Semi-Automatic techniquesfor Estimating Climatic Conditions Recorded in the Tree rings

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Abstract:-*This paper describes a semi-automatic technique for dendroclimatology. Dating of tree rings and surveying the environmental changes by analysing the tree rings pattern in the cross section of tree image. Many algorithms are proposed, but still need sufficient improvement in this area. This paper describes a modified canny algorithm for detecting the edges and also proposed Hough transform technique for finding the annual period of trees and analysis the growth of tree which helps to get the environment changes in the particular area.*

Key-words: Hough Technique, dendrochronology, dendroclimatology, edge detection, Gaussian filtering, tree ring.

I. INTRODUCTION

In dendroclimatology, the tree ring is said to be a black box. The external influences, like carbon, sunlight, water, soil etc. is taken as an annual input and produce output in the form of rings' width.

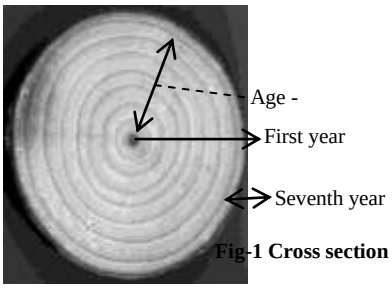


Fig-1 Cross section of tree ring

Hence the thickness of tree rings depends on physiological aging processes, climate and disturbance factors like disease, natural disaster.

It is essential issues to analyse the rings width in dendrochronology. For analysing this dendro data, many algorithms are proposed. Causes false ring detection in modified canny edge detector by Steven Corner [1]. Failed in the images having cracks in semi automatic tree ring detection by Laggoune, 2005[2]. Hang-jun provided mathematical morphology, which suitable for small discontinuity in the rings [3]. Many algorithms are provided for extracting this dendro data, but still there is anrequirements, because it is not possible to fit this concentric rings into a fixed geometric shapes. Many variety of formation appear in the trees. This paper describes the semi-automatic methods for identifying the boundary and width of annual rings on a digitized image of a tree disc. And also describes the implementation of algorithm in a software tool and testing it on several sample images. Modify the Canny edge detector for identifying the edges from the digital image of cross dating tree image and then apply a Hough technique to identify the width of the rings and also dating of tree.

II. APPROACH

In this paper, an approach is designed by consolidate the literature survey and test them by implementing in a software tool for extracting the rings data. The results of this approach is depends on the quality of input image. The efficient of the result is depends on its quality.

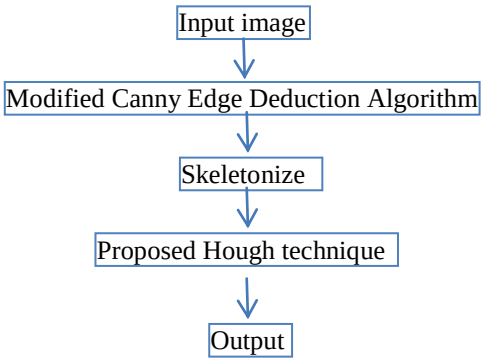


Fig-2 Steps for rings deduction

The proficient output depends on the quality of image. By comparative studies[4], Canny Edge Detection is more suitable for deducting the edges especially in the presence of noise. Modified this canny algorithm gives better result in deducting the concentric rings' edges in the image. Skeletonize the output of second steps makes easier for applying Hough transform technique and achieve the output.

Extracting features and shapes in the digital images is one of the important processes in image processing. Hough transform plays major role in extracting the objects from the digital images even in the discontinuity edges [5].

Output of this approach gives radius of the rings and estimates the growth of the tree by calculating the distance between the rings.

III. Improvised Canny Edge Detection

Overview of Canny Edge Detection

A block diagram of the Canny edge detection algorithm [7] is in fig 3.

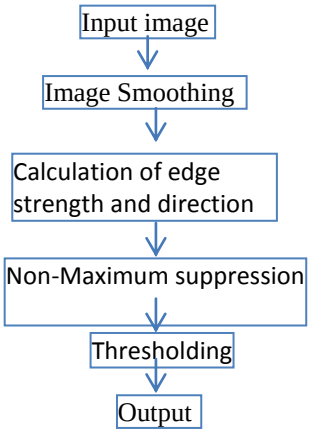


Fig-3 Block diagram of Canny Edge Deduction

Canny Edge detection is one of the optimal method for detecting edges[4]. Input Image should be 8-bit image. Image smoothing is to reduce the noise in the images, Gaussian Filtering is a pre-processing method for filtering the noise in the image.

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

The blurred image appears in the result of Gaussian filtering method. Calculation of edge strength and finding the directions by applying the Sobel convolution mask in each pixel of the blurred image and find the gradient of the image.

$$G_x = \begin{bmatrix} -1 & 0 & +1 \\ -2 & 0 & +2 \\ -1 & 0 & +1 \end{bmatrix} \quad G_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

$$G_i(x,y) = G_x * F(x,y) \;\&\; G_j = G_y * F(x,y)$$

Therefore edge strength or magnitude of gradient and the direction is given by

$$G = \sqrt{G_i^2 + G_j^2} \qquad \theta = \arctan\left(\frac{G_j}{G_i}\right)$$

In canny edge detection, the computed angle is rounded into four directions 0 °, 45°, 90 °, or 135 °. Edge strength is found by computing the gradient magnitude and angle of gradient vector for edge direction. To trace the edge, non-maxima suppression is applied to move along the edge direction and suppress thosepixel values that are not considered edge and thus resulting in thinning of edge.Final step is to detect and connect edge, hysteresis and connectivity analysis are used. Canny use two threshold to reduce the false edges.

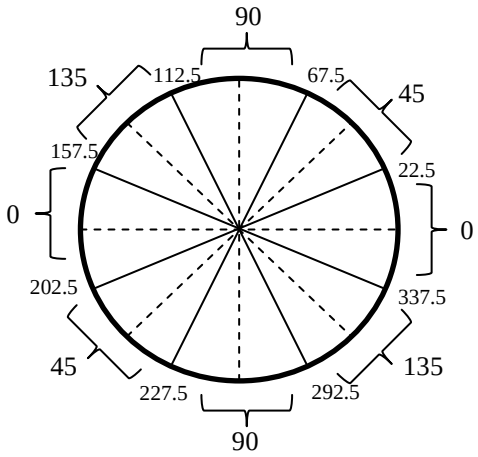


Fig-4 Calculate the gradient directions in Canny

III. MODIFIED CANNY EDGE DETECTION

In Modified, the gradient angles are computed and fall in 8 angles.

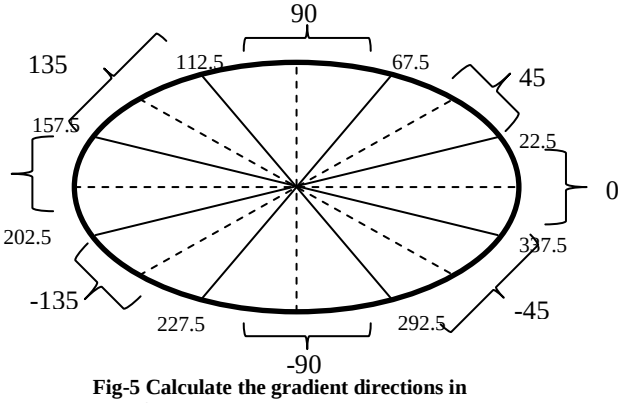


Fig-5 Calculate the gradient directions in Modified Canny

Divide the image into four quadrants and trace the edges in each quadrant according the edge direction in the following way:

In the first quadrant, check only the gradient angle

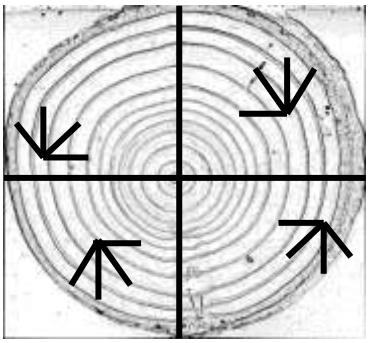


Fig-6 Splitting into four quadrant and trace the edge.

180°,-45°,-90°,-135°.

In the second quadrant, check only the directions 0°, 45°,90°,135°.

In the third quadrant, check only the directions 180°,45°,90°,135°.

In the fourth quadrant, check only the directions 0°,-45°,-90°,-135°.

IV. HOUGH TECHNIQUE IN DENDROCLIMATOLOGY

Hough Transform technique is used for extracting features from an image. The cross section of tree ring images cannot be fit into any fixed shapes. The shapes are concentric closed objects. So it's difficult for proposing any fixed algorithm for extracting Dendro data from this tree ring.

This technique is carried out by voting procedure. Results of modified canny images are used as an input for this Hough technique. Similar to modified-canny, split the image into four quadrants. Find the distance between each edge pixel and centre value. Accumulate the results in each quadrant separately. Calculate the radius by taking the average of accumulated radius in each curve separately for each quadrant. Compare the radius of each curve in four quadrant and estimate the radius of each ring

V. RESULTS

Implementation of Canny and Modified Canny Edge Detection: Implementation of this approach in image tool and tested for some sample image. In canny edge detection, for single ring two edges are calculated but in modified canny, single edge is traced for the each ring. From the fig-7 and 8 we understand that canny detect two edges for each ring but modified method detect single edge.

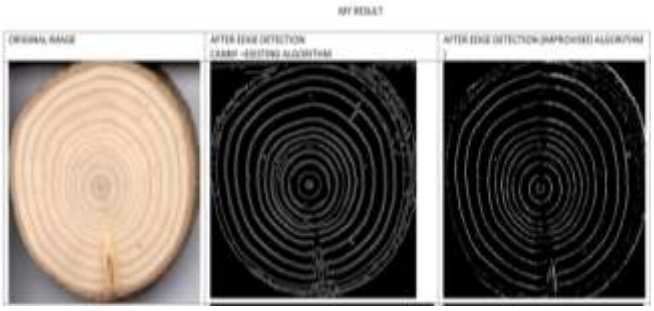


Fig-7(a) Original Image (b) Result of Canny Edge Detector(c) Modified Canny Detector

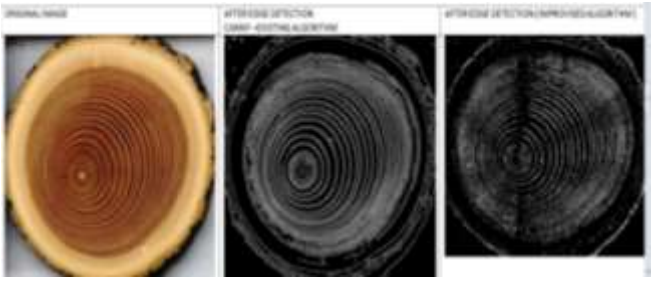


Fig-8(a) Original Image (b) Result of canny Edge detector (c) Modified Canny Edge Detector

Implementation of Hough Technique :

The main advantage of Hough technique in feature extraction is giving efficient result even in the discontinuity of edges[6]. Image is separated into four parts and calculated the distance of each edge pixel from the centre pixel. Next calculate the distance between two rings and estimate the climatic conditions. Fig 7(c) and fig 8(c) are the results of modified canny edge detection. Considerthe modified canny image as an input of Hough Technique's implementation. Split the image into four quadrants and find the distance between centre and each edge pixel and accumulate the results in each quadrant separately.Estimate the radius by taking the average of accumulated results in each curve separately for each quadrant. Compare the radius of each curve in four quadrant and estimate the radius of each ring.Extract the climatic condition recorded in the image.

	Radius_Distance
1	8
2	18
3	22
4	19
5	13
6	13
7	14
8	19
9	25
10	25
11	19
12	18

Fig -9(a) Radius of 12 rings. (b) Calculate the distance of 12

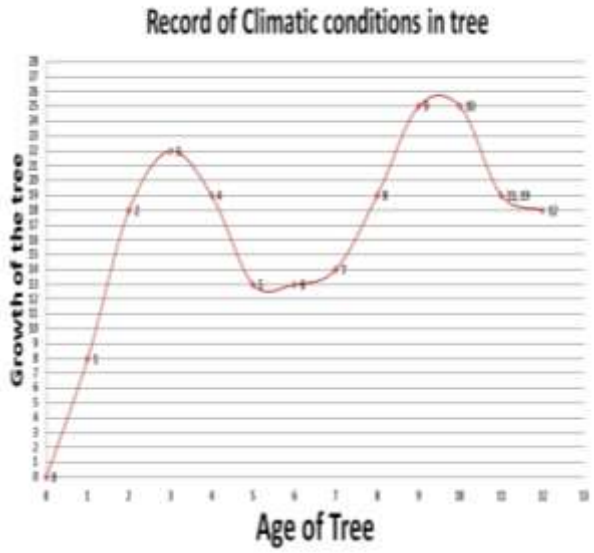
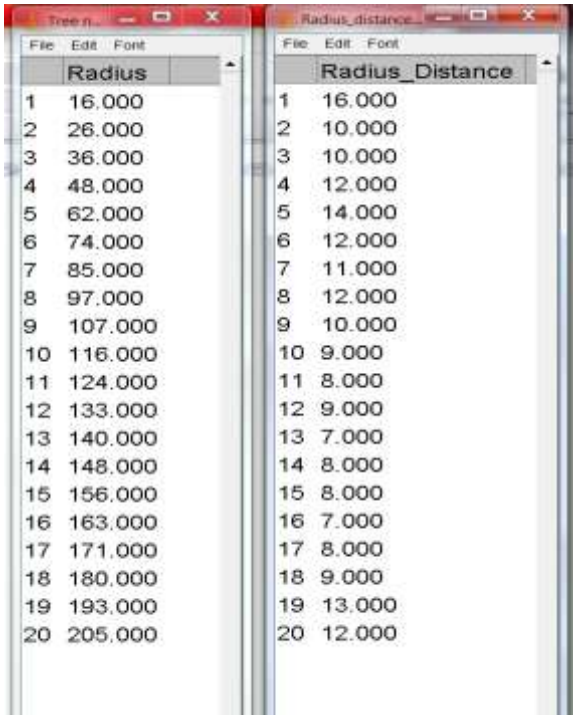


Fig 9(c) Record of climatic conditions



	Radius
1	16.000
2	26.000
3	36.000
4	48.000
5	62.000
6	74.000
7	85.000
8	97.000
9	107.000
10	116.000
11	124.000
12	133.000
13	140.000
14	148.000
15	156.000
16	163.000
17	171.000
18	180.000
19	193.000
20	205.000

	Radius_Distance
1	16.000
2	10.000
3	10.000
4	12.000
5	14.000
6	12.000
7	11.000
8	12.000
9	10.000
10	9.000
11	8.000
12	9.000
13	7.000
14	8.000
15	8.000
16	7.000
17	8.000
18	9.000
19	13.000
20	12.000

Fig -10(a) Radius of 12 rings. (b) Calculate the distance of 12 rings

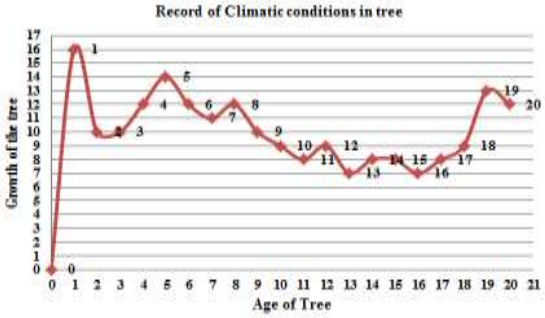


Fig -10 (c) Record of climatic conditions

Time complexity for this algorithm is $O(n^2/16)$ for each quadrant. Finally the time taken for entire algorithm is $O(n^2/4)$.

Fig 9(a,b,c) are the results of applying Hough transform algorithm to the fig7(c) and Fig 10(a,b,c) are the results of applying Hough Transform algorithm to the fig 8(c).

VI CONCLUSION

In the field of Dendrochronology and dendroclimatology, the requirements are very high. Many mathematical models and image processing methods are proposed but not compete the requirements. In this paper, we proposed semi-automatic methods for detecting edges and extract the climatic conditions recorded in the ring structure. Calculate the density between the rings is the first step for predicting the past climate. Different formations of tree rings areproduced by the beautiful creator, that is, nature. Hence there is no end for proposing algorithms in this area. Current research is going on to identify the future climate using this past data. Hence this paper initial steps for predicting future climate.

Image processing techniques are available for identifying tree rings, but not yet satisfy the requirements. Many mathematical models are also proposed. But still need some improvement in the algorithms for better performance. This paper proposed the steps for identifying the density between two rings after the delineation of edges of the rings in the input image. Analysing the density is the first step in predicting the past climate.

Still, improvements are needed for many aspects. Some of the aspects are overlapping rings, large crack,false ring etc. Nature is a beautiful creature and produce different formation of tree rings. Hence, there is no end for finding the methods to detect the tree rings.

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