Image Processing Prog
Meeting 10/11

Bo Han, Chen

National Yang Ming Chiao Tung University, Taiwan
bhchen312551074.cs12@nycu.edu.tw

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Presentation Overview

Experiment Setting

- Environment
  - Python 3.10.12
  - OpenCV 4.8.0
  - NumPy 1.23.5
  - Platform: Google Colab

Original Canny Edge Detector

Method

- according to original paper [1] and textbook

1. smoothing input image f with Guassian filter G, get blurred image f_s
2. computing gradient magnitude M_s an direction α
3. apply *nonmaxima suppresion (NMS)* to M_s get the candidate edge point
4. using *hysteresis thresholding* for strong (g_{nh}) and weak (g_{nl}) edge point
5. edge tracking by *hysteresis*

Original Canny Edge Detector

Experiment Setting

- sample image
  - lenna
  - scene
- gradient magnitude computation
  - Sobel operator
- ratio of T_H and T_L
  - $3:1$

Original Canny Edge Detector

Result - lenna

Figure 1: edge detection comparison of lenna

Original Canny Edge Detector

Result - scene

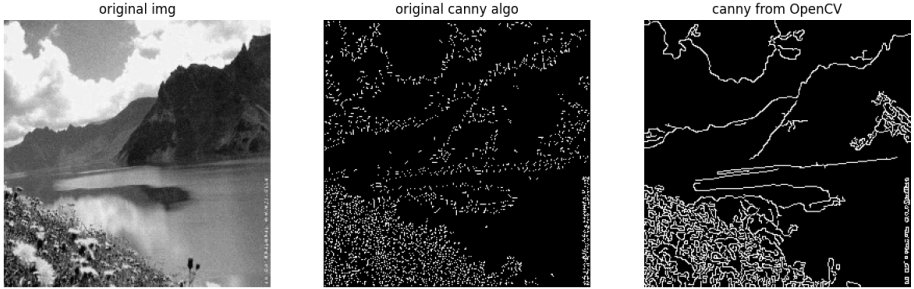

Figure 2: edge detection comparison of scene

Original Canny Edge Detector

Analysis

- bad threshold determination
- bad preformance in low contrast area
- sensitive to noise

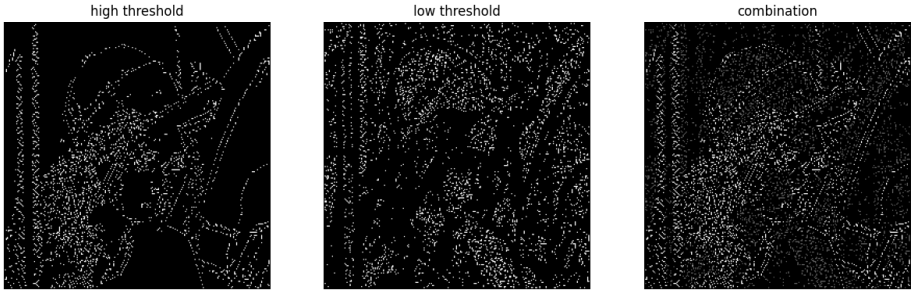

Figure 3: result of thresholding - lenna

Improved Canny Edge Detector

Method

- replace median filter with guassian filter [2]
- modify gradient computation
  - gravitational field gradient [3]
  - $G_x = \begin{pmatrix} -\frac{\sqrt{2}}{4} & 0 & \frac{\sqrt{2}}{4} \\ -1 & 0 & 1 \\ -\frac{\sqrt{2}}{4} & 0 & \frac{\sqrt{2}}{4} \end{pmatrix}$, $G_y = \begin{pmatrix} \frac{\sqrt{2}}{4} & 1 & \frac{\sqrt{2}}{4} \\ 0 & 0 & 0 \\ -\frac{\sqrt{2}}{4} & -1 & -\frac{\sqrt{2}}{4} \end{pmatrix}$
- adaptive thresholding [3]
  - marking non-edge with gradient $< E_{ave} \cdot 20\%$
  - determine T_h according to E and μ of neighbor gradients
  - $T_h = E + k \cdot \mu$
  - $T_l = T_h \cdot 0.5$
  - $k = 1.2$ in the following experiment

Improved Canny Edge Detector

Result - lenna

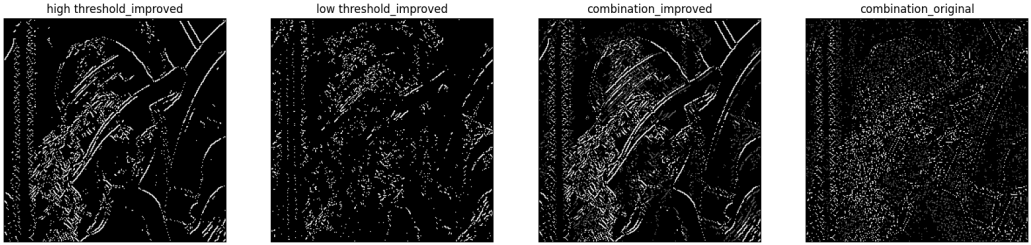

Figure 4: edge detection comparison of lenna with improved algo

Improved Canny Edge Detector

Result - scene

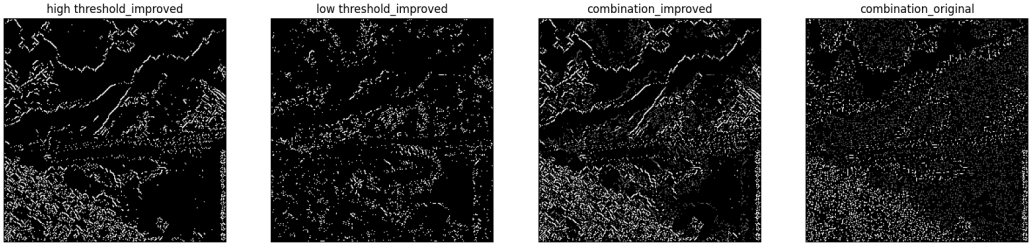

Figure 5: edge detection comparison of scene with improved algo

Improved Canny Edge Detector

Result - lenna

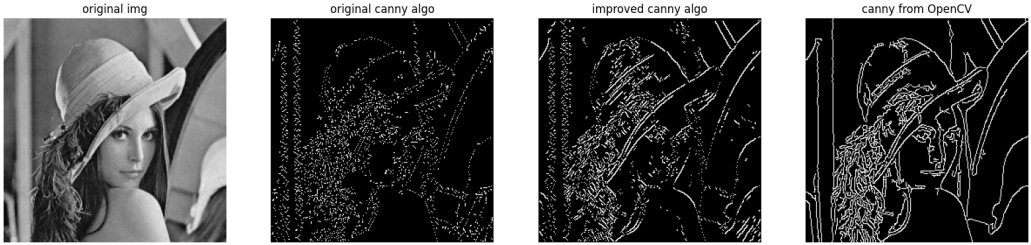

Figure 6: edge detection comparison of lenna with improved algo

Improved Canny Edge Detector

Result - scene

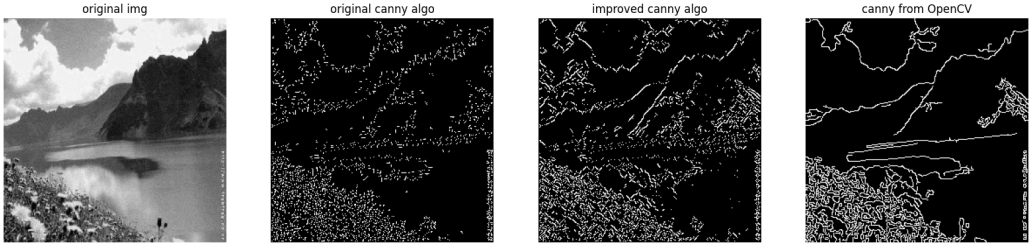

Figure 7: edge detection comparison of scene with improved algo

Improved Canny Edge Detector

Analysis

- better edge detection performance
- bad noise reduction
- issues of low contrast area still exist

Future Work

- Otsu's thresholding method for high / low gradient area [4]
  - find T_h according to Otsu's result
- Canny for color image

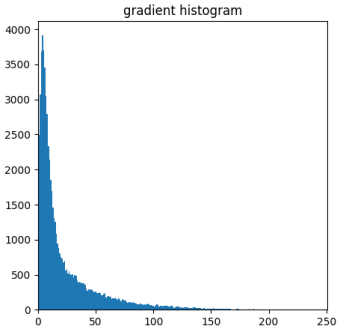

Figure 8: gradient histogram of lenna

References

[1] John Canny. “A Computational Approach to Edge Detection”. In: *IEEE Transactions on Pattern Analysis and Machine Intelligence* PAMI-8.6 (1986), pp. 679–698. DOI: 10.1109/TPAMI.1986.4767851.

[2] Li Xuan and Zhang Hong. “An improved canny edge detection algorithm”. In: *2017 8th IEEE international conference on software engineering and service science (ICSESS)*. IEEE. 2017, pp. 275–278.

[3] Weibin Rong et al. “An improved CANNY edge detection algorithm”. In: *2014 IEEE international conference on mechatronics and automation*. IEEE. 2014, pp. 577–582.

[4] Li Er-Sen et al. “An adaptive edge-detection method based on the canny operator”. In: *2009 International Conference on Environmental Science and Information Application Technology*. Vol. 1. IEEE. 2009, pp. 465–469.

Thanks for Listening

Q & A