Advances in Surgical Simulation

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The aim of this symposium is to bring together researchers in computational mechanics, computer science, medicine and applied mathematics, to tackle the problem of computer-based surgical simulation. Some conditions are rarely encountered and surgeons will only be trained in the specific skills associated with a given situation if they come across it. At the end of their residency, it is hoped that they will have faced sufficiently many cases to be competent. If we were able to reproduce faithfully, in a virtual environment, the audio, visual and haptic experience of a surgeon as they prod, pull and incise tissue, then, surgeons would not have to train on cadavers, phantoms, or on the patients themselves. Realistic surgical simulation could thus be used by surgeons to train, rehearse complex operations, but also to guide them *during* surgery.

The focus here is to address various requirements for interactive simulation of complex surgical procedures such as soft tissue deformation, contact modelling, haptic rendering and also cutting living tissue.

Several difficulties remain. To name a few, we are interested in the following:

1. handling the complex geometry of organs (patient specific image to mesh pipeline), including implicit boundary definition, Cartesian meshes meshless approaches advanced mesh generation, etc.

2. simulate cutting or needle insertion accurately and in real time, especially provide realistic force feedback

3. account for other mechanical and physiological effects (blood circulation, chemical modifiers such as hypotensors, multi-scale nature of tissues etc.) which may influence the organ behaviour;

4. fast, robust and non-locking formulations for incompressible materials;

5. error control and adaptivity, verification and validation;

6. audio-visual realism and augmented reality.

This symposium will present advances in the field of numerical techniques such as (but not limited to) the Finite Element Method (FEM), the Boundary Element Method (BEM), Meshless Methods, the Extended Finite Element Method (XFEM), Model Order Reduction and Multiscale Methods. Contributions in the area of advanced mesh generators and describing the image to mesh pipeline in patient specific computational biomechanics will be of high interest as well as contributions in the field of non-rigid image registration.

This minisymposium is organized with the aim of welcoming and bringing together the researchers to share ideas, problems and solutions relating to the simulation of surgery.