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

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Forintek Canada Corp.
one of the most abundant tree species in B.C.

constitutes 1.13 billion m$^3$ 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
-....lack of knowledge on quantitative variation of wetwood within stems

.......substantial economic losses occur when wet-wood affected timber converted into end-products
- 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
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
A joint project by:

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and

University of Northern British Columbia

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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
2-D Detection of Wetwood In CT Images

2-D wet-wood detection

original CT slice

extracted feature
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

<table>
<thead>
<tr>
<th>CT slice No</th>
<th>Wetwood</th>
<th>Heartwood</th>
<th>Sapwood</th>
<th>Knot</th>
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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).
Thank you/Merci

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