. Prewitt's edge detector (threshold: 24)

3. Sobel's edge detector (threshold: 38)

4. Frei and Chen's gradient operator (threshold: 30)

5. Kirsch's compass operator (threshold: 135)

6. Robinson's compass operator (threshold: 43)

7. Nevatia-Babu 5×5 operator (threshold: 12500)

2 Experiment result

The kernel-based operator is an approximation of the gradient of image intensity. Given the following kernels, we can detect the edge by using the convolution algorithm.

2.1 Robert's Operator

The kernel of Robert's operator are

$$\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$

Figure 1: edge of image with Robert's operator of threshold 12

2.2 Prewitt's Operator

The kernel of Prewitt's operator are

$$\begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}, \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

Figure 2: edge of image with Prewitt's operator of threshold 24

2.3 Sobel's Operator

The kernel of Sobel's operator are

$$\begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}, \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

Figure 3: edge of image with Sobel's operator of threshold 38

2.4 Frei and Chen's Operator

The kernel of Frei and Chen's operator are

$$
\begin{bmatrix} -1 & -\sqrt{2} & -1 \\ 0 & 0 & 0 \\ 1 & \sqrt{2} & 1 \end{bmatrix}, \begin{bmatrix} -1 & 0 & 1 \\ -\sqrt{2} & 0 & \sqrt{2} \\ -1 & 0 & 1 \end{bmatrix}
$$

Figure 4: edge of image with Frei and Chen's operator of threshold 30

2.5 Kirsch's Operator

The kernel of Kirsch's operator are

$$
\begin{bmatrix} -3 & -3 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & 5 \end{bmatrix}, \begin{bmatrix} -3 & 5 & 5 \\ -3 & 0 & 5 \\ -3 & -3 & -3 \end{bmatrix}, \begin{bmatrix} 5 & 5 & 5 \\ -3 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix}, \begin{bmatrix} 5 & 5 & -3 \\ 5 & 0 & -3 \\ -3 & -3 & -3 \end{bmatrix},
$$

$$
\begin{bmatrix} 5 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & 5 & -3 \end{bmatrix}, \begin{bmatrix} -3 & -3 & -3 \\ 5 & 0 & -3 \\ 5 & -3 & -3 \end{bmatrix}, \begin{bmatrix} -3 & -3 & -3 \\ -3 & 0 & -3 \\ 5 & 5 & 5 \end{bmatrix}, \begin{bmatrix} -3 & -3 & -3 \\ -3 & 0 & 5 \\ -3 & 5 & 5 \end{bmatrix},
$$

Figure 5: edge of image with Kirsch's operator of threshold 135

2.6 Robinson's Operator

The kernel of Robinson's operator are

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 1 & 2 \\ -1 & 0 & 1 \\ -2 & -1 & 0 \end{bmatrix}, \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}, \begin{bmatrix} 2 & 1 & 0 \\ 1 & 0 & -1 \\ 0 & -1 & -2 \end{bmatrix},$$

$$\begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}, \begin{bmatrix} 0 & -1 & -2 \\ 1 & 0 & -1 \\ 2 & 1 & 0 \end{bmatrix}, \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}, \begin{bmatrix} -2 & -1 & 0 \\ -1 & 0 & 1 \\ 0 & 1 & 2 \end{bmatrix},$$

Figure 6: edge of image with Robinson's operator of threshold 43

2.7 Nevatia-Babu's Operator

The kernel of Nevatia-Babu's operator are

$$
\begin{bmatrix}
100 & 100 & 100 & 100 & 100 \\
100 & 100 & 100 & 100 & 100 \\
0 & 0 & 0 & 0 & 0 \\
-100 & -100 & -100 & -100 & -100 \\
-100 & -100 & -100 & -100 & -100
\end{bmatrix},
\begin{bmatrix}
100 & 100 & 100 & 100 & 100 \\
100 & 100 & 100 & 78 & -32 \\
100 & 92 & 0 & -92 & -100 \\
32 & -78 & -100 & -100 & -100 \\
-100 & -100 & -100 & -100 & -100
\end{bmatrix},
$$

$$
\begin{bmatrix}
100 & 100 & 100 & 32 & -100 \\
100 & 100 & 92 & -78 & -100 \\
100 & 100 & 0 & -100 & -100 \\
100 & 78 & -92 & -100 & -100 \\
100 & -32 & -100 & -100 & -100
\end{bmatrix},
\begin{bmatrix}
-100 & -100 & 0 & 100 & 100 \\
-100 & -100 & 0 & 100 & 100 \\
-100 & -100 & 0 & 100 & 100 \\
-100 & -100 & 0 & 100 & 100 \\
-100 & -100 & 0 & 100 & 100
\end{bmatrix},
$$

$$
\begin{bmatrix}
-100 & 32 & 100 & 100 & 100 \\
-100 & -78 & 92 & 100 & 100 \\
-100 & -100 & 0 & 100 & 100 \\
-100 & -100 & -92 & 78 & 100 \\
-100 & -100 & -100 & -32 & 100
\end{bmatrix},
\begin{bmatrix}
100 & 100 & 100 & 100 & 100 \\
-32 & 78 & 100 & 100 & 100 \\
-100 & -92 & 0 & 92 & 100 \\
-100 & -100 & -100 & -78 & 32 \\
-100 & -100 & -100 & -100 & 100
\end{bmatrix}
$$

Figure 7: edge of image with Nevatia-Babu's operator of threshold 12500

3 Summary

In this homework, we use kernel-based methods to detect the edge of the image. The kernel with the convolution operator can detect the edge pattern, and we set the pixel to 255, which satisfies the condition. The final binary image is the edge of the image.