Real-Time Reconstruction Of Log Cross-Sections Using Tomographic Data

A thesis presented in fulfilment of the requirements for the degree of Doctor of Philosophy at Massey University

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ABSTRACT

This thesis examines the application of internal imaging technologies to the detection of defects within felled logs. This application requires images of moderate resolution to be generated at high-speeds. Transmission tomography is suggested as the most appropriate imaging technology, with particular reference to X-ray transmission tomography. High-speed X-ray scanners suitable to the application exist.

An international literature search was performed to find reconstruction systems capable of high-speed reconstruction of the X-ray data. Those systems claiming to be high-speed are discussed in regard to their means of achieving high-speed reconstruction. The discussions show that most effort has been directed toward sophisticated hardware implementation of the reconstruction process, rather then the mathematics of the reconstruction process itself. To increase the achievable rate of reconstruction, the mathematics of each process in the reconstruction algorithm are examined in this thesis, with the aim of reducing computational complexity.

Convolution backprojection is the most commonly used reconstruction method in transmission tomography when the X-ray data are complete, and can be neatly separated into two separate processes, convolution (filtering) and backprojection, as the name suggests. This reconstruction method was chosen as suitable for the log processing application because of its mathematical simplicity and quality of image reconstruction.

Truncation of the convolution kernel is examined, and simulated results show adequate reconstruction quality with significant truncation. An inexpensive hardware design capable of performing the convolution operation in real-time is developed.

The backprojection process normally employed is computationally expensive, and is the major encumbrance to the realisation of simple high speed image reconstruction from projections. A new backprojection algorithm for use in high-speed parallel-ray tomographic reconstruction systems is presented. The algorithm has the same functionality as the standard backprojection algorithm. However it has been arranged so that fast table look-up methods may be used, eliminating the need for time consuming mathematical calculations. The modified backprojection algorithm reduces the size of the required look-up table by an order of magnitude. Simulated results using the modified algorithm are provided and compared to those obtained using the unmodified algorithm. The resulting images are comparable with respect to feature identification, confirming that the two algorithms function similarly. High-speed implementations of the modified backprojection process used in tomographic reconstruction are presented.

By combining both the convolution and backprojection implementations presented, an inexpensive reconstruction system suitable for detection of defects in felled logs is achievable.

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