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A STUDY OF IMAGE PROCESSING IN ANALYZING TREE RING STRUCTURE

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ABSTRACT

This paper describes the design and implementation of an interactive image analysis system for dendrochronology, tree ring structure. Image processing is the highest level of the evolution of imaging techniques. New qualities are brought to imaging systems by digital computers and processors. Image processing has various application fields. Such application is tree ring analysis. It determines the living period of trees and all the factors affecting the tree. Image analyses transform the tree ring into digital data using processing software. This process includes resizing, density slicing, measuring (distances and angles), scaling, and stacking. Software are available for analysing the factors of various trees ring patterns. This paper study about the software used image processing for analysing dendrochronology.

KEYWORDS: Dendrochronology, Segmentation, Edge Detection

INTRODUCTION

Image Processing deals with images which are two-dimensional entities (such as scanned office documents, x-ray films, satellite pictures, etc) captured electronically through a scanner or camera system that digitizes the spatially continuous coordinates to a sequence of 0's and 1's.

A digital image is a mapping from the real three-dimensional world to a set of two-dimensional discrete points. Each of these spatially distinct points, hold a number that denotes grey level or color for it, and can be conveniently fed to a digital computer for processing. Here, processing essentially means algorithmic enhancement, manipulation, or analysis (also understanding or recognition) of the digital image data. Every image processing technique or algorithm takes an input, an image or a sequence of images and produces an output, which may be a modified image and/or a description of the input image.

Image processing has various application fields. Such application is tree ring analysis. It determines the living period of trees and all the factors affecting the tree.

The age of tree is determined by whorl around the tree, core of the tree rings and radiocarbon dating. The thickness of the tree-ring depends on various factors such as

- The age related growth trend due to normal physiological aging processes.
- The climate that occurred during that year.
- The occurrence of disturbance factors *within* the forest stand (for example, a blow down of trees).
- The occurrence of disturbance factors from *outside* the forest stand (for example, an insect outbreak that defoliates the trees, causing growth reduction).

The measurement of tree rings would allow us to understand the past climate and help us to predict drought and flood over a period of years, which would provide economic advantages for the agriculture.

Three major steps for tree ring analysis include:

- Preprocessing
- Finding the Center
- Generating Profiles

This approach allows the development of a robust system that can emulate the complex human vision analysis of tree samples which often tend to have unpredictable features and finalize the age of tree.

Factors for the thickness of the tree-rings:

- Physiological aging processes
- Climate
- Disturbance factors
  - Within forest
  - Outside the forest

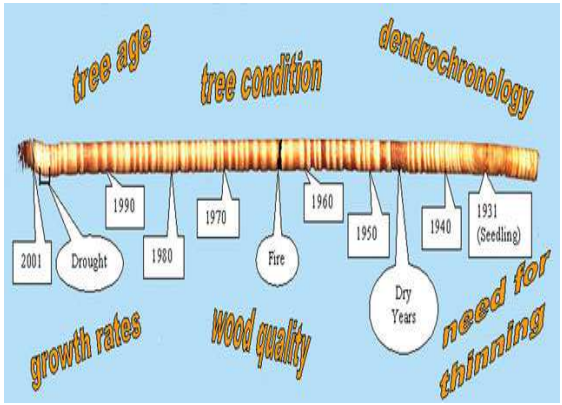

Figure 1: Structure of Tree Ring

PATTERN OF TREE – RINGS

The pattern of tree – ring is analysed by the following methods

- Whorl around the tree
- Core of the tree rings
- Radiocarbon dating.
- A whorl is the circular growth of branches in the same spot around the tree trunk. As the tree gets older, it will loose its whorls and markings will be left behind. Count from the bottom whorl up to tell how old it is.
- An increment core is a small-diameter (0.17 to 0.5 inch) tree cross section bored from the lower trunk

(see photos). These cores can tell many information about trees. Each year's growth is represented by the combination of a light (early wood) and dark (late wood) ring. Tree growth begins relatively rapidly in the spring, resulting in the light colored early wood; dark colored late wood results as growth decreases later in the year. The most common information obtained from tree cores is tree age and rate of growth. Decreased growth rates, evident by narrower growth rings, indicate reduced vigor resulting from environmental factors such as overcrowding, pest damage or drought. Informed decisions on when and how to harvest timber or to conduct other forest improvement operations may be made using tree rings as an indicator of management needs. The most specialized use of tree cores is dendrochronology, which is the dating of past events, such as drought and wildfire, through the study of tree ring growth. Historic climatic conditions may be indicated by the percentages of early to late wood. Poor growing conditions are indicated by narrow growth rings and a greater percentage of late wood. Frequency of wildfires also may be determined by examining cores for fire scars.

- Radiocarbon dating uses the amount of Carbon 14 (C14) available in living creatures as a measuring stick. All living things maintain a content of carbon 14 in equilibrium with that available in the atmosphere, right up to the moment of death. When an organism dies, the amount of C14 available within it begins to decay at a half life rate. Comparing the amount of C14 in a dead organism to available levels in the atmosphere, produces an estimate of when that organism died. Tree-ring dating is also used to calibrate radiocarbon dates. Radiocarbon years do not correspond exactly to calendar years. Since wood can be dated by both radiocarbon and dendrochronology, scientists have created a calibration curve using the absolute accuracy of tree-ring dates to indicate the true calendar age of carbon-14 dates.

Analysing the Factors Help us to Predict

- Age
- Drought
- Flood
- Other disturbance factors over the period of year

IMPLEMENTATION USING IMAGE PROCESSING

Three Major Steps

- Preprocessing
- Finding the Center
- Generating Profiles

Preprocessing

- Remove noise
- Skeletonise
- Cleaning

Figure 2: Original Image

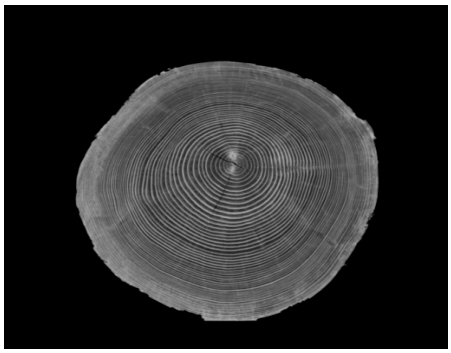

Figure 3: Remove Noise

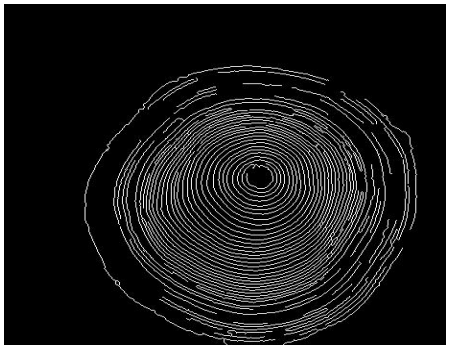

Figure 4: Skeletonise

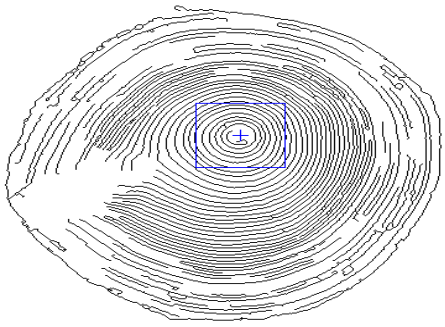

Figure 5: Centre Point Localization

Generating the Profile

Using the above skeleton structure, the profile of tree ring is generated. In that profile, we can get the following details

- Number of rings
- Path per image
- Ring features
- Density analysis
- Light reflection etc.

SOFTWARE

- ***WinDENDRO*** is a semi-automatic image analysis system specifically designed for annual tree-rings analysis. It can produce a few measurements per ring (ring width, earlywood width, min, max and average density...).
- ***WinSCANOPY*** is a canopy structure (LAI, Openness, Gap fraction, Clumping index, Gap Size Distribution) and solar radiation (Direct, Indirect, Total Site factors, PPFD above/below canopy, Sunflecks) analyser system. It is based on hemispherical images (acquired with a fish-eye or wide angle lens) or narrow view angle images analysis. As a complete system it comes with a camera, fish-eye lens and accessories (self-levelling mount, remote control and digital compass).
- ***WinRHIZO*** is an image analysis system specifically designed for washed root measurement in different forms. It can do morphology (length, area, volume ...), topology, architecture and color analysis.
- ***WinRHIZO Tron and Tron MF*** are manual root measurement programs that allows you to analyse images coming from minirhizotron underground video or digital camera systems or scanned images of rhizoboxes.
- ***WinFOLIA*** is a *Leaf Area Meter* that is also a *Leaf Morphology Analyser* and a Leaf Disease and Insect Damage Quantifier.
- ***WinSEEDLE*** (which comes from *SEED* and *NEEDLE* to design both) automatically analyses seeds or needles much more precisely than conventional camera or conveyor based area meters.
- ***WinCELL*** is an image analysis system for wood cell anatomical structure measurement. It can measure cell's walls and lumen (cell, vessel, parenchyma) area, length, width, number, density, position and more on images covering part of an annual ring or a few complete rings. It is an alternative to wood density analysis done using x-rays.
- ***WinCAM NDVI*** is a generic Color Area Meter that quantifies area occupied by colors of interest (soil cover, disease quantification), classifies objects in function of color (pass/fail, healthy/diseased), measures basic object's morphology (area, length, width...), do Color indexes and NDVI analysis (vegetation healthy/stressed) and can be used as a color or grey levels profilometer (to analyse their variations along paths). It can be calibrated to produce measurements in absolute reflectance values. WinCAM NDVI's applications are numerous. It is very sensitive and can detect and quantify very small color differences.

CONCLUSIONS

The measurement of tree rings would allow us to understand the past climate and help us to predict drought and

flood over a period of years, which would provide economic advantages for the agriculture. The science of tree ring dating known as dendrochronology, provides techniques for the precise dating of trees. In order to effectively use the information contained in the tree-rings, there is an impending need to establish a robust method to measure the tree rings.

Many computational models are available for analyzing the factors of various trees ring patterns. But there is not an efficient model for finding the age of tree and the climatic condition using the factors. Development of a robust system that can emulate the complex human vision analysis of tree samples which often tend to have unpredictable features and finalize the age of tree is necessary.

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