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Real-time Soft Tissue Modelling on GPU for Medical Simulation

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Contents

Contents	i
I Introduction	1
1 Medical simulation	3
1.1 General context and goal: medical training, patient-specific planning and per-operative guidance	3
1.2 Challenges (trade-off between accuracy and real-time)	3
2 One key point in medical simulation: soft-tissue modelling	5
2.1 Necessary background in continuum mechanics	5
2.1.1 Deformation tensor and strain tensor	5
2.1.2 Stress and constitutive laws	5
2.2 Tissue characterisation	5
2.2.1 Material models for organs (non-linear, visco-elastic and anisotropic)	5
2.2.2 Measure/estimation of model parameters	5
3 Main principles of Finite Element Method (or how to solve equations of continuum mechanics from previous section)	7
3.1 Discretisation	7
3.2 Derivation of element equations	7
3.3 Assembly of element equations	7
3.4 Solution of global problem	7
II Solid organs modelling	9
4 State of art: FEM	11
5 Linear not accurate => Non-linear FEM => Introduction of TLED	13
5.1 Differences with classic FEM and reasons of its efficiency	13
5.2 Visco-elasticity and anisotropy added (MICCAI 2008; MedIA 2009) .	13
6 GPU implementation of TLED	15
6.1 What is GPGPU	15
6.2 Re-formulation of the algorithm for its Cg implementation	15
6.3 CUDA implementation/optimisations (ISBMS 2008a)	15

7	Implementation in SOFA	17
7.1	Presentation of SOFA project and architecture	17
7.2	Implementation in SOFA and TLED released in open-source	17
III	Hollow organs modelling	19
8	State of art: hollow structures	21
8.1	Non-physic approaches (computer graphics stuff)	21
8.2	Physically accurate approches (plates/shells)	21
9	Colonoscopy simulator project	23
9.1	Project introduction	23
9.2	Mass-spring model for colon implemented on GPU (ISBMS 2008b) .	23
10	More accurate: a co-rotational triangular shell model (ISBMS 2010)	25
10.1	Model description	25
10.2	Validation	25
10.3	Application to implant deployment simulation in cataract surgery . .	25
11	'Shell meshing' method (MICCAI 2010)	27
11.1	State of art: reconstruction/simplification	27
11.2	Our method	27
12	Applications to medical simulation	29
12.1	Nice medical stuff to show	29
12.2	Interaction solid/hollow organs	29
IV	Conclusion	31
	References	33

Part I

Introduction

Medical simulation

- 1.1 General context and goal: medical training, patient-specific planning and per-operative guidance
- 1.2 Challenges (trade-off between accuracy and real-time)

One key point in medical simulation: soft-tissue modelling

2.1 Necessary background in continuum mechanics

2.1.1 Deformation tensor and strain tensor

2.1.2 Stress and constitutive laws

2.2 Tissue characterisation

2.2.1 Material models for organs (non-linear, visco-elastic and anisotropic)

2.2.2 Measure/estimation of model parameters

Main principles of Finite Element Method (or how to solve equations of continuum mechanics from previous section)

- 3.1 Discretisation
- 3.2 Derivation of element equations
- 3.3 Assembly of element equations
- 3.4 Solution of global problem

Part II

Solid organs modelling

CHAPTER 4

State of art: FEM

Linear not accurate \Rightarrow Non-linear FEM \Rightarrow Introduction of TLED

- 5.1 Differences with classic FEM and reasons of its efficiency
- 5.2 Visco-elasticity and anisotropy added (MICCAI 2008; MedIA 2009)

GPU implementation of TLED

- 6.1 What is GPGPU
- 6.2 Re-formulation of the algorithm for its Cg implementation
- 6.3 CUDA implementation/optimisations (ISBMS 2008a)

Implementation in SOFA

- 7.1 Presentation of SOFA project and architecture
- 7.2 Implementation in SOFA and TLED released in open-source

Part III

Hollow organs modelling

State of art: hollow structures

- 8.1 Non-physic approaches (computer graphics stuff)
- 8.2 Physically accurate approches (plates/shells)

Colonoscopy simulator project

9.1 Project introduction

9.2 Mass-spring model for colon implemented on GPU (**ISBMS 2008b**)

More accurate: a co-rotational triangular shell model (ISBMS 2010)

10.1 Model description

10.2 Validation

10.3 Application to implant deployment simulation in
cataract surgery

'Shell meshing' method (MICCAI 2010)

11.1 State of art: reconstruction/simplification

11.2 Our method

Applications to medical simulation

12.1 Nice medical stuff to show

12.2 Interaction solid/hollow organs

Part IV

Conclusion

References