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شبكة المعلومات الجامعية التوثيق الالكتروني والميكروفيلم



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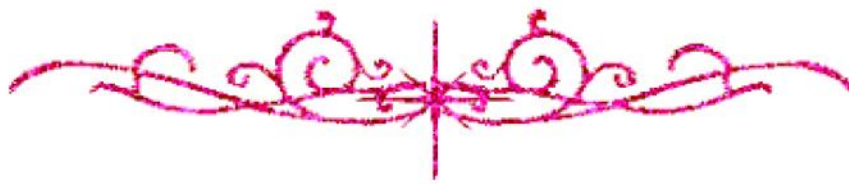
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Performance Evaluation of Parallel Computing For Real-Time Image Processing

By

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A Thesis Submitted to the
Faculty of Computers and Information
Cairo University

In Partial Fulfillment to the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY

In
COMPUTER SCIENCE

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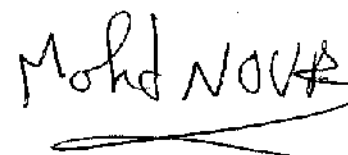



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EGYPT**

2004

Approval Sheet

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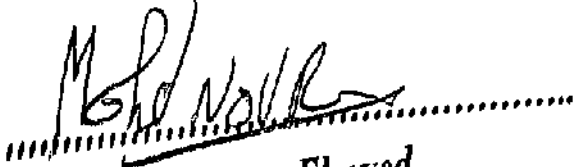
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Abstract

Real-time applications based on image processing are both computationally and data intensive. This fact presents real-time image processing as a strong candidate for parallelism. In this thesis, real-time image processing is exploited for parallel computing from two different views. The first is loop parallelization since loops are the dominant control structure existing in image processing algorithms. The second is volume visualization which is taken as a real-time image processing workload.

Concerning the loop parallelization aspect, a loop fusion algorithm is proposed. The objective is to fuse loops of the same type (either DOALL or DO loops) considering identical and overlapping bounds. Data locality is enhanced by bringing references to the same data in different loops into a single loop and therefore the need for communication and data replication is reduced. In this work, the iteration spaces of loops before and after using the proposed loop fusion algorithm are executed sequentially and on a multiprocessor computer based on message-passing. The proposed loop fusion algorithm proved to be effective for both sequential and parallel execution, fully and partially overlapped iteration spaces and different types of dependencies. Increasing either the shift size (negative dependence) or the peel size (positive dependence) increases the execution time for the same number of processors due to the resulting reduction in the fused iteration space. The performance improvement achieved by the fusion algorithm increases with the increase in the trip count of the fused iteration space i.e. larger overlap. As the overlap decreases, the gain of fusion diminishes.

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Loop skewing is a loop transformation that reshapes the iteration space of a loop nest. Some loop nests cannot be parallelized if kept in their original form. An analysis and investigation of loop skewing is performed for the objective of exposing parallelism. Unimodular transformation matrices are used to represent loop skewing. Loop bounds of a loop nest are represented as a linear system of inequalities. This linear system of inequalities is solved after applying the transformation to obtain the new loop bounds using the Fourier Motzkin algorithm. A detailed analysis is performed in terms of the shape of the skewed iteration space which is divided into

ons each of which containing a number of steps. The independent iterations, after sampling, are operated on a simulated message-passing parallel computer. An iteration space of two nested loops containing 5000 iterations is used i.e. $m \times n = 5000$ where m and n represent the number of iterations of the two loops. Nine different combinations of m and n are experimented.

The aim of three-dimensional visualization is to effectively display and represent the 3D nature of objects so as to provide for better means for their manipulation and analysis. A technique for parallel volume rendering based on the shear-warp volume rendering technique is proposed. The performance of the proposed technique, which is slices-based, is compared to the existing scanline-based technique using simulation and a set of performance measures such as execution time, speedup, average processor utilization, average processor wait time, average interconnection network utilization and average memory utilization. Four different image sizes (64^3 , 128^3 , 256^3 and 98×34^2) and three groups of typical machine simulation parameters are used. For each image size per group, six different shift ratios (0.1, 0.2, 0.3, 0.4, 0.5 and 0.9), reflecting variations in viewing angles, are experimented. A hierarchical cluster architecture with four clusters and four processors/cluster is simulated as well as the proposed slices-based technique and the scanline-based technique. Comparing the the proposed slices-based technique and the existing scanline-based technique, the percentage improvement in speedup is up to 19%.

Certification

I certify that this work has not been accepted in substance for any academic degree and is not being concurrently submitted in candidature for any other degree.

Any portions of this thesis for which I am indebted to other sources are mentioned and explicit references are given.

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Table of Contents

	Page
Table of Contents	i
List of Figures	v
List of Tables	vii
Acknowledgment	viii
Abstract	ix
 Chapter 1 Introduction and Scope of Work	
1.1. Introduction	1
1.2. Scope of Work	5
 Chapter 2 Review of Literature	
2.1. Introduction	7
2.2. Classification of Computer Architecture Models	8
2.3. Parallel Computer Architecture Models	8
2.3.1. MIMD Parallel Models	11
2.3.1.1. Shared Memory Multiprocessors	12
2.3.1.2. Message Passing Multicomputers	13
2.3.1.3. Distributed Shared Memory	13
2.3.2. SIMD Parallel Models	15
2.4. Parallel Computation Models	16
2.4.1. A Framework for Modeling Multicomputer Activity	17
2.4.2. Other Models	18
2.5. Real-Time Computing	19
2.6. Survey of Real-Time Image Processing	20
2.6.1. Levels of Image Processing Tasks	21
2.6.1.1. Low-level Processing	21
2.6.1.2. Intermediate-level Processing	23
2.6.1.3. High-level Processing	24
2.6.2. Grey-Level Segmentation (Thresholding)	25
2.6.2.1. Using a Single Threshold Value	25
2.6.2.2. Using Edge Pixels	25
2.6.2.3. Iterative Selection	26
2.6.2.4. Method of Grey Level Histograms	26
2.6.2.5. Entropy-based Thresholding	27
2.6.2.6. Fuzzy Sets	27
2.6.2.7. Minimum Error Thresholding	28
2.6.3. Parallel Watershed Transformation Algorithms for Image Segmentation	28
2.6.4. Parallel Range Image Segmentation	29
2.6.5. Parallel Image Registration	30
2.6.6. Parallel Algorithms for Image Histogramming and Connected Components	31
2.6.6.1. Parallel Transpose	32
2.6.6.2. Parallel Broadcast	32

	Page
2.6.6.3. Parallel Histogramming	33
2.6.6.4. Parallel Connected Components	34
2.6.7. Performance Modeling for Image Processing	34
2.6.7.1 One- and Two- Dimensional Decomposition	35
2.6.7.2. A Generic Performance Model	36
2.7. Parallel Languages and Compilers	37
2.8. Performance Evaluation of Parallel Systems	41
2.8.1. Performance Evaluation Methodologies	41
2.8.2. Performance Metrics	42
2.8.2.1. Application Structure Metrics	42
2.8.2.2 Scalability Metrics	43
 Chapter 3 Transforming Loops for Parallelism : Survey and Proposal of a Parallel Loops Fusion Algorithm	
3.1. Introduction	46
3.2. Basic Concepts for Loop Transformations	47
3.2.1. Task- and Data-Parallelism	47
3.2.2. Data Dependence	47
3.2.2.1. Types of Data Dependence Relations	48
3.2.2.2. Data Dependence in Loops	49
3.3. Loop Transformation Methods	52
3.3.1. Simple Loop Transformation	52
3.3.2. Statement Reordering	52
3.3.3. Unswitching	53
3.3.4. Loop Peeling	54
3.3.5. Loop Splitting	54
3.3.6. Scalar Expansion	54
3.3.7. Loop Fission	55
3.3.8. Loop Reversal	56
3.4. Scheduling Parallel Loops	58
3.4.1. Static Scheduling	58
3.4.1.1. Block Scheduling	58
3.4.1.2. Cyclic Scheduling	58
3.4.1.3. A Scheduling Method Based on Affinity Regions	58
3.4.2. Dynamic Scheduling	59
3.4.2.1. Chunk Self-Scheduling	59
3.4.2.2. Tapering Methods	59
3.4.3. Synchronization to Deal With Dependences	60
3.4.3.1. Using Critical Sections	60
3.4.3.2. Using Vectors of Words or Bits	62
3.4.3.3. Busy-waiting	62
3.5. Analysis and Investigation of Loop Fusion	63
3.5.1. Categorizing Loops for Fusion	64
3.5.2. Background on Loop Fusion	65
3.5.3. The Loop Fusion Problem	66
3.5.4. The Problem of Unsafe Fusion	68
3.5.5. Computing Accumulative Shifts	71
3.5.6. Effect of Loop Bounds on Fusion	71

	Page
3.6. The Proposed Algorithm for Loop Fusion	73
3.7. Implementation Work and Performance Evaluation	77
3.7.1. Implementation	77
3.7.2. Performance Metrics Used	78
3.7.3. Discussion of Results	79
3.8. Concluding Remarks	81
 Chapter 4 Performance Evaluation of Loop Transformation Based on Skewed Loops for Exploiting Parallelism	
4.1. Introduction	89
4.2. Definitions	90
4.3. Loop Transformations Using Matrices	91
4.3.1. Representing Loop Nests as Linear Systems of Inequalities	92
4.3.2. Unimodular Transformations	92
4.4. Analysis and Investigation of the Skewing Process	94
4.4.1. Exposing Parallelism by Skewing Loops	94
4.4.2. A Transformation Matrix to Model Skewing	96
4.4.3. Skewing the Iteration Space of Example 2	97
4.5. Implementation of the Skewing Process	98
4.5.1. Characteristics of Skewed Iteration Space	100
4.5.2. Scheduling of the Loops Iteration Space	101
4.5.3. Simulation	102
4.6. Discussion of Results and Conclusion	103
 Chapter 5 Investigation of Visualization and Medical Imaging	
5.1. Introduction	113
5.2. Medical Image Visualization	113
5.3. Volume Acquisition	114
5.3.1. Ultrasound	114
5.3.2. Imaging Modalities	115
5.3.3. Multi-modality Imaging	115
5.3.4. Volume Reconstruction	116
5.4. Imaging Science and Medical Imaging	116
5.4.1. Visualization and Medical Applications	117
5.4.2. Interactive/Real-time Visualization	117
5.5. Visualization Methods	117
5.5.1. The Two-dimensional Approach	118
5.5.1.1. Multi-planar Reformatting	118
5.5.1.2. Oblique Sectioning	118
5.5.1.3. Curved Sectioning	118
5.5.2. The Three-dimensional Approach	119
5.5.2.1. Surface Rendering (Fitting)	119
5.5.2.2. Volume Rendering	120
5.6. Ray-casting	121
5.6.1. General Ray-Casting Model	121