Chapter 7.10
Aspects of Visualization and the Grid in a Biomedical Context

Ian Greenshields
University of Connecticut, USA

Gamal El-Sayed
University of Connecticut, USA

ABSTRACT

This chapter introduces some aspects of visualization and the grid. Visualization --the art and science of representing data visually-- is now recognized as an equal partner in the conduct of science via the simulation and modeling paradigm. Although not usually associated with Grid-scale problems, there are a number of Grid-dominant issues which subtend visualization. Evidently, certain data grooming issues (e.g., image preprocessing/analysis, certain computational geometric processes, certain computational topological processes) are amenable to deployment over compute Grids, but there has been equal focus on the collaborative aspect of Grid computing which is driving collaboration-based visualization systems. Here we survey some of the roles of visualization as they relate to the role of Grid computing within a biomedical context. We conclude by examining certain scheduling strategies we believe to have value in terms of the distribution of visualization tasks over Grid fabrics.

INTRODUCTION

From the earliest days of computational medicine, visualization in some form has always played a role in the biomedical sciences, with a particularly strong role in clinical medicine through the requirements of radiology. The advent of PACS (Picture Archiving and Communication Systems) (Dwyer III, 2000) introduced the bulk of radiologists to the digital delivery of image data, and concomitantly to the role of image processing in radiology. In fact, in as much as radiological applications of visualization are concerned, it can be difficult to separate the visualization component of the display process from the imaging component which grooms images prior to display. Even with the advent of the routine use of 3D (perhaps more

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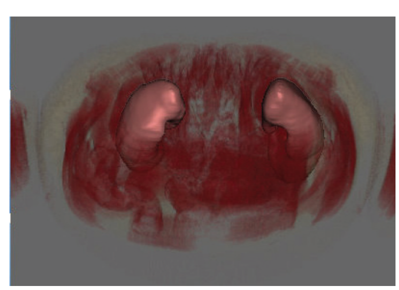
properly, pseudo-3D) imaging modalities such as CT (computed tomography) and MRI (Magnetic Resonance Imaging) the visualization aspect of the imaging process was largely inseparable from the purely imaging aspects(Udupa and Hermann, 1991), although purely visualization concepts associated with the display of surfaces from clinical images begin to play a role quite separate from those traditionally associated with the imaging/image analysis tasks(Udupa, 1991; Vannier et al., 1991; Hohne and Bernstein, 1986). These early papers reflect the genesis of visualization as an adjunct to imaging, especially as regards the problems of visualizing surfaces represented by sampled data in the image lattice, and indeed even at that early stage notions of the role of topology began to appear(Peters et al., 1992). Most practitioners in the field would agree that a watershed was reached in 1987 with the publication of Lorensen and Cline's marching cubes algorithm(Lorensen and Cline, 1987). As the cost of graphics hardware plummeted and the range of visualization/imaging/computational geometric algorithms expanded, so too did the role of visualization expand into science areas external to the purely clinical field, so that today drug design, genomics, proteomics, large-scale simulations of cells (NRCAM) (to name but a few) would be unthinkable without the direct support of visualization.

As alluded to above, there is no strict line of demarcation between visualization and image processing when it comes to image data. For example, Figure 1 shows the surface of a skull deduced from the CT dataset of the Visible Human Female from the Visible Human Project (NLM), and there would be universal agreement that the image shown is created from purely visualization processes (in this case, an application of the marching cubes algorithm), even given that the raw image data was denoised using classical imaging techniques. Figure 2, on the other hand, shows polyhedral surfaces (the kidneys) embedded in (fused into) a standard volume visualization (data again from the Visible Human Project (op. cit.)). The situation here is somewhat more complex, in that the deduction of the polyhedral surfaces comes from a long line of image and cluster/classification algorithms (which constitute the bulk of the computation time taken to produce the image shown), while the "visualization component" (rendering the polyhedral surfaces and rendering the volume) is, while not trivial, certainly orders of magnitude less demanding than the imaging component.

The reason we introduce this issue at this stage is because many of the final components of a visualization stream are often not truly Grid-scale in nature; certainly, handling ultra-large volumetric data is complex and demanding, but in truth few such image datasets (at the scale of the datasets seen in physics) are common (at least in clinical practice). The Visible Human Dataset alluded to above is possibly one of the more massive image datasets that can be encountered in

Figure 1. Isosurface (bone)

Figure 2. Polyhedral data fused into volumetric data



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