Extracting Tree Rings from Disc Bitmap Image

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Abstract: This paper determines the number of tree rings and the outline of growth rings from the bitmap image. The traditional method of determining tree rings is to polish surface of wood and put a high-resolution infrared scanner. This makes lower operational efficiency and higher costs. In order to solve these problem, this paper proposed a novel technique to extract tree rings automatically. The experimental resources show the method can determine the tree rings precisely.

Keywords: Tree rings, Regional growing, Detect tree rings, Disc bitmap image.

1. Introduction

1.1. Tree rings definition

It will be grow the new xylem when tree cells grow up in the spring. It called rings when tree through growing season. The growing layer is that trunk diameter lengthen and grow concentrically xylem around the pith. As shown in Fig. 1, the section is growing ring, it is only one live span in a year. It called annual layer or annual ring.

1.2. Causes

Tree grow new xylem around a live span in a year and the numbers of xylem is the growth increment. In first half of live span, cambium grows new cells which features diameter are longer and color fades that called spring wood. Because the weather, the new cell became small and darker that called summer wood in latter half of live span.

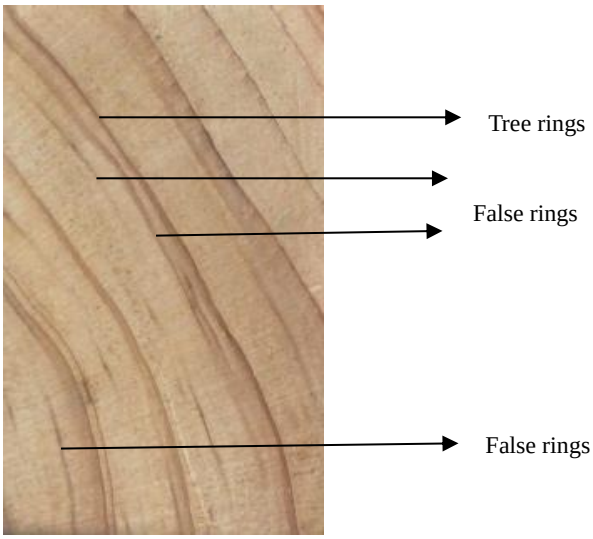
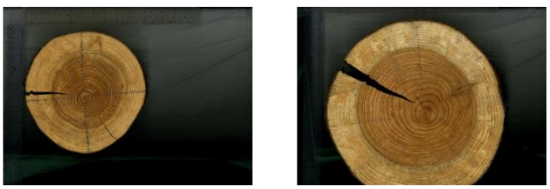


Figure 1. Tree rings



(a) Tree rings 1 (b) Tree rings 2

Figure 2. Tree rings of Cryptomeria

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2. Experimental Methods

For the purpose of achieving this paper aim, it be used to image processing techniques to extract the feature of tree rings. In the first step, transform 3D image to 2D image and use filter to remove noise. In the second step, strengthen the contours of tree rings and thresholding transform tree rings image to the 2D image. Finally, using Erosion and Dilation to process it.

The results maybe have some defect, so using thinning to repair them. The regional growing is to find the contour of tree rings. At this point, all experimental procedures mentioned above.

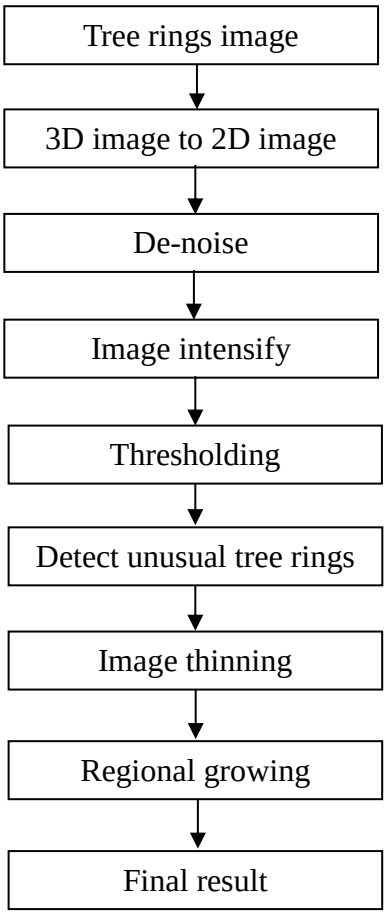


Figure 3. Flow chart

2.1. OSTU Algorithm

If an image include N pixel, t is the threshold, $N_1(t)$ is image all pixel less than equal t and $N_2(t)$ is more than t. When finding the least t, it is the optimal threshold.

$$q_1(t) = \frac{N_1(t)}{N},\ q_2(t) = \frac{N_2(t)}{N}$$

It seeks t that is the minimum variation in the set. The t is the best threshold.

$$\sigma_w^2(t) = q_1(t)\sigma_1^2(t) + q_2(t)\sigma_2^2(t)$$

2.2. Regional histogram

Uneven brightness of the background causes global histogram equalization out have optimal result, so the regional threshold method [1] is to improve this problem. The standard deviation and mean deviation are from any one of the image pixel neighborhood to image segmentation.

$$T_{xy} = a\sigma_{xy} + bm_{xy}$$

2.3. Dilation

Dilation [2] causes targets obvious in 2D image, the process control by structuring element. The image A and image B dilation are A⊕B.

$$A \oplus B = \{z|(\hat{B})_z \cap A \neq \emptyset\}$$

2.4. Erosion

Erosion [3] causes targets shrink or thin in 2D image, the process control by structuring element. The image A and image B erosion are AΘB.

$$A \Theta B = \{z|(\hat{B})_z \cap A \sqsubseteq A\}$$

2.5. Breakpoints connection

The breakpoints define that the end of a line. It is like circle, oval or square and so on. It does not have breakpoint. The breakpoint as shown in Fig. 4.

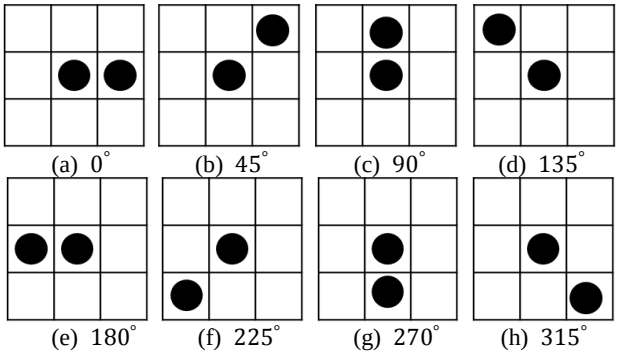


Figure 4. Breakpoint direction

After doing the above method, it has damaged in the result. The reason is the sunshine or water insufficient to the part of tree rings color fade. In order to solve the issue, it tried to take arc to repair the damaged area. The method take breakpoint and center, the same year ring points to calculate the radius of the circle.

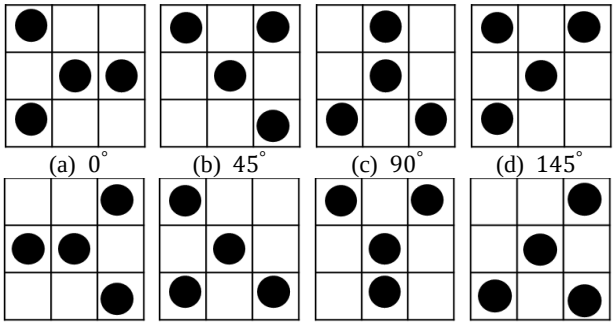
$$\sqrt{(x - x_0)^2 + (y - y_0)^2} = r$$

While get the radius, it can be find the circle equation and connect to the tree rings.

2.6. Regional growing

The turning points define that the branch of a line.

It needs to find the turning point because false rings maybe grow in this area. The turning points use to regional growing and find the correct tree rings.



(a) 0° (b) 45° (c) 90° (d) 145°

(e) 180° (f) 225° (g) 270° (h) 315°

Figure 5. Turning point direction

Regional growing [4] is applied to solve error discriminant problem.

It defines the correct direction by point to generate next point. When choose next point, it needs to determine the quadrant. The example is the first quadrant, choosing 1 if pixel is one or choosing 2 pixel is one and so on.

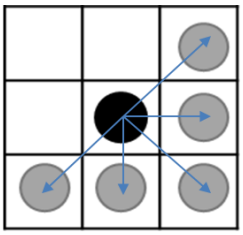


Figure 6. Quadrant select order

2.7. Image thinning

In order to de-noise, the image result needs to thinning process. The thinning process shrinks one pixel so as to keep the features of tree rings.

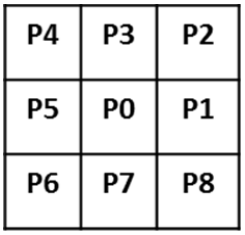
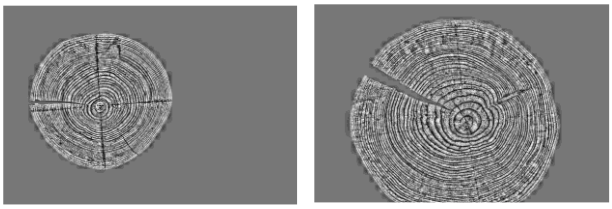


Figure 7. Pixel selection

It will have five rules needed to achieve. The one is that p1, p3, p5, p7 are not all of 1.The two is that in addition to p0, the sum need to more than 0 and less than 8.The third is that in addition to p0, the sum more than 2 at least. The firth is that p1, p3, p5 is 1 at least one. The fifth is that p3, p5, p7 is 1 at least one.

3. Experimental Results



(a) Tree rings 1 (b) Tree rings 2

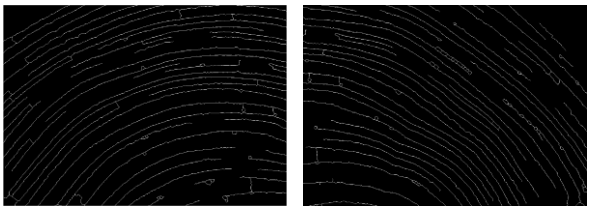
Figure 8. Contrast limited adaptive histogram equalization

The results of contrast limited adaptive histogram equalization could display the contour clear compared to gray level.

(a) Tree rings 1 (b) Tree rings 2

Figure 9. Thresholding results

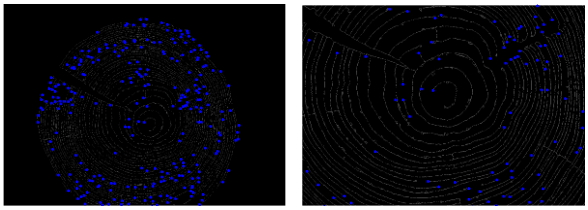
The areas between different tree rings are unnecessary noises, so execute erosion to remove it. The results still have some width between tree rings, the thinning process to solve the problem. In the first process, the result still have some noise, so performing a second time. The results are better than the first one.



(a) A part of tree rings 1 (b) A part of tree rings 2

Figure 10. Image thinning results

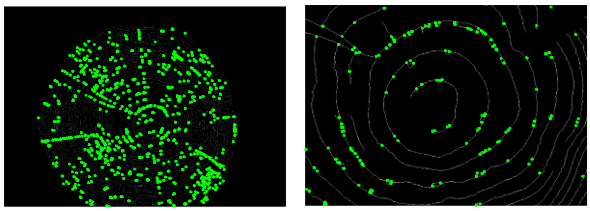
Breakpoints and turning points are the most important feature in the tree rings. With this feature, it defines the different tree rings which grows in what year. The features also become the start and end in the regional growing.



(a) Tree rings 2 (b) Tree rings 2 enlargement

Figure 11. Breakpoint images

The turning point can define the result if it is false ring. It can help to find the real tree rings which not the false rings.

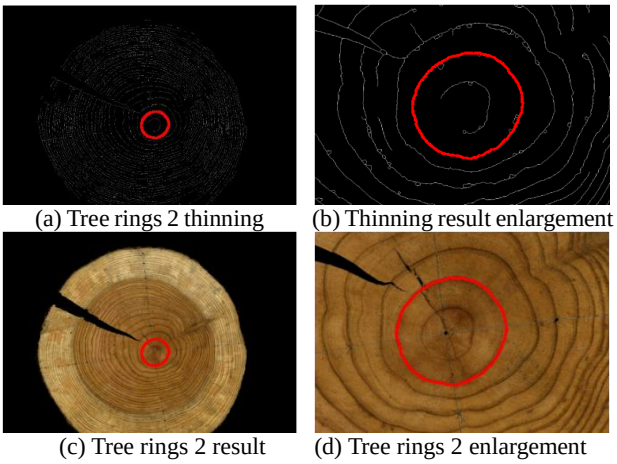


(a) Tree rings 2 (b) Tree rings 2 enlargement

Figure 12. Turning point images

After finding the breakpoint and turning point, some breakpoints become the start and execute regional growing to find the tree rings.

When finding the next breakpoint, it using arc to repair the damaged area. If finding the turning point, it defines the direction of regional growing. The termination condition is finding the start.



(a) Tree rings 2 thinning (b) Thinning result enlargement

(c) Tree rings 2 result (d) Tree rings 2 enlargement

Figure 13. Final results

4. Conclusion

The tree rings can be detected in our proposed method although there is missing some part of it. The big problem is artificial noise in experiment images, so our proposed method applied the morphology and filter to solve the issue. Different structuring element can be used in different experiment images size. In this case, it can improve the final results.

In the past, about detecting to tree rings needs scanner but it is inefficient. The proposed method is to locate position of tree rings and calculate the number of tree rings. In fact, by using the results, age of this tree and the contour of tree rings can be known.

It developed an image processing experiments to improve efficiency that is the original purpose. But it still has some issues needs to be addressed.

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