MULTI-RESOLUTION X-RAY COMPUTED TOMOGRAPHY FOR RESEARCH ON WOODEN MUSICAL INSTRUMENTS

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Introduction

The use of X-ray CT has increased considerably in the last decade. Actually, in recent years X-ray micro-CT (µCT) has seen a breakthrough in many research domains and is becoming a routine microscopy technique. Most researchers use commercially available desktop micro-CT scanners. UGCT (Ghent University Centre for X-ray Tomography) however develops in-house open modular scanners for more experimental freedom, both for applied research in various fields as for research on tomography itself. UGCT is a collaboration between three research groups operating as an open user facility offering researchers from different fields access to the infrastructure and expertise [Dierick et al, 2014]: the Radiation Physics group, the Geology group and the Laboratory of Wood Technology. The scanner park at UGCT allows scanning from submicron resolution of very small samples up to scanning of large objects at resolutions depending on sample size. We hereby present the Nanowood scanner, a flexible multi-resolution scanner which was specifically designed for wood. Different examples will highlight the possibilities and opportunities of such a scanning tool for research on wooden musical instruments.

Methods

Nanowood is the a multi-resolution X-ray scanner developed at UGCT. It consists of an 8-axis motorized stage with two X-ray tubes and two X-ray detectors, specifically designed to obtain very high resolution scans as well as scans of larger objects. The system offers a large range of operational freedom, all combined in versatile acquisition routines (standard or fast scanning, tilling, helix, etc). It has a generic in-house developed CT scanner control software platform [Dierick et al, 2010] that allows full control of the scanner hardware. Reconstruction of the scans is performed with Octopus [Vlassenbroeck et al, 2007]. The latest developments include GPU-based helix reconstruction and phase-contrast filtering using dedicated algorithms such [Boone et al, 2009; De Witte et al, 2010. Thanks to the flexibility of Nanowood, this state-of-the-art scanner can be deployed in many different fields of research with an interest in non-destructive visualization of the internal structure of objects in a high-throughput chain, but Nanowood is dedicated to wood research sensu lato [Van den Bulcke et al, 2011]. The modular and flexible set-up (Figure 1) allows scanning with a resolution of 0.2 mm for samples of 37 cm in diameter and a maximal length of approximately 20-30 cm down to approximately 400nm for objects that have about the size of a splinter.

Figure 1: Nanowood X-ray CT scanner @ Woodlab-UGent.

Results

Different examples are shown in Figure 2, showing the opportunities and possibilities of X-ray CT scanning in the framework of wooden musical instruments.

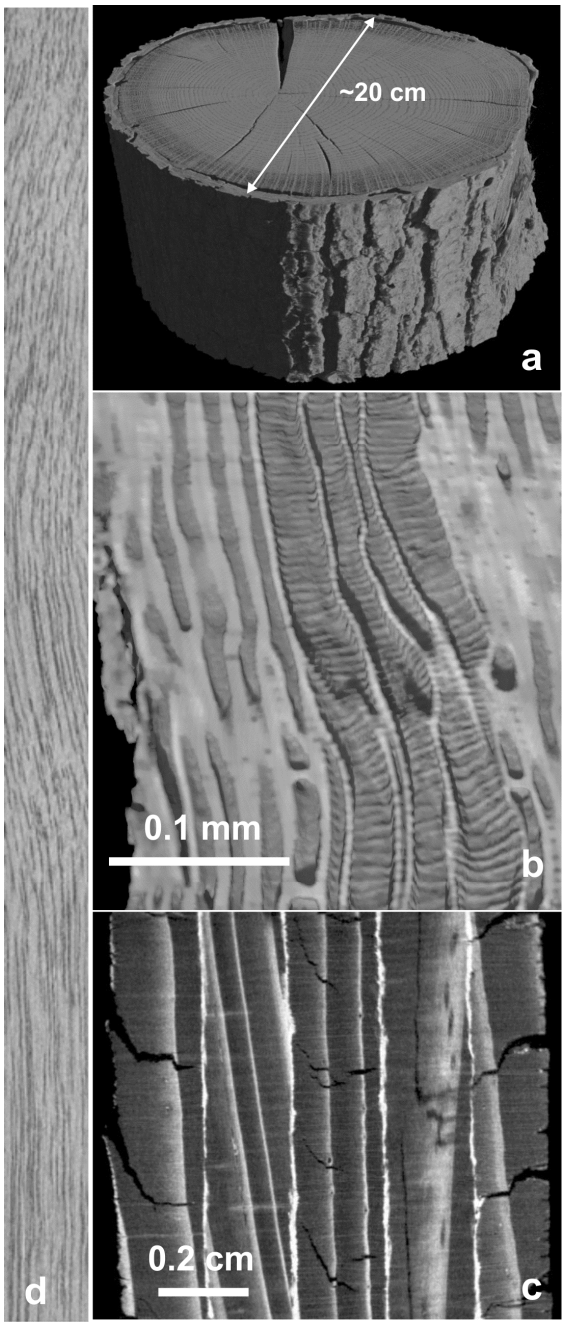

Figure 2: Examples of X-ray CT scanning. See text for explanations.

Figure 2a shows a large wood stem, illustrating the maximum size that can be scanned with Nanowood e.g. for evaluation purpose of instruments of certain sizes. Figure 2b shows a high resolution rendering of a small piece of wood (approx. 0.7 mm wide) with a resolution of approx. 0.75 micron [Haneca et al, 2012] for the purpose of wood identification [Van den Bulcke et al, 2009]. Figure 2c shows a cross-section through a piece of plywood, illustrating the visualization of glue lines [Van den Bulcke et al, 2011] and assessment of their condition, possibly of interest for wooden musical instruments as well. Figure 2d shows the internal structure of a beam of pernambuco wood just before making the violin bow, in order to evaluate straightness of grain.

Discussion

The fast evolving field of X-ray computed tomography and its broad employability make it one of the leading techniques for non-destructive visualization and quantification in many different research fields. The flexible Nanowood scanner offers a wide range of opportunities, yet size can be a limiting factor when studying wooden musical instruments. Another scanner at UGCT, HECTOR [Masschaele et al, 2012], can be used to scan larger and heavier objects at high resolution and therefore complements the Nanowood scanner. Combining both scanners a wide range of wooden musical instruments could be analysed for a large range of purposes such as general evaluation, glue line inspection, wood identification, coating inspection, growth ring analysis, etc. Access to the scanner can be obtained via the European project Trees4Future (www.trees4future.eu).

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