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COMPARE AND ANALYSIS OF DETECTION ALGORITHM OF CROP LEAF AREA BASED ON MATLAB SOFTWARE

Abstract. *Traditional edge detection operators belong to linear filtering methods. Mathematical morphology is a non-linear filtering method, which can maintain the basic shape characteristics of the image and is widely used in various fields of image processing. Only the edge detection operator or mathematical morphology processing can't get ideal segmentation results. According to the results of edge operator detection, morphological filtering and mathematical morphological operation are carried out, and the edge information of plant leaves is extracted by repeated experiments with different structural elements. Based on MATLAB software, the image of plant leaf was analysed by the diffent mathod of Sobel, Prewitt, Canny, and Morphology. The result of Sobel mathod as the best one was chosen to be analysed by Denoising mathod. The last result was suitable for the image area algorithm.*

Key words: Sobel mathod; Prewitt mathod; Canny mathod; Morphology mathod; Denoising method

Problem statement

In the measurement of the area of crop leaves, the leaf shape paper weighing method, the length&width coefficient method, the fresh sample weighing method, the dry sample weighing method, the regression equation method and so on, all of these methods need to pick the leaf off and cause the damage to the leaf. Leaf morphology is relatively stable, which is an important basis for plant classification and recognition. Therefore, leaf edge information is selected as the research object. Choosing appropriate threshold segmentation targets in computer vision system is a common processing method. Threshold segmentation based on histogram is an important method of image segmentation, but histogram reflects the gray distribution of the image. Only when the object and background are contrasted greatly, the effect is better.

Latest research and publications analysis. The current instrument for measuring leaf area [1], can be used for wheat and other the simple leaf shape of crops, and it has some limitations for the complex shape of leaf. In the image detection and recognition, there are some study on the method of plant leaf image segmentation based on mathematical morphology [2]. The MATLAB software can be used to build a system for plant leaf parameter measure [3]. Matlab digital image can analyze and measure leaf area of apple [4]. Computer vision and Matlab can be used in the feature extraction system design of mango [5]. A grain particle counting method has built based on Matlab [6]. There are some researches in Jujube Image Processing Technology based MATLAB [7; 16]. Based on the application of computer vision technology, mango weight and fruit surface damage, surface defect detection system have been built [8 – 10]. And there are many other technologies used with MATAB in the plant image processing [11 – 15].

THE ARTICLE AIM is to study the optimal method by comparing the different algorithms, such as Sobel operator, Prewitt operator, Canny operator, and morphological processing based on MATLAB software, and then further de-noising. It can be used to measure the area of crop leaves.

Basic mathods and results

The sobel operator is the weighted difference between the gray values of four fields in the upper, lower, left and right images of each pixel in the image. The edge detection is achieved at the edge to achieve the edge detection. Sobel operator is one of the most important operators in pixel image edge detection. It plays an important role in machine learning, digital media, computer vision and other fields of information technology. Technically, it is a discrete first-order difference operator used to compute the approximation of the first-order gradient of the image luminance function. Using this operator at any point in the image will result in the corresponding gradient vector or its normal vector.

It can be defined as follows:

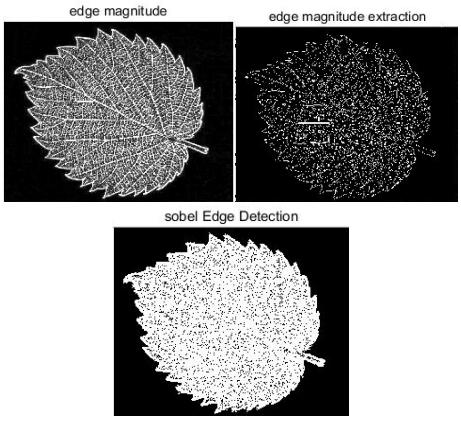
$$S_X = \left[f(x+1, y-1) + 2f(x+1, y) + f(x+1, y+1) \right] -$$
$$- \left[f(x-1, y-1) + 2f(x-1, y) + f(x-1, y+1) \right];$$
$$S_y = \left[f(x-1, y+1) + 2f(x, y+1) + f(x+1, y+1) \right] -$$
$$- \left[f(x-1, y-1) + 2f(x, y-1) + f(x+1, y-1) \right].$$

Each pixel in the image is convolution with the following two cores, one of which has the greatest impact

on the vertical edge, while the other is the most affected by the horizontal edge. The maximum value of the two convolution is used as the output value of the pixel point. The convolution template of the operator is:

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

The algorithm can produce better detection effect, and it has a smooth suppression effect on noise, but the edge is coarser and may appear pseudo edge. It needs to be reasonably designed according to the specific conditions.



The blade edge of the algorithm is clear, and the internal effect of blade is suitable for further processing.

The prewitt operator expands the size of the edge detection operator from 2x2 to 3x3, calculates the difference operator, and combines the direction difference operation with the local average, thus reducing the influence of the noise on the image edge detection. Prewitt operator is a kind of first-order differential operator for edge detection. It uses the gray difference between the upper and lower points of pixels and the left and right adjacent points to reach the extreme value at the edge and remove some false edges. It has a smooth effect on noise. The principle of this method is that the image space is convoluted by two directional templates, one is to detect the horizontal edge and the other is to detect the vertical edge.

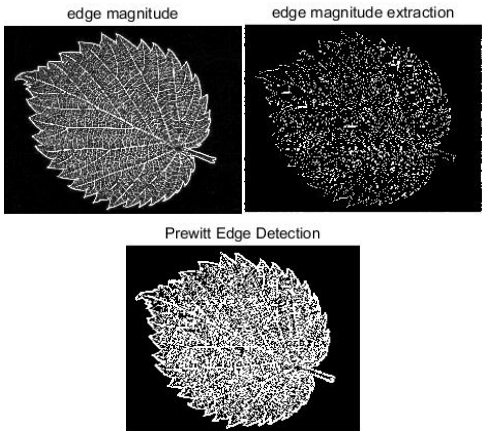
The expression is as follows:

$$S_X = [f(x+1, y-1) + 2f(x+1, y) + f(x+1, y+1)] -$$
$$-[f(x-1, y-1) + 2f(x-1, y) + f(x-1, y+1)];$$
$$S_y = [f(x-1, y+1) + 2f(x, y+1) + f(x+1, y+1)] -$$
$$-[f(x-1, y-1) + 2f(x, y-1) + f(x+1, y-1)].$$

Prewitt operator convolution template is $G(i, j) = |P_x| + |P_y|$, and

$$Px = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}, \qquad Py = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}.$$

Px means horizontal template, Py means vertical template. Each pixel in the image is convoluted by these two templates, and the maximum value is taken as output, and finally the edge image is generated. The effect of Prewitt algorithm on image edge detection is coarse, and the background noise has great influence on the effectiveness of the algorithm, and the improper selection of threshold will result in the error of edge detection.



The edges and meridians displayed by this algorithm are clearer, but the internal effect of blade is difficult to deal with further.

The canny operator. The goal of Canny is to find an optimal edge detection algorithm. The best edge detection means: Good detection algorithm can identify as many edges as possible in the image. Good location – the edges identified should be as close as possible to the actual edges in the actual image. Minimum Response – Edges in an image can only be identified once, and possible image noise should not be identified as edges. To meet these requirements, Canny uses the variation method, which is a way to find functions that satisfy specific functions. The optimal detection is represented by the sum of four exponential functions, but it is very close to the first derivative of the Gaussian function

The canny edge detection algorithm is the first derivative of Gauss function. It is an optimal approximation operator for the product of SNR and location accuracy. The algorithm first uses the first order reciprocal of the two-dimensional Gauss function. The image is smoothed and the two-dimensional Gauss function is set as follows:

$$G(x, y) = \frac{1}{2\pi\sigma}\left[-\frac{x^2 + y^2}{2\sigma}\right],$$

the gradient vector is as follows: $\nabla G = \begin{bmatrix} \frac{\partial G}{\partial x} \\ \frac{\partial G}{\partial y} \end{bmatrix}$.

The sigma is the Gauss filter parameter, which controls the smoothness. For a filter with a small Sigma value, the location accuracy is high and the signal-to-noise ratio is low. The Sigma value ratio is too large, and the SNR is high and the positioning accuracy is low.

Therefore, the size of Gauss filter parameter sigma should be determined according to the actual situation.

The traditional Canny algorithm uses the first order partial derivative finite difference of 2x2 domain to calculate the gradient magnitude and gradient direction of I (x, y) of the smoothing data array. Among them, the two array Px (i, j) and Py (i, j) of X and Y directional partial derivatives are:

$$P_x(i,j) = (I(i,j+1) - I(i,j) + I(i+1,j+1) - I(i+1,j))/2;$$

$$P_y(i,j) = (I(i,j) - I(i+1,j) + I(i,j+1) - I(i+1,j+1))/2.$$

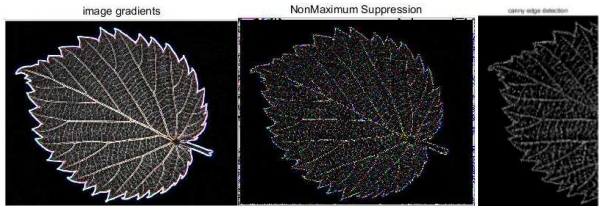
The gradient magnitude and gradient direction of the pixel are calculated by the coordinate transformation formula from rectangular coordinates to polar coordinates, and the gradient magnitude is calculated by the two order norm.

$$M(i,j) = \sqrt{P_x(i,j)^2 + P_y(i,j)^2}.$$

The gradient direction is:

$$\theta[i,j] = \arctan(P_y(i,j) / P_{xj}(i,j)).$$

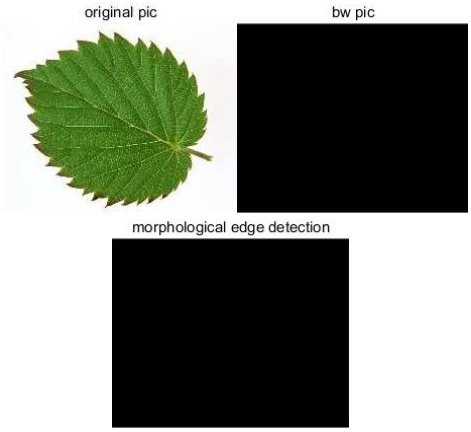
The image edge detection of the Canny operator is more effective. The noise and location of the detection samples are accurate, but the texture of the leaf detection results is fine. It is not of great value for the further area calculation.



This algorithm can only get leaf meridians, and can not get the whole internal part very well.

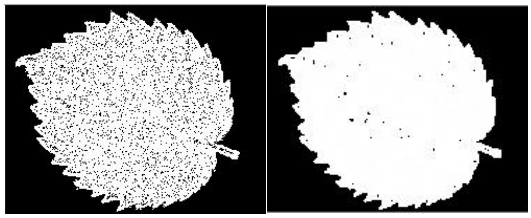
Morphological processing. Mathematical morphology is a mathematical tool for image analysis based on morphology, which is applied to image processing and pattern recognition. It uses mathematical morphology to analyze the geometric structure of objects, which is the process of approximation between subject and object. Using several basic concepts and operations of mathematical morphology, it combines and decomposes structural elements flexibly, and achieves the goal of analysis by applying morphological transformation sequence. Expansion, erosion, open operation and closed operation are the basic operations of mathematical morphology.

The basic idea of mathematical morphology processing is to measure and extract the corr esponding shape in the image with a certain form of structural elements, which has reached the purpose of image analysis and recognition. The application of mathematical morphology greatly simplifies the image data, keeps their basic shape features, and removes the irrelevant structure and improves the analysis and processing speed of the image. The method uses the three primary color RGB channel linear combination model RGB'=aR+bG+cB to get the two-dimensional image which highlights the feature of the leaf target. The two valued image is optimized by filling, expansion and corrosion operation. The noise can be suppressed to a great extent and the edge is detected in the detail. The algorithm is simple and the structure element is flexible.



The algorithm is less effective in the case of small background interference.

Image dryness treatment



The results of denoising and reprocessing of Sobel operators are compared before and after.

After de-noising, the effect of the interior of the blade is better. It is suitable for the simple algorithm of the pixel statistics, which can realize the rapid detection of the area of the blade.

Conclusions

In this paper, the image processing based on MATLAB is carried out through four algorithms. The results of the Sobel operator are best in the blade internal effect. The results of the Prewitt operator are clearly seen in the leaf texture and the blade is not clean enough. The processing results of the Canny operator are intelligent to see the meridians of the blade, and the leaves can not be well represented as a whole. Inside the film, the result of morphological processing basically can not see any effect.

By comparing and analyzing the processing results of the Sobel operator, and then doing the image de dryness processing, the better graphic processing results are obtained. On the basis of the analysis of the results, the statistic of pixel points can be used to calculate the area of crop leaves well, so as to realize fast online nondestructive measurement of the area of crop leaves.

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ПОРІВНЯННЯ ТА АНАЛІЗ АЛГОРИТМУ ВИЯВЛЕННЯ ПЛОЩІ ЛИСТОВОЇ КУЛЬТУРИ НА ОСНОВІ ПРОГРАМНОГО ЗАБЕЗПЕЧЕННЯ MATLAB

Анотація. *Традиційні оператори виявлення межі належать до лінійних методів фільтрації. Математична морфологія – це нелінійний метод фільтрації, який може підтримувати основні характеристики форми зображення та широко застосовується в різних областях обробки зображень. Лише оператори виявлення межі або обробка математичної морфології не можуть отримати ідеальні результати сегментації. За результатами виявлення морфологічної фільтрації та математично-морфологічної експлуатації здійснюється виявлення морфологічної фільтрації, а крайова інформація рослинних листя витягується багаторазовими експериментами з різними структурними елементами. На основі програмного забезпечення MATLAB, зображення рослинного листа було проаналізовано різними методами: Собелем, Превитом, Канні та Морфологією. Результат методу Собеля був обраний як найкращий для аналізу метод знешумлювання. Останній результат був придатним для алгоритму області зображення.*

Ключові слова: Собел матод; Prewitt mathod; Canny mathod; Морфологія матод; Метод Denoising

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