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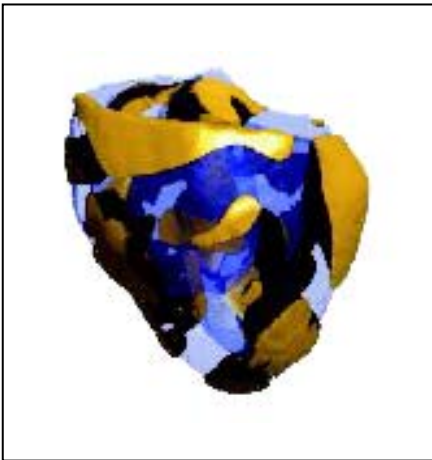
Remote Visualisation and Computational Steering of Cardiac Virtual Tissue using gViz



- exploiting e-science to combat fatal diseases

Introduction

The Integrative Biology project (IB) is bringing together an international consortium of leading biomedical and computing researchers to address two of the most important problems in clinical medicine today: understanding what causes heart failure and how cancer tumours develop and grow. Together these diseases account for about 60% of UK deaths. We are developing detailed, accurate multi-scale computational models of the heart and of cancer tumours.



By exploiting the new Grid infrastructure to run these models on the most powerful supercomputers available for research in the UK today, we are gradually improving our understanding of these two complex systems. This will eventually lead to better control and treatment regimes.

As well as facilitating new science directly, the IB project seeks to build an infrastructure that enables scientists to run jobs, manage their data, and visualise their results in a secure but straightforward environment.

IB at Leeds.

The University of Leeds has two strands of research within the Integrative Biology Project; firstly to help develop the computational steering capabilities

of the IB infrastructure – specifically using the gViz steering library – and secondly to develop novel visualisation techniques. We are collaborating closely with research in Sheffield University on both counts. To date this research has been carried out on heart models.

Computational Steering

The gViz computational steering library enables interaction with *executing* simulations, even if these are on remote grid computing resources. This allows simulations to be monitored and steered with a diversity of clients, including IRIS Explorer, Matlab, VTK, and web services. Furthermore, many clients can connect to a simulation, which allows collaborative visualisation and steering when co-researchers are not in the same geographical location. On the simulation side, the library has bindings in C/C++ and Matlab. The latter means any gViz client can connect to a model written in Matlab, allowing more sophisticated visualisation techniques to be used, as well as collaborative visualisation and steering.

The simplest application of such a library is monitoring the current state of a simulation, either to review its progress or to easily checkpoint or terminate simulations. This has been extended to the monitoring of several simulations that are being executed simultaneously, such as when performing a search of some parameter space.





A computational steering client has been written for a 2D heart model developed at Leeds by Arun Holden and Oleg Aslanidi, which enables the application of small, localised stimuli to a heart model that is exhibiting re-entrant arrhythmia. The use of computational steering enabled experiments to be performed *in-silico* that otherwise would have been very difficult. The initial results will be presented at the 2005 All Hands Meeting. Ultimately this client will be extended to full 3D interaction and more sophisticated steering, such as the localized cooling or heating of tissue.

Visualisation

The other major strand of research within IB at Leeds is that of visualizing the *entire* state of the heart model. Existing visualisation techniques tend to revolve around a single parameter or variable of the model – for example the image on the front of this leaflet shows the wave-fronts of action potential for one of Richard Clayton’s 3D Cardiac Virtual Tissue models.

The models themselves are 4-dimensional (with 3 spatial dimensions, and 1 temporal dimension), and for a single variable there are a number of established techniques such as iso-surfacing and volume rendering. For 2 or even 3 variables, colour or multiple plots are typically used in image formation - however the more sophisticated CVT models have several dozen state variables that need to be visualised. The projection of 4-dimensional, multi-variate CVT data to a 2D computer screen is a huge challenge, yet one that needs addressing if the entire state of a heart model is to be viewed.

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Steering and Visualisation

These two strands are not distinct, but rather feed off one another. To view the state of an executing model, one must be able to both connect to the simulation to obtain the data, and then visualise these data. In a similar manner, if one is going to interact with a model as it’s running, there are a number of visualisation and interface challenges – for example, the application of a stimulus to a specific region in a 3-D space.

Further Information

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The Project Web site:

<http://www.integrativebiology.ox.ac.uk/>

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