

Real-time Soft Tissue Modelling on GPU for Medical Simulation

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DRAFT - Fri 16th of July 2010 at 10:37

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Part I

Introduction

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CHAPTER 1

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)

CHAPTER 2

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

CHAPTER 3

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 =>
NON-LINEAR FEM =>
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

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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)

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COLONOSCOPY SIMULATOR PROJECT

9.1 Project introduction

9.2 Mass-spring model for colon implemented on GPU ([ISBMS 2008b](#))

CHAPTER 10

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

CHAPTER 11

'SHELL MESHING' TECHNIQUE (MICCAI 2010)

11.1 State of art: reconstruction/simplification

11.2 Our method

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CHAPTER 12

APPLICATIONS TO MEDICAL SIMULATION

12.1 Nice medical stuff to show

12.2 Interaction solid/hollow organs

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Part IV

Conclusion

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References