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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 than 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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TABLE OF CONTENTS

1	INTRODUCTION	1-1
1.1	LOG PROCESSING	1-1
1.1.1	Tree Pruning	1-1
1.1.2	Log Processing	1-2
1.1.3	Defect Detection	1-3
1.2	THESIS OUTLINE	1-5
2	NON-DESTRUCTIVE IMAGING METHODS USED FOR VIEWING THE INTERNAL STRUCTURE OF OBJECTS	2-1
2.1	TRANSMISSION TOMOGRAPHY (X-RAY)	2-2
2.2	EMISSION TOMOGRAPHY	2-4
2.2.1	Single Photon Emission Computed Tomography (SPECT)	2-4
2.2.2	Positron Emission Tomography (PET)	2-6
2.3	NUCLEAR MAGNETIC RESONANCE IMAGING (NMR OR MRI)	2-8
2.4	ULTRASONIC IMAGING	2-12
2.5	ELECTRICAL IMPEDANCE TOMOGRAPHY	2-16
2.6	COMPARISON OF IMAGING TECHNIQUES FOR LOG DEFECT DETECTION	2-18
3	OVERVIEW OF X-RAY COMPUTED TOMOGRAPHY	3-1
3.1	DATA ACQUISITION	3-1
3.1.1	X-ray Generation	3-2
3.1.2	X-ray Absorption	3-3
3.1.3	X-ray Detection	3-4
3.1.4	X-ray Scanners	3-6
3.2	IMAGE RECONSTRUCTION	3-9

4	DERIVATION OF RECONSTRUCTION ALGORITHMS	4-1
4.1	USEFUL OPERATORS	4-2
4.1.1	Radon Transform Operator	4-2
4.1.2	Backprojection Operator	4-3
4.1.3	Fourier Slice Theorem	4-4
4.2	TRANSFORM METHODS	4-6
4.2.1	Direct Fourier Method (DFM)	4-6
4.2.2	Convolution Backprojection	4-7
4.2.3	Convolution Backprojection for Divergent-Ray Data	4-10
4.2.3.1	Rebinning divergent-ray projection data	4-16
4.3	SERIES EXPANSION METHODS	4-17
4.3.1	Direct Matrix Inversion	4-18
4.3.2	Algebraic Reconstruction Techniques (ART)	4-18
4.3.3	ART With Relaxation	4-22
4.3.4	Maximum Entropy Methods	4-23
4.4	COMPARISON OF RECONSTRUCTION METHODS	4-25
5	CURRENT REAL-TIME RECONSTRUCTION SYSTEMS	5-1
5.1	COMPOSITE DIGITAL/ANALOGUE RECONSTRUCTION SYSTEM - VIDEOGRAPHY	5-2
5.1.1	Acousto-Optic Convolver	5-2
5.1.2	Surface Acoustic Wave (SAW) Convolver	5-4
5.1.3	Digital Convolver	5-5
5.1.4	Optical Backprojector	5-7
5.2	PARALLEL PIPELINE PROJECTION ENGINE (PPPE)	5-8
5.3	TRANSPUTER RECONSTRUCTION	5-10
5.4	REVIEW OF REAL-TIME RECONSTRUCTION SYSTEMS	5-12

6	HIGH SPEED RECONSTRUCTION METHODOLOGIES	6-1
6.1	REDUCTION OF PROJECTION DATA	6-1
6.1.1	Results And Discussions	6-3
6.2	MODIFICATION OF THE RECONSTRUCTION ALGORITHM	6-7
6.2.1	Derivation Of Modified Backprojection	6-7
6.2.1.1	Image Area Discretisation	6-10
6.2.1.2	Equi-Radial Best-Fit Area Pixel Geometry	6-11
6.2.1.3	Equi-Radial/Angular Pixel Geometry	6-12
6.2.1.4	Aliasing	6-13
6.2.1.5	Reconstruction Interpolation	6-15
6.2.1.6	Posterior interpolation	6-16
6.2.2	Reduction Of The Convolution Kernel	6-16
6.2.2.1	Optimum Kernel Coefficients Using Chebychev Minimisation	6-17
6.2.2.2	Results and Discussions	6-18
7	IMPLEMENTATIONS OF MODIFIED BACKPROJECTION	7-1
7.1	SOFTWARE IMPLEMENTATION/SIMULATION	7-1
7.1.1	Standard Tests - Results And Discussions	7-6
7.1.2	Noise Simulation Tests	7-14
7.1.2.1	Results And Discussions	7-14
7.1.3	Reduced Convolution Kernel Tests	7-34
7.2	DIGITAL HARDWARE IMPLEMENTATIONS	7-39
7.2.1	Schematic Design	7-39
7.2.1.1	Field Programmable Gate Array (FPGA)	7-44
7.2.1.2	Discrete Hardware Components	7-49
7.2.2	Systolic Array Architecture	7-53
7.2.2.1	Discussion of Systolic Array Implementaion	7-55
7.2.3	Implementations For Divergent-Ray Projection Data	7-58
7.2.4	Reduced Convolution Kernel	7-59
7.3	COMPOSITE ANALOGUE/DIGITAL HARDWARE IMPLEMENTATION	7-62

8 CONCLUSIONS

8-1

8.1 FUTURE WORK

8-4

REFERENCES

BIBLIOGRAPHY

APPENDICES

- Appendix A - Pascal program for projection data generation.
- Appendix B - Pascal program for image reconstruction using Algebraic Reconstruction Technique.
- Appendix C - Pascal program for projection data convolution.
- Appendix D - Pascal program for image reconstruction using convolution backprojection method.
- Appendix E - Pascal program for image reconstruction using equi-radial/angular modified backprojection method.
- Appendix F - Pascal program for image reconstruction using equi-radial best-fit area modified backprojection method.
- Appendix G - International literature database search, details and results.
- Appendix H - Timing analysis from Field Programmable Gate Array software.