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Proposed Hough Technique for Estimating Climatic Conditions recorded in the Cross Section of Tree Images

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Abstract: *Complex ensemble of shapes in an image is very difficult for segmentation. Hough transform is one of the robust algorithms for detecting geometric shapes in the images. The modification of this Hough transform is used for effecting way of segmenting images. By tuning the parameters of the circle detection model, extracting the concentric shapes is achieved. In this paper, we proposed an algorithm for finding the distance between the concentric closed shapes in an image. These achieved by splitting the image into four quadrants and apply the Hough transform for detecting the curves in each quadrant and finally combine the result of four quadrants and achieve the result.*

Key-words*: Hough Technique, dendrochronologydendroclimatology, edge detection, Gaussian filtering, tree ring.*

I. Introduction

Tree rings records the age of tree and also responses the climatic conditions over the period of growth. It is well known that the approximate age of a temperate forest tree can be established by counting the growth rings in the lower parts of the stem. Growth rings records would be of much promise to retrieve past climatic information in time scale of annual resolution [1]. The pattern of radial growth in trees depends largely on

the climatic conditions of different localities and the yearly sequence of favourable and unfavourable climate (wet and dry, warm and cold) is faithfully recorded by the sequence of wide and narrow rings in large numbers of trees[2]. It is essential requirement to study the tree ring for identifying this environment changes. It is also challenging issues for extracting the dendro data from the tree rings. From literature survey [5 - 8], many methods are used for analysing the dendroecological data in the field of dendrochronology, dendroecological and dendroclimatology but failed to meet the requirements. Otherwise, it is limited for use and not focused on the solution of new tasks connected with environment heterogeneity [8].

In this paper, studied the Hough transform and apply it for identifying the growth of ring in each annual.

II. Overview Of Hough Transform

Feature extraction technique is one of the important processes in digital image processing. Hough transform technique is used for extracting features from an image. This technique is carried out by voting procedure.

For detecting parameterized curves in images, this technique is used by mapping the edge points into manifolds in the parameter space[9].

The Houghdetect the peaks in the parameter space, which can be used to trace the shapes in the images. In a straight line (y=mx+b), each edge pixel is mapped with the parameter space m x b (b=-xm+y). To find the peaks in the parameter space, histogram procedure is used by Hough method. The cells, which received more voting in the parameter space, are indicating the shapes in the images.[9]

Steps for Hough transform:

Pre-processing of Hough transform is smoothing the image by Gaussian filter and then edge detection

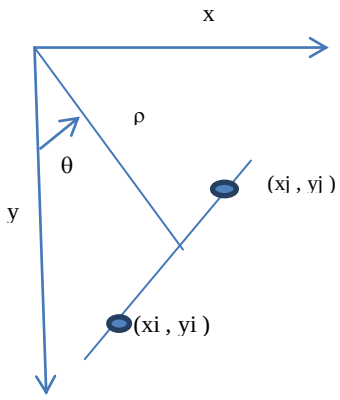

Fig -1 (a) xy plane

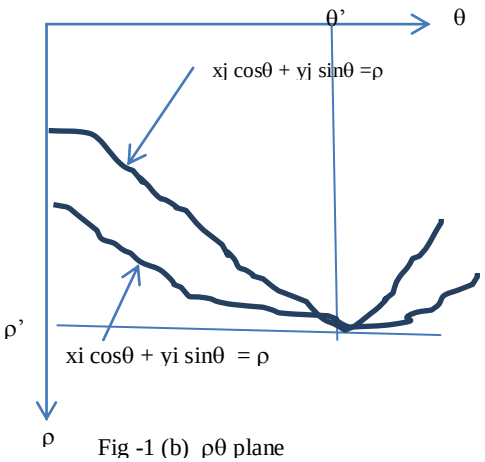

Fig -1 (b) ρθ plane

Method is used to trace the edges.

After Pre-processing, we have n pixels that may partially describe the boundary of shapes. We have to extract the set of pixels which represent the specific objects. For example, the polar representation of straight lines is x cosθ + y sinθ = ρ. Sinusoid in the ρθ- plane is represented by each point (xi ,yi) in the xy-plane. M collinear point lying on the ρθ- plane give M curves that intersect at (ρi ,θj) in the parameter xi cosθ + yisinθ = ρ.

Each curve in the fig -1 (a) represents family of points (xi ,yi) , (xj ,yj)that present in a particular line in the xy-plane. Each curve in the fig- 1 (b) represents family of points that intersection on the point (ρ',θ') corresponds to the line passes through two points (xi ,yi) and (xj ,yi) [14].

More than 2D parameterizations can be decomposed into smaller sets is extremely beneficial in memory requirements and time taken for calculations. For examples, circles are described by centre and radius. Hence three parameters are required. So the problem can be decomposed into a two-stage process. First stage, identify the centre coordinate and second stage to find the best value for radius. Similar ideas can be applied to ellipse which has 5 parameters.

But hough techniques have been proposed to deal with the localization and discretization errors in image edge points. This has not been satisfactory in locating noisy shapes and also considering false. Additionally, this technique has been very expensive in computation and memory requirements[9].

In this paper, we consider the techniques to extract the concentric irregular rings, not exactly circle or ellipse in tree rings and identify the growth of climatic conditions over the period of tree growth[14].

III. Proposed Algorithm

Fig -1 (a) and (b) are images after applying edge deduction in the cross section of tree ring images. These images are cannot be fit into any geometric shapes. The shapes may vary for each tree. So it's difficult to propose an algorithm for the tree rings. In this paper, we design an algorithm which suitable for calculating the distance between two radius and estimate the climatic conditions.

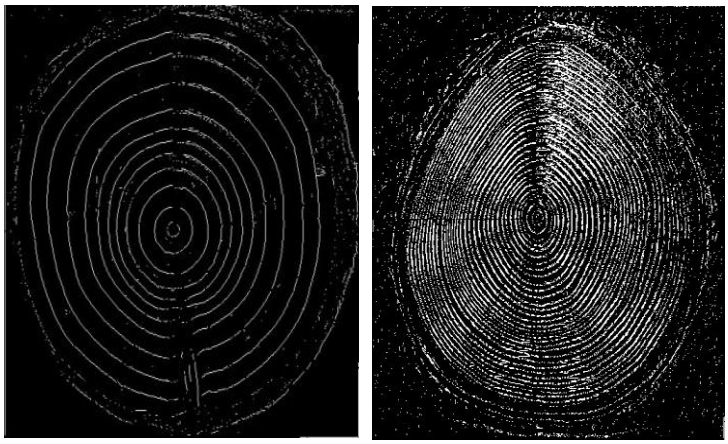

Fig-1 (a) and (b) Tree rings after edge deduction.

Steps for proposed Algorithm

1. Divide the rings in the image as four quadrant as in fig-2

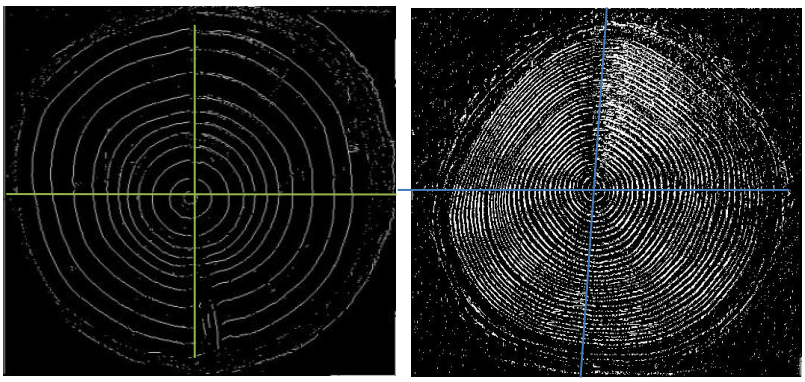

Fig-2 (a) and (b) Tree rings after edge deduction.

2. Calculate the distance between centre and each edge pixel and accumulate the results in each quadrant separately.
3. Estimate the radius by taking the average of accumulated results in each curve separately for each quadrant.
4. Compare the radius of each curve in four quadrant and estimate the radius of each ring.
5. Extract the climatic condition recorded in the image.

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

Splitting the image into four quadrant and apply the hough technique for each quadrant separately. Hence the memory requirement and amount of time taken is less compared to applying the hough circle for the entire image.

IV. Results

Implement the algorithm in java using ImageJ tool. Applying the proposed technique in the image fig 2 (a), we can get the radius of 12 rings in fig-3(a);In fig – 3 (b), we can estimate the distance of the 12 rings. Using this estimation, we can calculate the age of tree as 12 and climatic condition can be analysed by the distance between the rings. In fig 3(c) we can extract the climatic condition of the tree which recorded in its bark.

	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 -3(a) Radius of 12 rings. (b) Calculate the distance of 12 rings

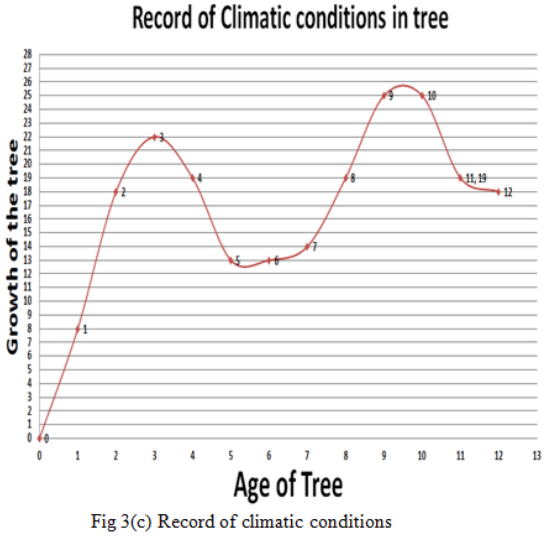

Fig 3(c) Record of climatic conditions

Applying the proposed technique in the image fig 2 (b), we can get the radius of 43 rings in fig-3(b); In fig 4 (b), we can estimate the distance of the 43 rings. Using this estimation, we can calculate the age oftree as 43 and climatic condition can be analysed by the distance between the rings. In fig 4 (c), we can extract the climatic condition of the tree, recorded in its bark.

	Radius
1	17
2	26
3	35
4	41
5	48
6	56
7	65
8	71
9	77
10	84
11	91
12	97
13	104
14	113
15	120
16	126
17	132
18	138
19	143
20	149
21	154
22	159
23	165
24	170
25	176
26	181
27	186
28	191
29	196
30	202
31	207
32	212
33	217
34	223
35	228
36	233
37	239
38	245
39	250
40	257
41	267
42	288
43	202

	Radius	Di
1	17	
2	9	
3	9	
4	6	
5	7	
6	8	
7	9	
8	6	
9	6	
10	7	
11	7	
12	6	
13	7	
14	9	
15	7	
16	6	
17	6	
18	6	
19	5	
20	6	
21	5	
22	5	
23	6	
24	5	
25	6	
26	5	
27	5	
28	5	
29	5	
30	6	
31	5	
32	5	
33	5	
34	6	
35	5	
36	5	
37	6	
38	6	
39	5	
40	7	
41	10	
42	21	

Fig -4(a) Radius of 43 rings.
(b) Calculate the distance of rings

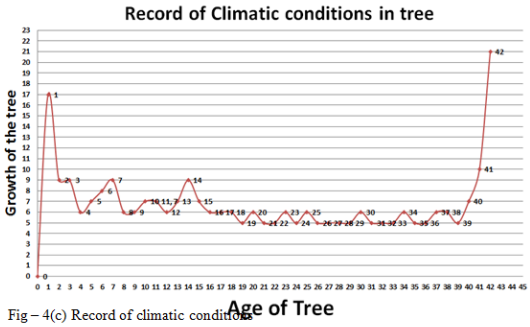

Fig – 4(c) Record of climatic conditions

V. Conclusion

Counting the rings and finding the climatic condition from the tree ring record is very crucial issues. By applying the Hough technique in the proposed way can extract the information from the image. Nature is a best creator, hence the formation of ring is vary from tree to tree. It is difficult to propose an algorithm for fixed shapes. Some boundary may lose during the deduction of edges in the image and also cracks in the rings may affect the result of edge deduction also. Proposed Hough technique can count the rings and identify the growth of the tree. Time complexity and memory requirement also less compare to the Hough circle techniques.

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