Study on the Secant Segmentation Algorithm of Rubber Tree

Shute Li 1, Jie Zhang 1, Jian Zhang 1, Liang Sun 2 and Yongna Liu 1,*
1Institute of Tropical Agriculture and Forestry, Hainan University, Danzhou, Hainan 571737, China
2Rubber Research Institute, Chinese Academy of Tropical Agricultural Sciences, Danzhou, Hainan 571737, China

*yongnaliu@qq.com

Abstract. Natural rubber is one of the most important materials in the national defense and industry, and the tapping panel dryness (TPD) of the rubber tree is one of the most serious diseases that affect the production of rubber. Although considerable progress has been made in the more than 100 years of research on the TPD, there are still many areas to be improved. At present, the method of artificial observation is widely used to identify TPD, but the diversity of rubber tree secant symptoms leads to the inaccurate judgement of the level of TPD. In this paper, image processing technology is used to separate the secant and latex, so that we can get rid of the interference factors, get the exact secant and latex binary image. By calculating the area ratio of the corresponding binary images, the grade of TPD can be classified accurately. and can also provide an objective basis for the accurate identification of the tapping panel dryness (TPD) level.

1. Introduction
Natural rubber has become one of the indispensable materials in the development of national defense and industry because of its good characteristics. However, the tapping panel dryness (TPD) has a certain harm to the planting of rubber tree, which seriously affects the production of natural rubber. Therefore, it is of great significance and value to study the tapping panel dryness of the rubber tree. Grading of rubber bark cut secant is a prerequisite for studying the mechanism of the tapping panel dryness and the prevention and control technology of the tapping panel dryness. Traditional manual classification methods are subjective and have adverse effects on research results. In order to ensure the objectivity of the classification of the tapping panel dryness symptoms and improve the accuracy of classification, we use image processing technology to study the segmentation of rubber tree secant and latex image.

2. Related research
Skin symptom rating is the base of the study on TPD, and currently the classification of TPD is mainly by human eye observation and judging according to a certain standard. Grade 0 (normal tree), grade 1 (TPD length less than 2cm), grade 2 (TPD length 2cm to 1/4 the length of secant, grade 3 (TPD length is the length of the 1/4 secant to 2/4), grade 4 (TPD length is the length of the 2/4 secant to 3/4), grade 5 (TPD length is the length of the 3/4 or more) [1]. With the development of artificial intelligence, pattern recognition and machine learning, image processing technology is widely used in the field of agriculture and has achieved good results. The extraction and recognition of leaf of sunflower and jujube under natural environment using computer vision technology, the research results have certain
reference significance for field leaf extraction and leaf lesion segmentation and classification [2]. Kyung-Mo Koo enhances image recognition performance by using the idea of image normalization [3]. Article [4] studied for maize disease diagnosis, and puts forward some methods on leaf spot extraction and lesion type identification. These methods are good for identifying specific samples. Literature [5] uses an automated active shape matching weeds identification (AASM) technique to identify crops and weeds according to their shapes. The above research has a good effect in its corresponding field, but it is not suitable for the study of the TPD of the rubber tree. In this paper, we divide the rubber tree secant and latex by digital image processing technology, so as to reduce the subjectivity and instability of the TPD level by directly observing the secant of human eye.

3. Research framework and image acquisition

3.1 Research framework
The research of image segmentation based on image processing technology can be divided into the following parts: image acquisition, image preprocessing and image segmentation. Image acquisition is the premise and foundation of the follow-up work, collecting equipment selection, acquisition environment and other factors directly affect the segmentation effect; image preprocessing is to as much as possible to eliminate the interference factors, this part mainly used enhancement and denoising technique to eliminate interference factors; image segmentation is to extract the target from the background, the extraction effect directly effect of identification and classification of the late. The framework of image segmentation in this paper is as follow shown in figure 1:

![Figure 1. The framework of image segmentation.](image)

3.2 Image acquisition
Image acquisition is the basis of the study of the TPD of rubber tree based on image processing technology. The quality of image acquisition directly affects the effect of late treatment. The construction of collection environment is one of the most important links, which mainly involves the selection of light and acquisition equipment.

Illumination is one of the key that affect the quality of image acquisition. In order to avoid the influence of light on image acquisition, we choose clear weather in the morning to collect data between 4:00-7:00. This time is in the lowest temperature and humidity maximum of a day and rubber trees after a night of rest, the body of water is full, water transpiration leaves are lowest, this period is the best time for tapping.

Because the location of the image acquisition is in the field, the acquisition device has to satisfy the characteristics of the field operation, and requires the equipment to be portable, flexible, abundant in power and high in image accuracy, while considering the moderate price of the equipment. Through comprehensive comparison this paper selects the Nikon D90 camera as the acquisition equipment, in order to ensure the position of the camera lens and the secant accords with the acquisition requirements, in the process of collection with three fixed camera tripod, camera and relationship to adjust the position of secant mainly considers three aspects of factors, namely height, distance and angle. The height adjustment is that the lens is parallel to the secant, the distance between the lens and the secant is 40cm, and the lens is on the cut face when the image is imaging. The image resolution is 4288 * 2848 pixels by using the automatic white balance mode.

4. Preprocessing and Segmentation
4.1 preprocessing

The digital image is obtained directly from optical equipment such as high precision digital camera or camera, which saves the process of image digital conversion. Although various measures have been taken to improve the quality of photography, due to the imaging characteristics of optical devices, there still exist some disturbing factors, which influence the segmentation of secant. Using some preprocessing algorithms in digital image processing, we can greatly improve the symptom expression forms in the image, and create favorable conditions for the accurate extraction of secant features. Before image segmentation, it is necessary to normalize the contrast, angle and scale of the image. The tapping method has strict restrictions, so the general case is operated by trained professionals. Therefore, the length, width, depth and inclination angle of every secant are basically the same. We can use the geometrical characteristics of secant to normalize the angles and scales.

In the process of collection, sometimes the latex will overflow the Secant and attach to the trunk, which will cause serious interference to image segmentation. We must exclude the factors that interfere with it. As shown in Figure 2, according to the 2D coordinates of point A, point O and point B, \( A(x_a, y_a), O(x_o, y_o), B(x_b, y_b) \), the position and size of parallelogram can be calculated, and then the parallelogram \( AOBC \) can be tailored.

Rotation transformation, the parallelogram \( AOBC \) is rotated, so that the OB side and the level of the same level. The angle between the OB and the horizontal line DB is recorded as \( \theta \), and using formula 1, the \( AOBC \) is rotated to the angle \( \theta \) in the direction of the DB, thus the image with the same direction as the OB side and the horizontal direction is obtained.

\[
\theta = \arctan \left( \frac{|y_o - y_b|}{|x_o - x_b|} \right)
\]

(1)

Where, \( x_o \) and \( y_o \) are the horizontal and vertical coordinates of O, \( x_b \) and \( y_b \) are the horizontal and vertical coordinates of B, \( |y_o - y_b| \) is the length of OD and \( |x_o - x_b| \) is the length of OB.

Although the camera and secant distances are consistent in the process of image collection for each shot, but inevitably there will be some errors, in order to exclude the interference distance difference brings to the image recognition, the secant image scale normalized, uniform adjustment of the image size of 100*400 pixels.

After processing these three steps, the geometric invariance of secant images is obtained to a certain extent, and the interference factors of the background are basically eliminated. The image after preprocessing is shown in Figure 3.

Figure 2. Preconditioning schematic diagram.

Figure 3. Preprocessed image.
4.2 Secant and latex image segmentation

Image segmentation means that the image is divided into several regions according to different characteristics, and the interest target is extracted from it. The application field of image segmentation is very wide, such as identification of plant diseases and insect pests, forest fire identification, Coastline Extraction, traffic image analysis and so on. Due to the complexity and diversity of segmentation objects, so far, there is no general segmentation method. In many segmentation methods, the largest class variance method has good segmentation effect and strong adaptability. In this paper, the method of OTSU is used to divide the secant of rubber tree and the white latex on the cut secant.

The OTSU method belongs to the threshold segmentation method, and its theoretical basis is to use the least square method to deduce the gray histogram. The criterion of selecting threshold by the maximum inter class variance method is to determine the threshold according to the background and target of the image according to the maximum of the inter class variance. The best threshold selection method is: set the image to contain N pixels, the gray level is \([1, m]\), and the \(n_i\) pixels are used to represent the gray level \(i\), then the probability of each gray value is \(p_i = n_i / N, (i = 1, 2, 3, ..., m)\). The image is divided into two regions \(C_0 = \{1 - T\}\) and \(C_1 = \{T + 1 - m\}\) by the threshold value \(T \in [1, m]\).

The mean of \(C_0\) and \(C_1\) is as follows:

\[
\bar{u}_0 = \sum_{i=1}^{T} i p_i / w_0, \bar{u}_1 = \sum_{i=T+1}^{m} i p_i / w_1
\]

(2)

Among,

\[
w_0 = \sum_{i=1}^{T} p_i, w_1 = 1 - w_0
\]

(3)

And the OTSU value is,

\[
\sigma^2(T) = \alpha_0(u_0 - u_r)^2 + \alpha_1(u_1 - u_r)^2 = \alpha_0 \alpha_1 (u_1 - u_0)^2
\]

(4)

T is valued in \([1, m]\). When the formula 4 reaches the maximum, the T is the best threshold. The largest class variance method is used to measure the distribution of grayscale with variance. The larger the variance is, the greater the difference between the two regions is. The lower the probability of mismatch between the target and the background is. This method has the advantages of simple model, stable effect and strong adaptive ability.

5. Experiment and analysis

In order to verify the effectiveness of the method, the experiment was carried out on the secant and the latex image of the rubber tree on the Matlab platform. Because the gray value of secant and white latex is closer to the trunk, the secant and the rubber part are cut out first, and then the rubber part is segmented from the secant line. In the first round, we first normalize the pre-processed images. The purpose of gray normalization is to increase the contrast of images, so that the computer can automatically analyze and process according to the gray value. After the completion of gray normalization, the secant as part of a class, the trunk as part of another class, using variance method based on the pixel value will be separated from line and bark, the secant segmentation denoising, which become a cut or approximate a continuous closed curve. In the second round, the secant area divided by the first round is used as the processing area, and the latex part is taken as a class, and the secant is divided into the other part except the rest of the latex. First, the pixel gray value of the region is normalized, and then the latex part is separated from the secant by the maximum inter class variance method.

For using the OTSU method, should retrieval the gray value \(T\) of the image between \([1, m]\) first, and calculate the value of \(T \in [1, m]\) when \(\sigma^2(T)\) gets its maximum value. Then set \(T\) as the segmentation threshold of the image, the target and the background will be segmented. The image of
different levels of TPD is divided, the size of the image is pixel of $100 \times 400$, and the gray level is $[0, 255]$. Figure 4 gives the segmentation results of the normal and 1~5 level TPD images. From the image segmentation effect, the secant and the latex segmentation effect is ideal.

![Figure 4. The secant and the latex segmentation effect.](image)

6. Summary and discussion
Aiming at the existing problems of rubber tree's OTSU level, this paper adopts image processing to separate the secant and latex. In order to eliminate the interference factors in secant segmentation process to ensure the segmentation effect, we first precut the secant image, including clipping, angle and scale processing. On this basis, the segmentation of the Secant and the background, the latex and the background are divided by the maximum variance method, and the effectiveness of the method is verified by the experiment. However, due to the complex illumination conditions in the practical application environment and the white marks on the trunk, it will cause some negative effects on segmentation. Therefore, secant and latex segmentation algorithms still need further improvement and optimization.
Acknowledgment
This work was funded by the Natural Science Foundation of Hainan Province of China (20166212), the Natural Science Foundation of Hainan Provincial Department of Education (Hnky2016-5) and the Research on Education and Teaching Reform of Hainan University (hdjy1730).

References
[1] Kouadio Dian, Abdourahamane Sangare, Jacques Kore Diopoh, Evidence for specific variation of protein pattern during tapping panel dryness condition development in Hevea brasiliensis, Plant Science, vol.105, pp. 207-216, 1995.
[2] Wang J, He J, Han Y, et al, An adaptive thresholding algorithm of field leaf image, Computer and Electronics in Agriculture, vol.96, pp. 23-29, 2013.
[3] Kyung-Mo Koo, Eui-Young Cha, Image recognition performance enhancements using image normalization, Decision Sciences, vol. 7, pp. 1-11, 2017.
[4] J.M. Guerrero, M. Guijarro, M. Montalvo, J. Romeo, L. Emmi, A. Ribeiro, G. Pajares, Automatic expert system based on images for accuracy crop row detection in maize fields, Expert Systems With Applications, vol. 7, pp. 1-11, 2017.
[5] Kishore C. Swain. Michael Nørremark. Rasmus N. Jørgensen. Henrik S. Midtiby. Ole Green, Weed identification using an automated active shape matching (AASM) technique, Biosystems Engineering, vol. 110(4), pp. 22-103, 2011.