Numerical simulation in Medicine:
SimBio & BloodSim

Numerical simulation has long been used by many industrial sectors to improve engineering designs and to shorten product development times. Biomedical systems are often very complex, may require sophisticated modelling tools and can consume vast computational resource. The Medical Physics Group, based in the Royal Hallamshire Hospital, has featured in four recent projects aimed at bringing the power of modern high performance computing to bear in the biomedical environment. A key element in the success of these programmes is strong industrial collaboration and contribution. Total CEC funding for the four projects is close to seven million Euros, with approximately 1.4 million Euros funding the Sheffield elements of the programmes.

‘SimBio’ (IST-1999-10378)
Generic Biomedical Simulation Environment
Visit www.simbio.de

For the simulation of biomedical problems anatomical data is usually collected in the form of a medical image. The body is divided into cells (voxels), each of which is assigned a ‘colour’ based on some physical property. The labelling process is called segmentation.

SimBio is delivering an array of tools including automatic segmentation and registration, mesh generation, solution, inverse solvers and visualisation elements. The software is demonstrated in Sheffield in the context of prediction of knee kinematics pre- and post-surgical intervention. European partners are exercising the software in the contexts of maxillo-facial surgery planning and source localisation in the brain.

The partners in SimBio are: NEC Research Laboratories, University of Sheffield (Medical Physics, Academic Radiology, Sheffield Centre of Sports Medicine), Sheffield Teaching Hospitals Trust, Max Planck Institute (Leipzig), Smith and Nephew, Engineering Systems International, CNRS, ANT Software, BMZ. Sheffield participants: David Barber, Derek Bickerstaff, David Chan, Gail Darwent, Avril McCarthy, Jill Vandermeulen, Iain Wilkinson, Steven Wood.

‘BloodSim’ (EP28350)
HPCN-enabled Cardiovascular Simulation

In many engineering applications the solid and fluid phases of a device can be treated separately, but in cardiovascular systems this separation is inappropriate. The propagation velocity of the pressure pulse in an artery is determined by its geometry and by the ratio of the vessel wall stiffness to the blood density. The motion of a heart valve is determined by the complex interplay of structural displacement and stress and fluid pressure and momentum.

In BloodSim custom interface software passes data between two commercial codes, CFX for computational fluid dynamics and ANSYS for structural mechanics. Dynamic simulations of stented arteries, of mechanical and tissue valve prostheses, and of a cardiac assist device were performed. The multidisciplinary strength of the Sheffield team, including close collaboration with clinical colleagues Professor David Cumberland and Dr Julian Gunn, was a key element in the success of the programme.

The partners in BloodSim were AEA Technology, University of Sheffield, Angiomed, ASD Advanced Simulation & Design (GmbH), Autogenics, IDAC Ireland, Berlin Heart, Medtronic AVE, Performance Fluid Dynamics. Sheffield participants: David Cumberland, Julian Gunn, Andrew Narracott, Justin Penrose.

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