A Study on Tree Rings: Dendrochronology using Image Processing

Divya.K\textsuperscript{1}, Sukhvir Kaur\textsuperscript{2}
\textsuperscript{1}Research Scholar, Department of Computer Science and Engineering, Lovely Professional University, Phagwara, India
\textsuperscript{2}Assistant Professor, Department of Computer Science and Engineering, Lovely Professional University, Phagwara, India
\textsuperscript{1}divi786@gmail.com, \textsuperscript{2}sukhvir.25374@lpu.co.in

Abstract:

This paper outlines an introduction to dendrochronology. The tree rings are being identified through image processing and statistical simulations. The study of the tree rings is known as dendrochronology but the techniques do need to be modified for better performance. Image analyses convert the tree ring into digital data using imaging tools. This method involves the scaling, piling, width calculation. Technology is required to evaluate the factors of different tree ring pattern. In this review paper, literature survey has been provided which deals with the contribution of different researchers, which methodologies they preferred and what were their limitations. And two attributes are being calculated named MSE and PSNR, as these obtainable values indicates to work further with the enhanced image. Also, researcher can get idea what all the attributes are important to implement this technique.

Keywords: Dendrochronology, Tree-Ring, Earlywood, Latewood, Segmentation, Edge detection.

1. INTRODUCTION

Dendrochronology is a branch of study that focused on knowledge processing found in tree rings. It is reliable absolute dating approach that also helps to answer questions in number of ways in the field of science from quaternary geology to archeology, geomorphology, ecology, climatology, environment sciences. These all comes under the applications of dendrochronology. The basic function of the tree ring used into dendrochronology. This method measures the width of the annual rise of wood. Dendrochronological divided into two terms Dendron like tree chain, time or chain tree date and chronological means the growth analysis of tree. Study of the rings of the tree, the date of the vine and the detection of certain aspects of the past nature are probable. Survey changes in the ecological trend used to take the required measures for our conservation area. In tree, primary and secondary are two kinds of development. Vertical tree growth is the main production i.e branching. Horizontal growth is the secondary root of the vine growth. The width and density of the tree rings allow us to accommodate wood products in the bark and branches and the relationship among tree growth and atmospheric variables. In dendrochronology, the tree ring boundary analysis is a critical problem. Most hardware and the experimental research techniques are used to analyze field dendroecological results.[1]-[3]

Image acquisition is often the first step in the workflow series, since without an image no processing is possible. As a part of image processing, image acquisition is a method of obtaining an image from a source,
usually a hardware-based source, so that it can be processed with whatever operations need to proceed afterwards. The image which has been obtained from hardware is unstructured therefore different methods have to be applied to retrieve the output. Capturing image is crucial factor through equipment’s like scanner and optical telescope etc. are required. For image acquisition, in literature survey the researchers have used various methods like microscope, data recorder, scanner to analyze the image with high resolution so that the image can be study in a well-mannered and the data can be retrieved easily. The different types of species are used to experiment. There various species which gives best result such as Pine tree withstand with the pollution well.

Image preprocessing is the terminology for the image operations at the lowest abstraction level. These actions do not improve the level of the image information, but reduce it if the uncertainty is an information metric. The goal of pre-processing is to optimize image data that remove undesired defects. In preprocessing stage, the author performed techniques like segmentation, conversion from RGB to HSI. To fragment the dataset, some researchers have used the segmentation techniques. Watershed is one of the techniques used by author [17], [27]. Edge is being detected for retrieving the data. Out of all edge detection method, canny edge gives the better output.

Feature extraction defines the appropriate design information found in the pattern such that the process of defining the pattern is made easier by a systematic method. The performance measures of different researchers have been listed in survey table. The survey table in Table 1 has been elaborated. The paper got divided into few sections where Section II explains the contribution of different author, their methodologies used in their paper. Section III describes the proposed work followed by conclusion.

2. LITERATURE SURVEY

Dendrochronology is the study of the tree rings, on experimenting the researchers have provided various result. This helps the scientist to predict the past climate, the growth of the tree and the age of the tree. There are various features by studying that one can predict the tree is unhealthier or not. Here work of researchers has been discussed below and even their methodology in Table 1:

Filipe Campelo, et al [1] was planned to clearly find and label tree rings in X-ray micro-density profiles. This package is free and offers flexibility for visualizing and calibrating X-ray pictures, recognizing tree rings on walls, and defining the movement of the earlywood-latewood by utilizing inter-and intra-ring differences in wood density. The author used coniferous species for analysis. The X-ray images has been visualized, tree rings are identified and measured. The crop function in R has been used for segmentation. The author defined two classes xRing and xRingList which helped to calculate the grayscale images and analyzed accurate density profiles of the tree rings.

Anna Fabijanska, et al. [2] built detector which was created for DeepDendro technique, that is to say, the automatic tree-ring cap on the U-Net networks. The author presents ConvNets to identify tree rings automatically. Films from the three organism wood cores, which serve for the ring-porous sort of anatomical structure, were checked to assess the durability of existing technologies. 2500 testing datasets boundaries was used. Input scanned images of RGB get converted into HSV model, h component is of no use, s component barely visible, v component is trained to CNN. 96% of which have been decided correctly by proposed approach. 0.97 accuracy rate that just confirms a few false boundaries have been launched by this method. Ring-porous gives best result. The proposed approach successfully finds the tree-ring
boundaries of different width, structure and orientation. No parameter setting is required.

Malgorzata Danek, et al [3] suggests a strategy works nicely on bunch of corresponding tree and wood type’s species. The outcomes of using the suggested method of scanned videos of wood cores representing 12 tree species are offered. Scanners are used to obtain the images of wood core. Microscope with digital camera is used to obtain input data. Color normalization is done. Input data converted into HSV model. Noise removal done using Gaussian filtering. Evaluation of the results demonstrates the method performs faultlessly for conifer species, detecting about 100% of tree ring boundaries. The situation of diffuse porous species, the quality of 85% of effectively detected tree ring boundaries.

Malgorzata Danek, et al [4] used image enhancement approach that boosts the amount of the tree rings recognized in the timber picture by CooRecorder application. The outcomes offered by various preprocessing methods are evaluated using the quantity of the recognized tree rings. Interpretation and discussion of the outcomes will also be provided by preprocessing of the wood. The amount on the tree rings detected by CooRecorder software is increased by core pictures. Filtration is performed on HSV component. The best result gotten as 5 tree rings out of the 37 have been skipped and there were simply no incorrect tree rings at exactly the same period. The detection rate on the initial picture of wood strip was 43% which has been enhanced.

Marek Krapiec, et al [5] reviewed the wreckage of the earth during the time with the dendrochronological method. The author analyzed industrial temporal and spatial images for evaluation. The analysis was according to 814 samples, taken from 53 researchers. A significant enhancement in the condition of pine forests was noticed in the majority of the research plots. The tree ring width is calculated. The author observed the sample, and noticed that how the removal of damage tree enhances the results. At the end, author concluded as out of all input data, the pine tree withstands than other samples.

Lara.W, Bravo.F, et al [6] extracted the pixel field and light data from photograph generated. The author obtained a gray value matrix and smooth gray values are measured. In this paper, a luminance functions are defined to measure the model data for users to visualize or automatically identify TRW on picture segment. Similar mechanism measured, created a matrix which include gray value, and these values used in segmentation process. Data analyzed from the pictures and computation phase were carried out both with gray matrix or smooth gray matrix. To process the image the author defined ringSelect and ringDetect functions and reported the output.

Pol Kennel, et al [7] explained an important way for wooden images to delineate tree rings and even inter-tree lines. The technology and the multi-scaled gradient map resulting from the Dual Tree Complex Wavelet Transform (DT CWT) rely upon an energetic contour strategy. DWT method attempts to partition a signal into a multi-scale representation that isolates rough picture components into a small coefficients range. The proposed method lowers the energy values to fragment artifacts along reference limits. The technique is automatic and needs no monitoring. The technique was used by user to treat entire Abies alba wood strips, about 200 rings trees from bark to pith. The approach was carried out and received F-score 0.91 for delineation efficiency.

Salvador Arenas-Castro, et al [8] described an inexpensive and innovative technique using DIVA GIS freeware software to evaluate true color high resolution scanned images of cores with ImageJ freeware (GIS SDI), plus evaluate its accuracy against the widely used WinDENDRO and LINTAB-TSAPWin methods.
The Divas-GIS, a free computer program designed for mapping and geographical data analysis examined for digital images. Abies Pinsapo and Pyrus Bourgaena increment cores were processed independently. The proposed approach calculated accuracy using WinDendro and LINTAB-TSAP. Segmentation is done as it allows to compare new methods and other existing one. The outcome was statistically compared. Dating results have been consistent across all three techniques, though identifying rings was quicker and easier to do on the electronic photographs. DIV-GIS proved to be inexpensive and gave higher accuracy rate and enables digital record of every core analyzed.

Micheal Henke, et al [9] described an effective and easy way to remove tree rings which completely independently from the origin from the tree disk images. Computer assisted way and macroscope images were used. Active contour method is used which are even used in healthcare image processing to discover organs. Outline tree rings are measured by Sobel operator. Special focused to remove essential bodily problems brought on by branches, colorizations or crack. The manual measurements were compared and revealed it as reliable device and outcomes are reproducible. The resulting data are able to provide lots of info on exactly how trees adapt growth to green problems that further may be utilized to analyze wood quality or even for describing as well as model changes in stem development.

Meenakshi Sundari.P, et al [10] determined the trees lifespan and much of the forest variables. No species, rather than gathered documents, X-ray films and satellite pictures. Noise is removed at the same time skeletonization and cleaning is performed. Analyzed picture transformed the tree band into electronic data. The method includes image resizing, density slicing, calculating and topping. The tree ring is transformed into digital data using computer tools via image analysis. The proposed work is on the system used image recognition for dendrochronology analysis. The image processing handles pictures that are digitally captured two-dimensional items by scanners or camera structures that decode in a series of 0’s and 1’s spatially contiguous coordinates.

Meenakshi Sundari.P, et al [11] discussed a dendroclimatological method. For the detection of the circles on the tree rings, image recognition methods and mathematical models were used. In this paper, the distance between two circles may be determined and this allows predicting the atmosphere. The input images of the tree are obtained using X-ray Tomography, previous images cost more as they are big in size i.e, 512*512 pixel. Gaussian filter is used to get Gray digital image. Edge detection is performed and finally circular closed active contour is applied. The author suggests steps to determine the density between two circles after the edges of the circles in the input picture have been delineated. To identify the pith of images, tree rings have been counted and density has been measured. The author offers basic guidelines for projection the potential climate to address the challenges in our habitats.

Meenakshi Sundari.P, et al [12] performs comparison to find the best choice for further analyzing the various edge detection strategies in relation to the ring picture of the tree. Various gradient and Laplacian based edge detection methods used to find missing edges and detect false rings. The method focused on gradients such as the Prewitt filter has a significant drawback on the noise signal. Through changing the function, the efficiency of the canny rim algorithm is increased. The author compared with the Sobel, Prewitt and Roberts user; it is technically more complex. The output image showed the tracked intensity discontinuity. Eliminated the duplicate edges, better edge detection without noise. Yet this algorithm is stronger at removing rings in the picture than all those operators. Improved algorithm for the canny edge recognition in all forms in ring images is studied.
Waleed Abu-Ain, et al [13] introduced a modern skeletonization method. The method analyzes document image and performs recognition to improve information. The suggested approach was carried out in standard datasets studies for evaluation. Comparison aspect contains the finding that significantly stronger outcomes are achieved than other thinning processes. The process is made up of three steps. The first two steps enable the separation of the skeleton and the third is to require the skeleton to be configured in 1-pixel space. The tests are carried out in a multi-class collection of MPEG-7 type data groups to test the approach suggested. High quality performance obtained.

Peter Hietz [14] presented current latest tools related to image processing system, for tree-ring research applications, one for spreadsheets (Excel), and one for predictive analysis (R). In this first macro, ring width indicated by the consumer is computed throughout scanned images, raw and trendy data is processed in Excel and the gap between pith and the series is determined. Conifer species are used. In second macro, it tests darkness in a certain route to define the change from latewood to earlywood in conifers and a third indicates that border may be automatically identified. While calculating the tree ring duration, error values were also verified. The proposed system includes vessel size, wood density or distribution of cell types detected automatically which is hard to obtain. For processing, software is made using R, Excel. SigmaScan for image analysis and detection of boundaries. The applications incorporate the features of current applications and are thus rather cost-effective and fairly easy to conform to the needs of other initiatives or to extend with same framework.

Stockton Maxwell, R, et al [15] used a study design for pseudo of 2*2 relating traditional plot estimating the system of semi-automatic image processing by the two professionals. COFECHA, ANOVA, Window software were used to test the exact parameters for the width measurement. Red Cedar is used in this approach. WinDendro software is used to semi-automatically analyze the image by detecting the annual and inter-annual boundaries based on changes in light intensity of an image and adjustment required to ring boundaries. In both measuring and crossing schemes, the author recommends the creation of a comprehensive uniform description of the EW-LW frontier. The automated preservation of tree-ring collections often tends to overcome the long-term storage issue and enables a researcher to return to the forest, also with certain resolve restrictions.

Wagner, B, et al [16] reconstructed 3D root-floor model, the tree rings are replicated to shape the basis for a potential 3D core model. For the processing of the 3D root template, a FARO ScanArm has been used for acquisition. To recreate inner ring width profiles in the cross parts, a graded interpolation algorithm was used. The algorithm found both the neighboring radii’s ring-width variance and the cross-sectional outer form using two independent datasets one is 3D lazer scanner for root structure and second is 2D ring width data. The objective was to approximate root circumferential ring widths by using 4 radii measurements in ring widths and root surface dimensions. In order to monitor the established interpolation algorithm, interpolated ring-width data were compared to the tree-ring data calculated. A mean absolute failure of 0.06 mm was observed for contrasts between modeling and empirical values and development rates could be correctly simulated with a few exceptions.

Hong Zhou, et al [17] deployed Hue Saturation Intensity (HSI) color method to erase the blue wood context. The distort picture is dichotomized, accompanied by a cross-calibrated wrong measuring adjustment to incorporate missing bands, by watershed system and the window procedure. The age is determined, scanned image database is detected, miss and fallout values are detected. The Runoff Ratio is often decreased with a policy focused on distance prohibitions. This mentions the cumulative number of tree rings finally. A
strategy focused on distance constraints is often used to reduce the runoff ratio. It eventually lists the total amount of tree rings. Observational tests indicate that this approach can be used to calculate ring numbers even though the sapwood and heartwood variations in color, and to correct mistakes in identification of loss, and improving the precision of the ring matching.

Borianne. P, et al [18] proposed an original method as X-ray Computed Tomography images of timber for instant tree ring boundary detection. CT acquisition performed with the Xyloscience platform with a tube voltage of 100 kVp and an intensity of 50 mAs with the helical pitch of 1. Two measures are employed to evaluate the method: tree tagging and ring marking. First, the radio-intensity profiles are analyzed after automatic position of the pith and the second, using active contours which track the different tree-rings from the surface to the pith sequentially. Hough transform, ring circle, radius profile detected. The proposed method is robust to handle the override main artifacts of the dendrology. The geometric constraints used in the active contour method enable stable constraints to be accomplished without interruption or divergence. The system is sufficiently robust to bypass the key dendrological entity. Tagging step has to be improved and more species of wood have to be included.

AlessandrinI. A, et al [19] made a usage of ecological variables was believed to compatible to each zone and as an implication of evolving specialization as per effects of natural processes. In this research, in Latium, a dendroecological method has been test and paired with the phenological answer of forests in identifying regions of authorship. The photosynthetic behavior signals represented in the uniform differential vegetation (NDVI) index quantified the phenological habits of forest organisms. NDVI was equated to dendroecology over a beech tree network utilizing geographical Information System research, which achieved a high-level of resolution.

Mauricio Cerda, et al [20] suggested a tree-ring detecting procedure automatically and equates it to a dendrology expert’s manual identification. In this paper analysis is done by recording the ring width of 4 or 8 directions wood disc. The methodology suggested is based on a version of the Generalized Hugh Transformation (GHT), which is generated using an extremely simple increasing tree model. Radiate Pine Truck species is used. The automated algorithm shown displays resistance to textured and extremely noisy artifacts and offers typically strong tree-ring identification. The tree-rings in our study set correctly detect 80%. Novel concept is to take, without any inference previously created in the form of the circles, and to modify this ring-prototype by means of a basic rising model of the tree, the ring-prototype taken from wood-trees pictures as feedback for this highly like turn.

Tom Levani [21] found a new system named ATRICS for image acquisition in Dendrochronolology. The author used microscope to analyze the clear image. Quercus, Fagus, Acer, Alnus, Picea, Pinus, larix and Betula species is used to experiment. Errors are being identified. The experimental framework was contrasted to current systems of calculation. The photographs obtained from the ATRIC Scanning Software and produced in some of the available systems for automated tree ring recognition are far more accurate than those from the flatbed scanning method, as the optical enlargement provides many benefits over the visual amplification. In this testing done using visual assessment, the blurred areas were being removed. And no more missing areas were found. A distortion check did not reveal variations between the initial and the captured rectangle, which meant that the pictures captured are free of distortion. At the end, automatic measurement is observed.

Rochelle Campbell, et al [22] followed a method that drawn on McCarroll, but while utilizing consumer
applications which are utilized by other Dendrochronology laboratories. A generic method of adjustment is suggested to ensure a replication of the findings of various scanners and laboratories. Flatbed scanner is used to collect the tree ring image. Pinus sylvestris species are used. With a young and mature Scot Pine tree this method has been seen to perform well. All X-ray densitometry and blue strength require thin wood laths, resin removal and other hardware products to chemically process and results need to be standardized to eradicate ageing patterns. The system is designed to deal with color differences and harmonization. The time-series, x-ray intensity data has been obtained for the same observations.

Hayet Laggoune, et al [23] outlined a semi-automatic system for measuring and 3D reconstruction of the tree ring region. All types of wood species are evaluated. A good filter for blurred and distorted pictures is used for detecting the ring branch. Ring edge detection is done using optimal operator and further contour techniques are applied. A one-pixel broad edge is given by the classification of the pixels and the contour on the gray map, an essential phase in calculating the region and breadth of the tree rings. If the specimens are well collected, the 3D reconstruction can be carried out effectively. Ring area, blurred and noisy images are handled. Specific techniques including laminated sediments, fingerprinting or assessing the age of fish were also established and followed methods. The future work to study the tree disease and the physical anomalies development studied using data mining.

Giuliana Defloria, et al [24] designed a framework that includes the usage of microorganisms to uncover wood on cell wall culminated in a macroscopic view of the ring boundary. Sycamore silver birch, aspen and two fungi is analyzed. The outcomes of this analysis were contrasted with those obtained using certain traditional methods, such as sanding, staining and integrating the above process. The findings suggested that the use of decay fungi in diffused porous hardwoods for visualization of the tree ring boundaries could be an effective approach for examining the tree ring. Decay fungi and Sycamore gives the best result. Tree rings were also strengthened by dark red fungi in studied of birch tree wood. The future work is to explain the decay fungi that be more valuable.

Nivaor Rodolfo Rigozo, et al [25] introduced a new interactive approach for evaluating tree ring diameter. The scanner and a monitor are used in high resolution. Pinus taeda from Southern brazil is used as dataset. In the interactive data language (IDL 5.0) framework, software had been created to process scanned tree ring pictures. The method conducts interactive image processing with tree-rings without cost-effective complex hardware. The precision measures the ring size from a slice of tree Pinus taeda in southern Brazil were tested in a common procedure. In order for the phases of geophysical phenomenon such as the 11- and 22-year periods of solar activity, which have an effect on lunar tides over 18.6 years, to be determined, these techniques were used for calculating the ring diameter using microscope.

Romualdas Jukyn, et al [26] analyzed the different aspects of anthropogenic tree-rings series transitions in a toxic environment, tree severity increases, tree-ring series uncertainty shifts, increases in relationships with natural external influences. The Pinus sylvestris species has been experimented. Three separate tree reaction cycles have been identified: fertilization cycle, drought phase and time to recover since annual emissions have been drastically reduced. In the contaminated climate, the variation of the tree ring sequence has increased several times. The changes in the sample have been recorded. Trees have adapted dramatically in the contaminated atmosphere in response to the effect of climate variables and their resilience has improved. The obtained output provides the sensitivity of the trees that play major role in pollution.

Pierre Soille, et al [27] presented a semi-automated approach to quantify annual ring size. Morphological
image analysis done by computerized scanned images for cross-section of stem. Picea abies is used in this approach. The cross section of a tree stem is then primed to keep it from splitting by sanding onto polyethylene glycol. Segmentation done using watershed method. At a spatial resolution of 600 points per inch, a scanned gray representation of the corresponding stem disk was then collected from a scanner. This image is processed in order to automatically outline the rings of the trees using a sequence of morphological image analysis transformations. Contrasted bright image, bright streaks appearing, occurrence of false rings, radial cracks these features were detected. STAR CARTO is used to vectorize the image manually. User contact restricted to correct the distracting aspects such as knots and low-contrast or very near circles with alien or incomplete limits. The future work will be automatic detection of morphology images.

Peter Ian Kuniholm [28] discuss about the term Dendrochronology. The author explains the surface of the samples is handled with the sandpaper and also collected the morphological images. The author experimented summer & spring, dry & wet, burned & sanded wood. Statistical analysis and complete measurement of ring series are done. The author highlights the various applications of the Dendrochronology. To explain in detail, the author discussed various case studies at various field like climatic and environmental basis with respect to the different countries. Also, the author highlights the future prospects in this handbook.

Steven Conner. W, et al [29] defined a computer-based Dendrochronology analytics framework architecture and implementation for problems related to the identification and study of the rings of the trees are not specific to the program, but perhaps of concern to all those that build automatic imaging systems. The author used microscope images and preferred conifer species. The research found the automatic correlation between images can be useful for final result. For edge detection, canny edge method is used. Before counting the number of rings, the image has been cleaned and enhanced. The author describes the Fragment linking techniques adds an advantage to the result.

Innes.J.L, et al [30] studied tree-ring study to demonstrate the tree-growth consequences of environmental contamination. Random species have been collected. Tree species of red spruce and silver fir is used. It employed regional-level pollution contaminants. Non-stationary reaction functions built using Kalman filter technology give significant potential for assessing the effect of regional air contaminants. Red spruce development has been smaller than expected by climate conditions demonstrating that the influence of any other impact for development has enhanced or that climate factors that affect growth have shifted. Some of them could be emissions, although the tree-ring study would certainly not be able to reliably assess the connection contamination brings to the measurable decrease. The nature of the data is predicted through this study.

**Table 1: A survey on the study of Dendrochronology**

| S.No. | Acquisition Techniques | Sample Type & Size | Preprocessing | Segmentation | Feature Extraction | Performance Measure | Remarks/Drawbacks |
|-------|------------------------|--------------------|---------------|-------------|-------------------|---------------------|-------------------|
| [1]   | Earlywood and latewood are studied | Coniferous Species | Visualization and Processing X-rays images to identify and measure tree rings. | Crop Function in R is used. | No features are extracted. | Adjusting and calculated grayscale images derived from X-rays densitometry. | The interface allows it easy to view and accurate density profiles. |
| [2] | Worked on Darker-one and Light-one stripes | Conifer, Ring-porous, Diffuse-porous | Converted RGB input to HSV model. | Patch size of 128*128 pixels used for segmentation. | - | Ring-porous gives best result. | Tree ring detection is quick as compared to exiting system. |
|---|---|---|---|---|---|---|---|
| [3] | Scanners and microscope with digital cameras are used to obtain the images of wood core. | 4 Conifer and 8 Angiosperm | Gray scale images are processed. | - | - | HSV images give suitable result for tree ring detection. | The future work of this paper is to design multi-operative graphical user interface. |
| [4] | Microscope, sliding table and Data recorder used for measuring tree-ring width. | Coniferous Tree. | Haralick features are extracted. | Not performed. | Features which give relevant result were considered for presentation. | Manual and Semi-automatic detection is observed. | Future work to emphasize image processing technique for tree-ring detection. |
| [5] | Analyzed the industrial sample as Temporal and Spatial images. | Pine Trees, 814 pines were sampled which 463 and 351 cores. | Not defined | No segmentation is done. | No features are extracted. | Observed how the removal of damage tree enhances the result. | The Pine tree withstands the pollution than other samples. The tree-ring width analyzed. |
| [6] | The pixel field is extracted and light data used to generate gray value matrix. | Type of wood is not defined. | Visually recognize or automatically identify TRW on picture segment. | Gray value matrix segmented. | No features are extracted. | Data analyzed in the form of gray matrix and smooth gray matrix. | Two functions ringSelect and ringDetect defined to analyzed. |
| [7] | For delineation of tree rings automatic techniques have been applied. | Abies alba wood | DWT method used for partition of multi-scale rough picture. | Picture gradient used to draw the active contour to target border. | Tree ring thickness is estimated. | Edge junction contour components are connected and implemented. | An automatic delineation system was conducted correctly with an average F-score of 0.91. |
| [8] | The Divas-GIS, a free software | 8 of Abies Pinsapo and Scanned images | Segmentation is done. | Using fundamental identification of rings on visual | DIV-GIS proved to be inexpensive and... | | |
| Reference | Methodology |
|-----------|-------------|
| 8 of Pyrus bourgaeana | Computer program designed for mapping and analyzing digital images. |
| ImageJ freeware and accuracy calculated using WinDendro and LINTAB-TSAP. | tools, the growth is analyzed. |
| photos was simpler and faster. | gave higher accuracy rate. |
| [9] | To remove tree rings Computer assisted way and macrocope images were used. |
| Several Conifer species. | To detect and count the rings segmentation is performed. |
| Noise is eliminated. | Semi-automated ring segmentation used for free and open source software solution. |
| The quality and description of model of wood is the future wok. |
| [10] | Scanners or camera used to decode the coordinates that are digitally captured 2D images. |
| X-ray films and satellite pictures. | Noise is removed. Skeletonization and Cleaning is done. |
| No segmentation is performed. | Number of rings, path per image, ring features, density analysis and light reflection. |
| Input data got transformed into digital data using computer tools. | Various software description is given which can be used to study dendrochronology. |
| [11] | The input images of the tree are obtained using X-ray Tomography. |
| Not specified | Gaussian filter is used. |
| Segmentation process not performed. | Identifying the pith of image, listing down the radius of rings, counting the rings and density of each ring. |
| The proposed method gives to find the density of two tree ring after delineation of edges. | The future work is finding the future climate using past data. |
| [12] | Missing and false edge detected by various gradient and Laplacian based edge detection methods. |
| Tested for all types of wood to detect the edges. | Sobel operator, Prewitt & Roberts and even Canny detection are used. |
| Segmentation is not done. | The output image showed the tracked intensity discontinuity. Elimination of duplicate rings were done. |
| Comparison of all the detection methods. | Canny edge detection method has been improvised gives better result for all type of wood. |
| Reference | Methodology | Application | Text Processing and Recognition | Segmentation | Document Texts, Edges of Images | Approach | Performance |
|-----------|-------------|-------------|---------------------------------|--------------|-------------------------------|----------|-------------|
| [13]      | Document image analysis and recognition used to improve information. | Textual and graphical applications | Text processing and recognition is performed. | No segmentation done. | The approached system gets divided into three stages. | High quality performance obtained for binary images. |
| [14]      | Raw and detrended data is calculated in Excel using scanned images. | Conifer species. | The tree ring duration is calculated, and error tests were verified. | Segmentation is not done. | Vessel size, wood density detected automatically. | Software is made using R, Excel and SigmaScan for image analysis and detection of boundaries. | User feedback is also collected and discussed in this paper. |
| [15]      | The windows software, ANOVA, and correlation matrix were used to evaluate raw observation of sum earlywood and latewood breadth from both approaches. | Juniperus virginiana knowns as red cedar. | The annual and inter-annual boundaries based on changes in light intensity of an image is measured using WINDENDRO software. | No segmentation is performed. | No features are extracted. | NA | Allow able boundaries |
| [16]      | FARO ScanArm designed to reconstruct the tree ring for acquisition. | Two independent datasets, laser scan and width data are used. | Laser scanning and ring width detection are performed | No segmentation is done. | Accuracy rate is predicted and compared with the existing one. | The proposed method able to plot between the 4 radii of cross section on the ring width data. | Mean absolute error of 0.06mm comparison between modelled and empirical values for patterns that are accurately stimulated. |
| [17]      | Dataset images are being scanned. | Pinus massoniana | For background transformation colored image converted to HSI. | Watershed method is used for segmentation. | Age, miss and fall out values are detected. | Distinct color rings have been detected and counted. | Detection has to be increased using image enhancement is the future work. |
| [18]      | CT acquisition | Scanned Jack Pine | Radial intensity profile and | Segmentation is not | Hough transform, | The proposed method is | Tagging step has to be improved and |
| Reference | Methodology                                                                 | Species                                                                 | Techniques/Analysis                                                                                   | Additional Notes                                                                                      |
|-----------|----------------------------------------------------------------------------|-------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| [19]      | Performed with the Xyloscience platform.                                    | Log, Ash tree, Spruce                                                  | Active contours are used for ring detection.                                                          | Robust to handle the override main artifacts of the dendrology.                                      |
|           |                                                                             |                                                                         | Ring circle detected, radius profile analysis.                                                        | More species of wood have to be included.                                                            |
| [20]      | Analysis is done by recording the ring width of 4 or 8 directions wood disc.| Forest Species                                                        | The three bioclimatic PCA                                                                               | NVDI values are compared with the geographical information analysis, obtained high-resolution.        |
|           |                                                                             |                                                                         | Not specified.                                                                                        |                                                                                                     |
| [21]      | Microscope yielded for the clear image.                                    | Quercus, Fagus, Acer, Alnus, Pinus, Larix and Betula                   | Identified the error.                                                                                | Automatic and manual measurement are observed.                                                        |
|           |                                                                             |                                                                         | Tree rings are detected.                                                                              |                                                                                                     |
| [22]      | Flatbed-scanner is used to collect the tree image.                         | Pinus sylvestris                                                       | Thin laths of wood were analyzed for blue intensity and x-ray densitometry.                          | The subsequent time-series, x-ray intensity data obtained from the same observations are strongly correlated and the same high signal intensity is retained |
|           |                                                                             |                                                                         | Segmentation is not performed.                                                                        |                                                                                                     |
| [23]      | Semi-automated system designed to analyses the tree image.                 | All types of wood.                                                     | Optimal operator and contour techniques are applied.                                                 | Future work to study the tree disease and development of the physical anomalies using the data mining.|
|           |                                                                             |                                                                         | Segmentation is not the part of the process.                                                         |                                                                                                     |
| [24]      | Using Microscope, the wood images are analyzed                             | Sycamore, silver birch, aspen and two fungi.                           | Sanding and ring porous wood techniques proved best for                                            | To explain the decay fungi be more valuable will be future work.                                     |
|           |                                                                             |                                                                         | This step not required.                                                                               |                                                                                                     |
|           |                                                                             |                                                                         | Dry weight loss of incubated wood samples is                                                         |                                                                                                     |
|           |                                                                             |                                                                         | Decay Fungi and Sycamore gives best result.                                                          |                                                                                                     |
| No. | Method                                                                 | Species/Details                                                                 | Analysis/Processing                                                                 | Results/Comments                                                                 | Conclusion                                                                 |
|-----|------------------------------------------------------------------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| 25  | Applied simple techniques scanned image to enhance and as per time series. | Pinus taeda from Southern Brazil.                                                | The resolution of scanning is found as per distance between the rings.                | Not required.                                                                   | The optical rings identified using microscope.                                  |
| 26  | The samples are analyzed and monitored.                                | Pinus Sylvestris                                                                | Three stage sampling patterns are used for the collection of like field materials.  | Segmentation is not done.                                                        | Obtain result predicts that the sensitivity of trees plays major role in pollution. |
| 27  | Computerized scanned images taken for cross-section of stem.           | Picea Abies                                                                     | Ring areas provides better index of stem-wood than ring width.                       | Segmentation done using watershed                                                 | Automatic detection of morphology images will be the future work.              |
| 28  | Fine sandpaper and razor blade are used to handle the samples.         | Summer woods, Spring wood, Dry wood, wet wood, burned wood and sanded charcoal. | Complete measurement of ring-series and statistical analysis are done.               | Not performed.                                                                  | Archeology has been discussed, how the wood is being determined, its quality and age. |
| 29  | Using microscope, the images are collected.                            | Conifer Species                                                                 | Automatic correlation between the images are found which can be useful for final output. | Canny edge detector is used to find the edge of given dataset.                   | Fragment linking techniques adds an advantage to the result.                   |
| 30  | Random images have been collected not through the                      | Red Spruce species and Silver fir                                               | The environment effect is predicted by this system.                                 | Not required.                                                                  | Nature of data is predicted through this terminology i.e., dendrochronology    |
scanners.

and different regions. respect to the pollution.

But yet appropriately not able to conclude that pollution is devastating the tree-growth.

3. Proposed Method

To process further, the original image has been interrupted by adding noise. Motive of adding noise is to remove all the errors that get added while acquisition process. When the image is being analyzed through some hardware’s like microscope and scanners. The error to an image is added automatically. In this to deal with this problem, the original image made noisy using salt and pepper and then denoised with the median filter. At last the MSE and PSNR value is obtained which will provide an idea to the researchers, as this output image will provide better results. The MSE obtained is quite efficient for further processing. The PSNR value obtained as 20 db which is best to proceed for rest evaluation. The Figure 1 represent the original image, Figure 2 is noisy image i.e salt and pepper noise added and Figure 3 shows median filter.

Figure 1: Original image of tree ring
Figure 2: Salt and Pepper noise
The dataflow shows how the proposed work has been done. The software used is MATLAB. The implemented work takes place in following steps in Figure 4:

4. Conclusion

Evaluation of the tree rings will help us to determine the past climate and enable us to forecast drought and the flood. Inundation for number of years, which will have economic benefits for agriculture. The science of tree ring described as dendrochronology; it includes strategies for reliable tree dating. In order to exploit the details correctly found in the tree rings, there is an immediate need to create a rigorous system for
calculating tree rings. There are variety of statistical models available for evaluating the factors of different tree ring patterns. Still an effective model for finding the age of the tree using climatic conditions is not there. To study this branch dendrochronology, the review has been done where the researcher can conclude which species gives better result with which methodology. To proceed the acquisition step further denoising is done in this paper and obtained two attributes as MSE and PSNR. The PSNR obtained as 20 db and MSE obtained value is sufficient to analyze other attributes.

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