

Detection and 3D Visualization of Wetwood in Subalpine Fir Trees Using Industrial X-ray CT Imaging

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Subalpine fir



Jozsa, L., 1991

- one of the most abundant tree species in B.C.
- constitutes 1.13 billion m³ of standing tree volume in B.C.
- 22% of total softwood volume and 45% and 36% of standing volume in Prince Rupert and Prince George regions of B.C.



underutilization is in part due to:

-a high percentage of wet-wood within its stems





problem:

**-...lack of knowledge on quantitative variation of
wetwood within stems**

**.....substantial economic losses occur when
wet-wood affected timber converted into *end-
products***





Solution?

-To adapt a non-destructive imaging techniques to obtain the internal information

- To develop a three 3D model of the subalpine fir tree as a tool that can accurately describe and measure every log by its internal and external properties



Objectives:

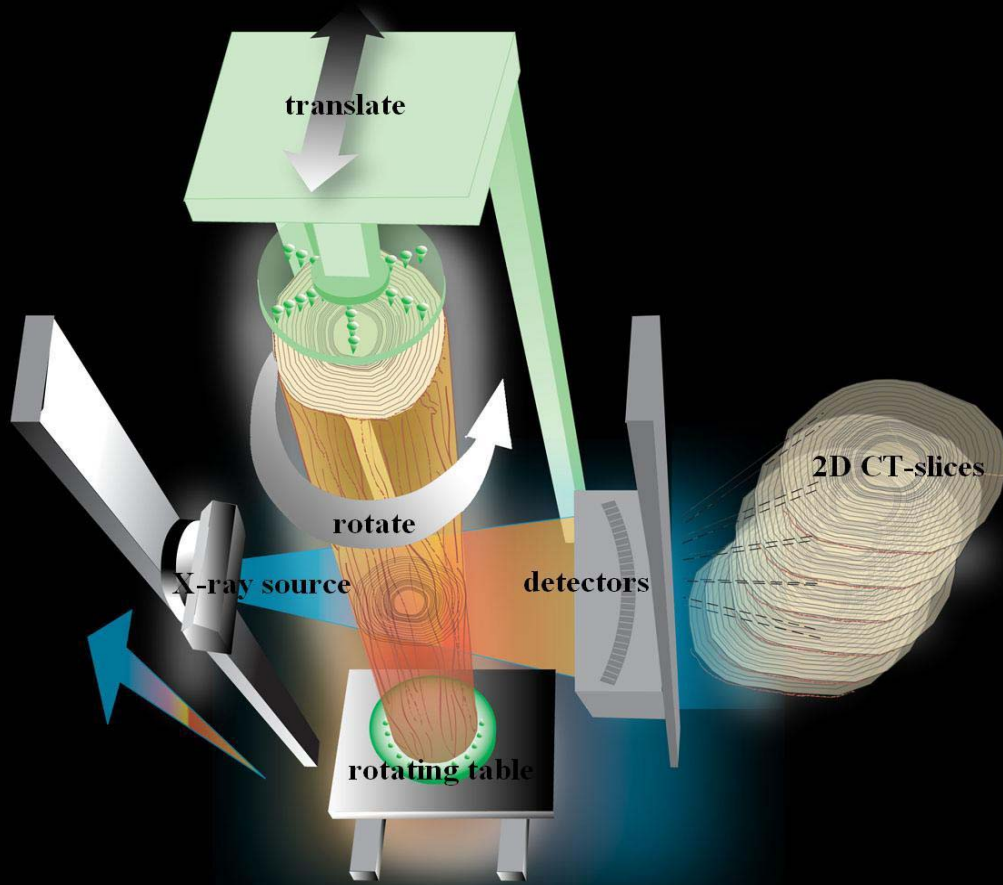
- To determine feasibility of X-ray computed tomography (CT) scanning for imaging wetwood in subalpine fir logs
- To develop software to detect wetwood in CT images
- To develop a 3-D subalpine fir stem model based on CT images to determine 3-D distribution of wetwood in stems



Material

A total of 3 sample trees (total 9 logs, each 5m in length) were sampled from subalpine fir natural stands in northern Kamloops region in B.C.

CT Scanning of Logs



Forintek/UNBC CT Imaging Centre

A joint project by:

Forintek Canada Corp.

and

**University of Northern British
Columbia**

Infrastructure funding from:

Canada Foundation for Innovation

and

B.C. Knowledge Development Fund

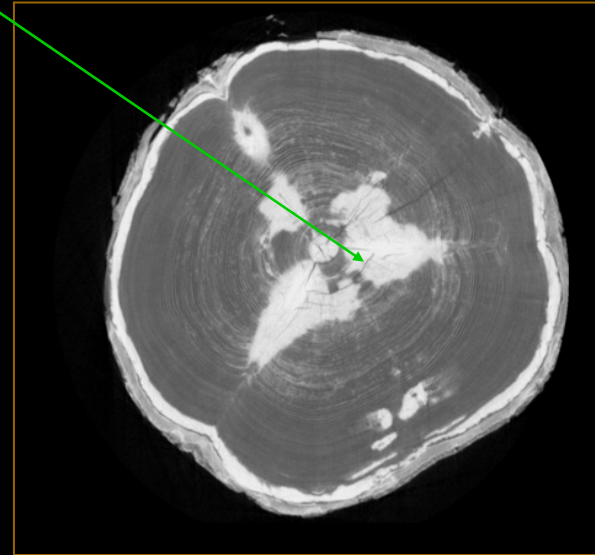
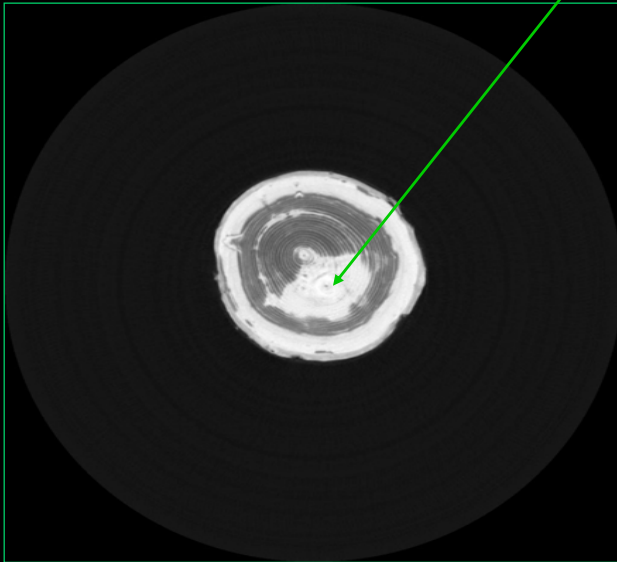


CT Scanner Specifications

- X-ray energy: 3.5MeV
- CT slice thickness: 0.5 – 10 mm
- 512 detector channel
- Spatial pixel resolution: 0.6 mm
- Intensity resolution: 8 or 16bit grayscale
- Scan interval: adjustable
- Maximum object diameter: 90 cm
- Maximum length: 5 m
- Maximum non-wood material:
 - 500 mm for aluminum
 - 200 mm for steel
- Scan time: 0.4 – 5.0 min / slice

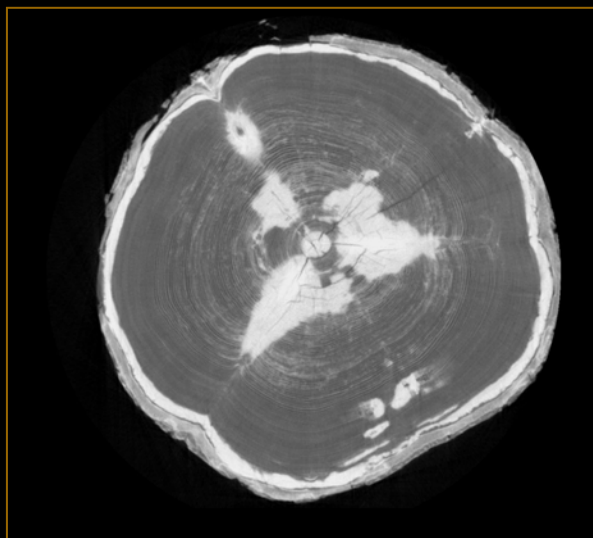
Subalpine fir CT images

wetwood

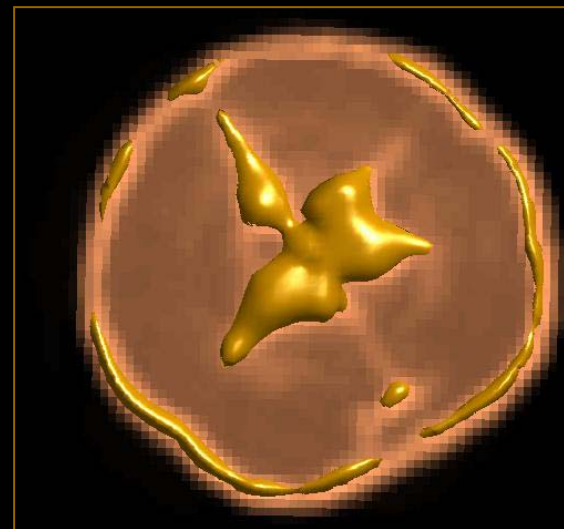


2D Detection of Wetwood In CT Images

2-D wet-wood detection

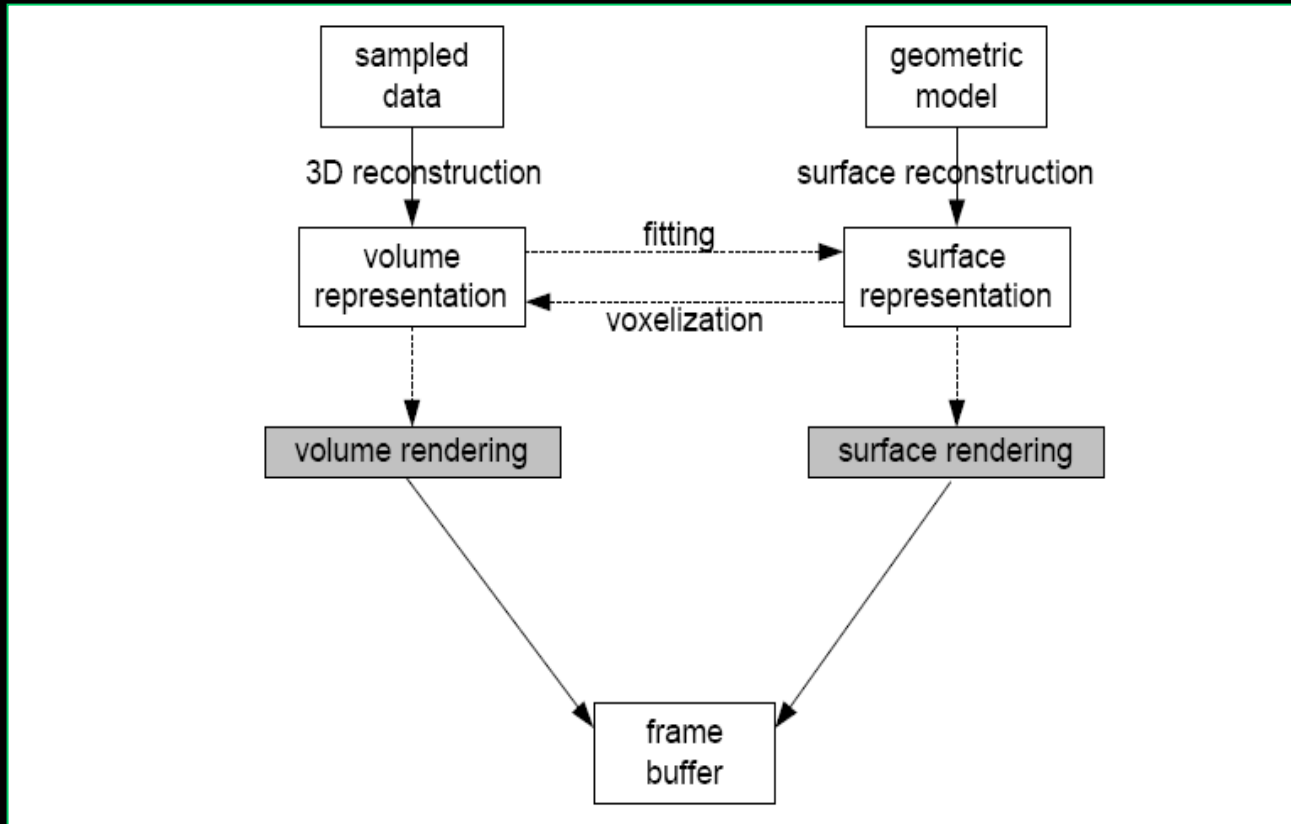


original CT slice

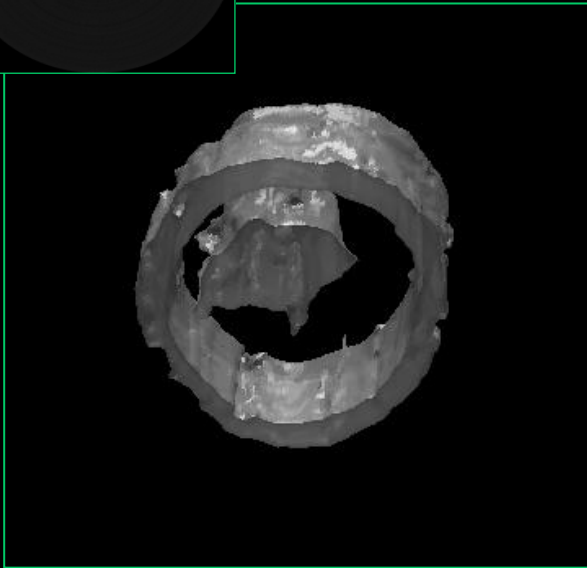
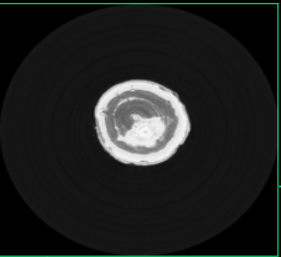


extracted feature

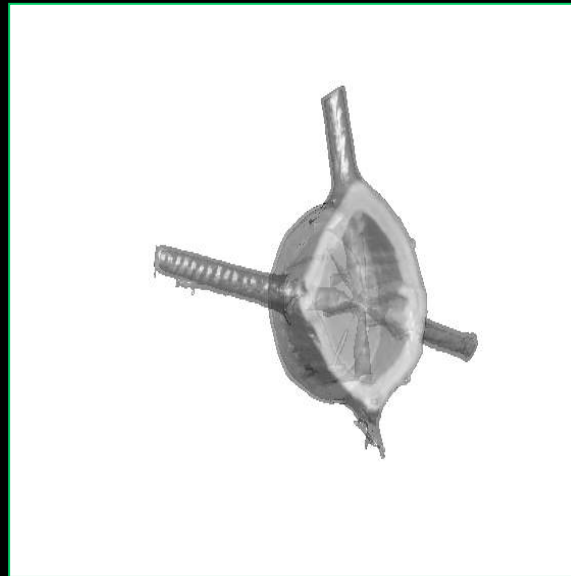
3D reconstruction model(CTSTEM)



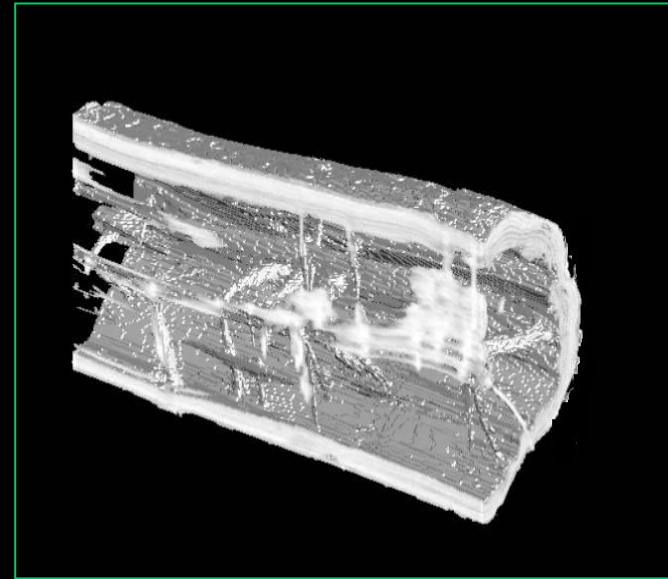
Reconstructed 3D log features



3D wetwood

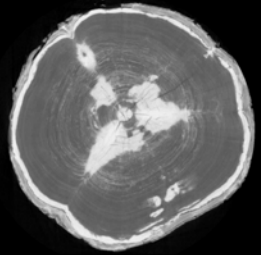


A knot whorl

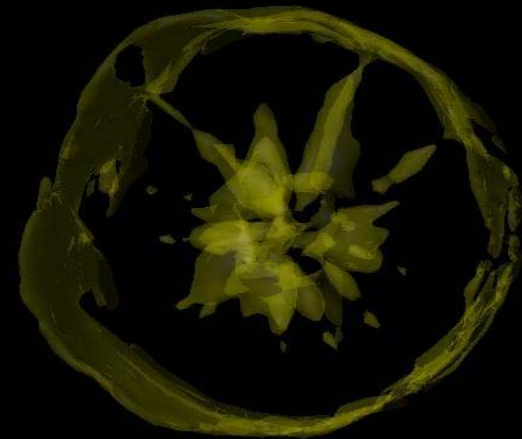


3D wetwood

Reconstructed 3D log features



3-D log
shape



3-D log shape and
wetwood

Reconstructed 3D log features

3D wet-wood
streaks



3-D log



Example volume (in m³) calculation of features

CT slice No	Wetwood	Heartwood	Sapwood	Knot
4-99	0.001417	0.04571911	0.02373209	0.001416
100-199	0.000131	0.04126757	0.02430127	0.001595
200-299	0.000982	0.04668576	0.02382522	0.000932
300-403	0.000631	0.04901418	0.02330185	0.001732
404-499	0.005499	0.03932908	0.02066396	0.001923



Conclusions and Recommendations

- > Computer Tomography scanning (CT) scanning is a powerful research tool for acquiring data for the modelling and visualization of different stem properties of subalpine fir species.
- > CTSTEM is capable of automatic detection, 3D modelling and visualization and calculation of parameters of subalpine fir stem modelling units (wetwood, sapwood boundary, knots, and branch segment).



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Thank you/Merci