Chapter 7

3D Non-Destructive Evaluation Techniques for Wood Analysis

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ABSTRACT

Non-destructive testing techniques allow the analysis of wood characteristics without altering its end-use capabilities. Wood morphology, wood density, moisture content, and wood decay are some of the features detectable by means of different non-destructive methods. Among them, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) stand out because of their ability to measure information in a three-dimensional fashion. This enables one to scan volumetrically an entire tree log, giving measurements of each location of the analyzed volume. The output data can provide information about internal structures or physiological features, which can then be used for optimizing industrial processing or for research purposes. In this chapter, the authors describe CT and MRI in terms of their operational principles, sampling conditions, data outputs, and advantages and disadvantages.

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INTRODUCTION

Wood is a matter of biological origin whose appearance and properties commonly deviate from what is considered desirable. The presence of pith, knots, fiber misalignment, resin pockets, cracks and wood alterations such as rot, color and other abnormalities generated during growth, determine the quality of the lumber and consequently its final value. Generally, the commercial value of the lumber is inversely related to the amount and size of those defects (Sarigul et al., 2003). Due to the increasing demand for higher quality lumber coming from logs felling, forest companies are devoting a significant effort to optimize log breakdown, sawing and peeling. Optimizing those processes can improve productivity, decrease production costs and improve recovery value. Productivity in sawmills mainly depends on the features of the raw material, the final product valuation, the type of technology employed, the maintenance of cutting devices and tools, operators training level, among other factors. Considering that raw material cost can account for more than 75% of the total production cost (Steele et al., 1992), an optimal log recovery is crucial for the profitability of the wood industry.

Currently, sawmills employ computing software to optimize cutting patterns, based on input information related to main external features of the log such as diameter, length, taper, curvature, etc. These features can be measured before starting the sawing process using commercially available technology such as 3D shape scanners. Additionally, if internal defects were known, the process could be optimized in relation to log location just when the log is going to be cut (Harless et al., 1991). Certainly, knowledge of internal defects before sawing procedure would improve lumber quality and would increase its value. According to Steele et al. (1994), lumber value could increase in 10% depending on internal defects identification and optimal log location with respect to cutting patterns. Even though there are a few technologies that could reveal internal features and defects of the logs, the wood industry has not introduced those technologies as a common tool for cutting optimization. There are however some relevant prototypes (Microtec CT and 2DX Ray scanner (Microtec Tomolog)) which have been developed for this particular purpose and they are being assessed at laboratory and industrial levels in Europe.

The need to detect and characterize internal features and defects has motivated several research efforts focused in the development and evaluation of non-invasive testing techniques of log and lumber pieces.

According to the working party 5.02.01 – Non-destructive evaluation on wood and wood-based materials – of the International Union of Forest Research Organization (IUFRO) – a non-destructive evaluation (NDE) is the science of identifying the physical and mechanical properties of a material without altering its end-use capabilities and then using this information to make decisions regarding appropri-