

# Study on Estimation Method of Plant Leaf Area Based on Image Processing Technology

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**ABSTRACT.** Plant is an important part of nature, the effect of plant photosynthesis directly affects the yield and growth of crops, and chloroplast is an important place for plant photosynthesis, so how to quickly and accurately measure leaf area has become a research direction. In this paper, the digital image processing technology is used to measure the leaf area of the sampled image. The image is processed by gray-scale transformation, threshold segmentation, morphological transformation and binary image identification to obtain the leaf area in the image. This method not only has the advantages of high efficiency, accuracy and scientificity, but also can process the image on the basis of no loss of plants..

**KEYWORDS:** Image Processing, Image Segmentation, Leaf Area, Morphology

## 1. Introduction

With the development of the level of theoretical knowledge of digital image processing technology, image processing technology has been applied more and more widely in people's daily life, and has also made great promotion and application in important agricultural fields. Compared with other methods, digital image processing technology has the advantages of more accurate, fast and real-time operation. The use of digital image processing technology can greatly save manpower and time, and the measurement results are more accurate and scientific, the operation is simple and orderly, and the results are not affected by the shape and thickness of the blade and other factors. Scientific analysis and Research on the data obtained from digital image processing can promote the yield of crops and the development of agriculture. To a certain extent, it can promote the development of information level in botany and agriculture, promote the development of agriculture and promote economic development

Vijai Singh [1] proposed a plant leaf image segmentation algorithm. The process of image recognition and segmentation is proposed. Firstly, different devices are

used to collect different types of images, and different segmentation methods are used to process the images. The author has taken an image of  $M * n$  size, each pixel has R, G, B components. Color symbiosis method is used to extract features. The above experiments are completed in MATLAB. The results of bean leaves, lemon leaves and banana leaves were only demonstrated. This method can be used to identify plant viruses in the early or early stage.

Pragya Adhikari [2] proposed the concept of sugarcane leaf disease detection based on feature extraction. The author studies the use of linear and nonlinear support vector machines, as well as the application of multi class support vector machines. Finally, it is concluded that the support vector algorithm has better results than other algorithms. This application will help farmers and laboratories because they can easily protect their crops and help increase yields.

Thae Nu Wah [3] and others proposed an image processing algorithm for rice. After more than 30 experiments, it was proved that the method of rice feature extraction and classification is feasible.

With the progress of science and technology, image processing technology has also been greatly developed. After years of development, it has brought great convenience to human daily life (film viewing, Internet communication, 3D games, etc.) and work [4]. With the development of information technology, digital image processing is widely used in various industries, and the requirements for this technology are higher and higher, and the quality requirements for image transmission are also higher. Therefore, image processing technology is developing more intuitively, timely and rapidly. As a high utilization technology, image processing technology has also been applied in all walks of life, such as biology, communication engineering and so on.

In this paper, the digital image processing technology is used to measure the leaf area of the sampled image. The image is processed by gray-scale transformation, threshold segmentation, morphological transformation and binary image identification to obtain the leaf area in the picture. This method not only has the advantages of high efficiency, accuracy and scientificity, but also can process the image on the basis of no loss of plants. Finally, MATLAB software is used. The existing function completes the image simulation.

## **2. Common Leaf Area Measurement Methods**

There are many kinds of leaf area measurement methods. This paper will introduce several mainstream measurement methods, such as grid paper method, drawing paper weighing method, leaf area measuring instrument and digital image processing. Finally, the leaf area was measured by ab2017b software.

Leaf area measuring instrument is a kind of commonly used instrument for measuring leaf area in agriculture. It is mainly a kind of precision instrument made by the principle of optical reflection and transmission. This instrument has the advantages of small error and fast measurement of leaf area, and does not need to

pick leaves, and is not affected by the shape and thickness of leaves. However, the cost of leaf area analyzer is high, so it is difficult to be widely used.

The principle of grid paper method is to draw the collected leaves along the blade edge on the paper with coordinates, and then calculate the number of leaves in the grid. When counting the number of lattices, we should take the standard of rounding in mathematical operation to count all kinds of cells. For example, if the area of each grid is more than one-half, it is calculated as 1, and if it is less than half of the lattice, the total area of the leaf is calculated finally. The principle of grid method is simple and easy to realize, but the operation process is cumbersome, the workload is large, the efficiency is low, and the blade edge is complex, the error is large, and waste of manpower and material resources.

Drawing paper weighing method is similar to the grid method. The target blade is drawn on the paper with uniform texture along the edge, and then the paper with uniform texture is cut off according to the shape and edge of the described blade, and then the unit area of each gram of paper is calculated according to the length and width of the paper, and then the final leaf area is converted according to the relationship between the area and the gram. This method has the characteristics of complex steps, damage to plant leaves, heavy workload, and is not suitable for a large number of measurements.

Regression equation method is to rely on mathematical principles to establish regression equation analysis between variables. To use regression equation to measure leaf area, we should first collect the leaves of the same variety as the premise, then measure the length and width of these leaves, and finally use the regression analysis knowledge in mathematics to establish the correct regression equation for these data. The measurement process of regression equation method is cumbersome and complex, and has high limitations. Each measurement can only find the same kind of blade for measurement, which is suitable for targeted blade measurement. If the target blade to be measured is irregular, then the measurement error is large.

Digital image processing is a simple and fast processing method. The image is composed of one pixel with the same size and regular shape. By obtaining the number of pixels of the target in the image, the size of each pixel is calculated according to the size of the reference object multiplied by the number of pixels of the leaf, and the area of the leaf can be calculated. Before getting the number of pixels, it is necessary to preprocess, segment and mark the image according to the principle of digital image processing. Compared with other traditional methods, digital image processing method is simple, fast, accurate and non-destructive.

### 3. Leaf Area Estimation Algorithm Based on Image Processing Technology

#### 3.1 Picture Sampling

In this paper, the leaf characteristics of this plant are mainly manifested in the green leaves, no pattern and variegated color, and the shape of the leaf itself has a

certain degree of curvature. In view of these characteristics, the sampling process is as follows: firstly, obtain a leaf of the green pineapple plant. Because the leaf characteristics of the green pineapple leaf have a certain degree of curvature, if you take a picture directly, it will produce error to the subsequent leaf area, so the leaf is clamped in a book with a certain thickness, so that the leaf is on the same horizontal plane. Then use the camera with the camera pixel of 12 million pixels to take a picture with the scale of 1:1 perpendicular to the leaf target under natural light conditions, as shown in Figure 1, and take the pentagonal coin with known area as the reference object of the blade, so as to calculate the specific leaf area in the future. Due to the light, the shadow will increase the leaf area. Therefore, it is necessary to remove the shadow of the leaf and coin in Figure 1. The result is shown in Figure 2.



Figure. 1 Original



Figure. 2 The picture after removing shadow

#### 3.2 Calculation Formula of Leaf Area

Based on digital image processing, the actual measurement result is the number of pixels contained in the target object in the image. Therefore, a reference object with known area is needed to measure the leaf area during leaf sampling. Then, the corresponding area of each pixel is measured by formula, and then according to the actual area of each pixel and the content of leaf The total number of pixels was used to measure the real area of the leaf. The calculation formula (1) of leaf area is as follows:

$$S_1 = m_1 \times \frac{S_0}{m_0} \quad (1)$$

$S_1$  Represents the true leaf area,  $S_0$  represents the actual area of the reference coin,  $m_1$  represents the number of pixels in the leaf, and  $m_0$  represents the area of the reference.

#### 4. Program and Simulation

##### 4.1 Overall Design

In this paper, based on the digital image, the leaf area image is processed to get the leaf area feature structure. The first step of this paper is to sample the target leaf, take photos of the leaf and the reference object, so as to obtain the image needed in the paper, and then use the digital image processing to transform the gray level of the sample image, and determine the threshold value of the threshold segmentation by using the gray histogram, so as to segment the leaf and the reference object from the background of the picture. The third step is to carry out morphological transformation on the segmented image to correct the interference of tiny pores after threshold segmentation. Finally, the image connected region labeling method is used to mark the leaves and reference objects. Finally, the leaf area is obtained according to the leaf area publicity 1. The flow chart is shown in Figure 3.

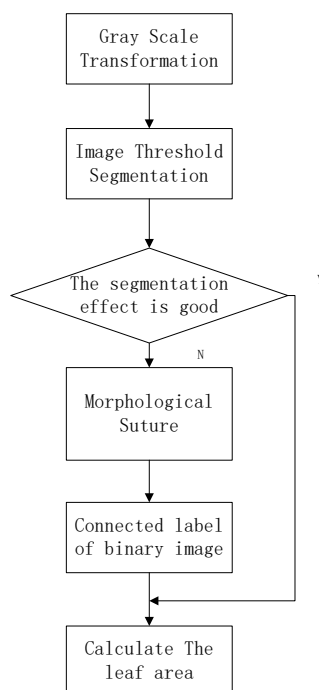
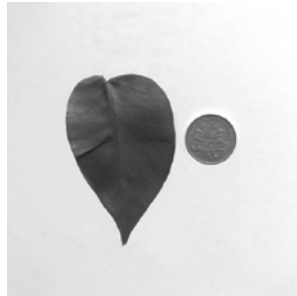


Figure. 3 Flow chart of estimation method of plant leaf area

#### **4.2 Image Gray Transformation**

Fig. 4 is the image after gray transformation. It can be clearly seen that the value of each pixel in Fig. 4 has changed compared with that in Figure 2, and Figure 4 presents the visual effect of grayscale as a whole. In this paper, the gray level transformation of Figure 2 is carried out. The color image is transformed into a gray image, which can simplify the information of the image. On the basis of removing the color information, the main information such as the image contour is not affected. The gray value of the gray image is used to reflect the color transformation and brightness of the color image. After the image is grayed, the gray histogram is provided for the threshold selection of later threshold segmentation. Figure 4 is the gray image transformed from Figure 2.

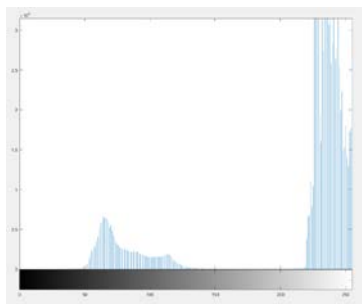


*Figure. 4 The grayscale image after adjustment*

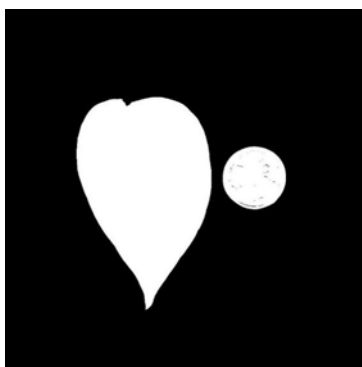
#### **4.3 Leaf Extraction by Threshold Segmentation**

In this paper, the threshold method is used for image segmentation. Because there is a large contrast between the target leaf and reference object in the image and the background gray level, and the content of the image is simple, so using the threshold method for image segmentation will better separate the target and the background in the image. The premise of using the threshold segmentation is to select the appropriate threshold, and only the threshold selection is appropriate, the target can be better the object is separated from the background to achieve the effect of image segmentation. Therefore, this paper first uses Figure 4 to obtain the gray histogram, because the gray histogram can determine the threshold size in the threshold segmentation. In this process, imhist function is used to process figure 4, and the gray histogram is obtained as shown in Figure 5. The gray value distribution area in Fig. 5 conforms to the threshold selection rule of histogram method, and the gray value is distributed in two regions. The first region is the area with threshold value greater than 200, and the second region with threshold value less than 200. According to this characteristic and the analysis of threshold selection method, the threshold value  $t = 200$  can be determined. After  $t$  is determined, the image threshold segmentation algorithm is used to traverse and judge each pixel value of the image. If the pixel value of the image is greater than 200, the pixel value becomes 0,

otherwise, take 1, and finally get the segmented Figure 6. As shown in Figure 6, the segmented image leaves and reference objects are white, the background is black, and the leaves and reference objects are clearly segmented from the background.



*Figure. 5 Gray histogram Figure*

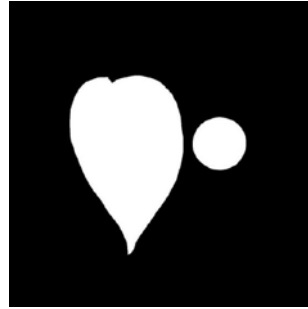


*Figure. 6 The image after threshold segmentation*

#### ***4.4 The Morphological Repair of Leaves***

As shown in figure. 6 after segmentation, there are some small pores in the reference object after segmentation. This is because when the image is sampled, the gray value of the reflective points on the coin surface caused by uneven light is greater than the threshold  $T$ , which results in the pixel value equal to 0 (black) when the threshold segmentation is performed, which results in the difference between these pixel values and the pixel values inside the reference. There are interference pixels with small pores in the film reference. Therefore, it is necessary to eliminate the pores in the image through the closed operation of mathematical morphology to obtain figure 7. After morphological processing, it can be clearly seen that the small pores in the reference object are filled, and the pixel values inside the leaf and the

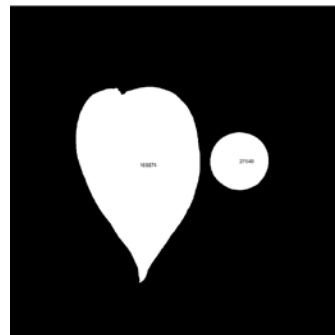
reference object are the same, so that the leaf area of the image can be measured later.



*Figure. 7 The picture after eliminating pores*

#### ***4.5 The Leaf Area Measurement and Image Marking***

In this paper, four neighborhood connected labeling method is used to label the binary image. As shown in Figure 7, the pixel values of leaf and reference object are the same, so the specific number of pixels contained in the two cannot be distinguished when calculating the number of pixels. Therefore, it is necessary to use image markers to mark the target in the image before measuring the leaf area. Image marking is the processing of binary image. The binary image is only composed of black and white pixel values. Each region in the binary image can be marked and distinguished, so that each area can be detected independently. The marked area can be used to measure the area, perimeter and other parameters. In this paper, the existing `bwlabel` function in MATLAB is used to label Figure 7. After labeling, the number of pixels in the image and the reference object is determined to obtain figure 8. As shown in Figure 8, the number of leaf pixels is 168874, and the pixel value of reference object is 27640.



*Figure. 8. Picture after measuring area*



## 5. Results

In this paper, the principle of digital image is used to process the image, such as gray-scale transformation, threshold segmentation, morphological transformation, and 4-neighborhood connected labeling method. Finally, the number of measured leaf pixels is 168874, and the number of reference pixels is 27640. The diameter of the reference coin is 2.05cm. According to the circular area formula, the reference area is about 3.3 cm<sup>2</sup>. According to the leaf area measurement formula 9, the actual leaf area is about 20.16 cm<sup>2</sup>.

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