State of the Art in Visualization Tools*

Michael M. Heck[1]

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[1]FEI Visualization Sciences Group, Houston, TX, USA (mheck@fei.com)

Abstract

This is indeed an exciting time to be involved in interpretation visualization. Great changes have occurred in the "every day" resources available that we have available for visualization. CPUs have many cores. GPUs are programmable and have many, many cores. Display devices are mobile. All these changes are well known and have resulted in some obvious increases in performance, capacity and productivity. But it has taken some time to rewrite existing software and implement new algorithms to really take advantage of these changes. The next shift in performance and capacity is just starting to roll out to end-users. Similarly, the adoption of techniques from other markets such as medical and material science is just starting to enhance and change interpretation workflows. FEI Visualization Sciences Group is in a unique position to summarize the changing state of the art in visualization tools for interpretation. We have been developing 3D visualization tools for over thirty years for multiple markets and our libraries power many of the most advanced applications in this market. We will present some of the latest tools for rendering and analyzing volumes, surfaces, meshes and images in the context of interpretation workflows. We will also highlight some techniques that have been re-purposed from other markets and show how these tools can be made available on multiple platforms, including mobile devices.

Introduction

Figure 1 summarizes, at a very high level, where these tools are applied in different stages of the overall workflow. The following sections summarize the key points to be presented:

- Very large scale volume rendering
- Very large scale horizon (surface) rendering
- Very large scale reservoir model (mesh) rendering
- Very large scale core sample imaging
- Advanced image processing, segmentation and quantification
- Browser based applications with server side rendering

Very Large Scale Volume Visualization

Advances in data management, multi-resolution rendering and (simulated) virtual memory on the GPU allow today's massive seismic data sets to be visualized interactively on everyday devices. Image enhancement techniques adopted from the medical market include lighting, shadows, ambient occlusion and "voxelized" (building block) rendering. New rendering algorithms from the games market allow the correct combining of multiple solid and transparent volumes and polygonal objects in a single pass. Flexible and general volume sculpting (clipping) using multiple geometry, horizon surfaces and masks allows interactive geobody extraction.

Very Large Scale Horizon Rendering

A relatively new programmable GPU feature called "tessellation shaders" was implemented mainly for the games and engineering markets, but has been used to dramatically increase the size and number of height-field surfaces, such as seismic horizons, that can be interactively rendered. Dynamic tessellation on the GPU provides continuous smooth level-of-detail changes without visible "popping".

Very Large Scale Reservoir Model Rendering

Reservoir model (mesh) visualization is migrating to a software architecture where, instead of providing arrays of vertex and connectivity data, the application provides implementations of predefined "interfaces" to the visualization library. Model capacity is increased because the library no longer needs to copy application data that is not in the expected format or data type. Algorithms for extracting derived meshes such as slices, skin (exterior faces) and isosurfaces are now highly optimized for multiple cores. This is allowing applications to push toward hundreds of millions of cells.

Very Large Scale Core Sample Imaging

The large volume techniques mentioned earlier allow imagery from many core samples to be assembled in virtual space to create a more complete model of the well. Techniques adopted from the medical market allow multiple volumes from different "modalities" (imaging techniques), with different resolutions, to be co-rendered. Volume editing techniques allow virtual plugs to be extracted from the imaged core samples.

Advanced Image Processing, Segmentation and Quantification

Image processing and analysis techniques adopted from the material science market build on large-scale core sample imaging to enable so-called "digital rock" workflows. Identification of macroscopic properties in core samples can now be augmented by identification of micro and nano scale features. These algorithms do not identify features; they also count and characterize pores or grains. New simulation algorithms, accelerated by GPUs, can compute properties such as absolute permeability without the time and expense of physical experiments.

Browser Based Applications with Server Side Rendering

Advanced features defined by HTML5 have been widely adopted in web browsers running on every kind of platform from desktop to tablet to smart phone. These features allow advanced 3D visualization to be packaged as a web “service” running on powerful server machines in the “cloud”. A new generation of applications with access to large data sets and large scale rendering techniques can now run inside the user’s web browser with no plug-ins or clients.

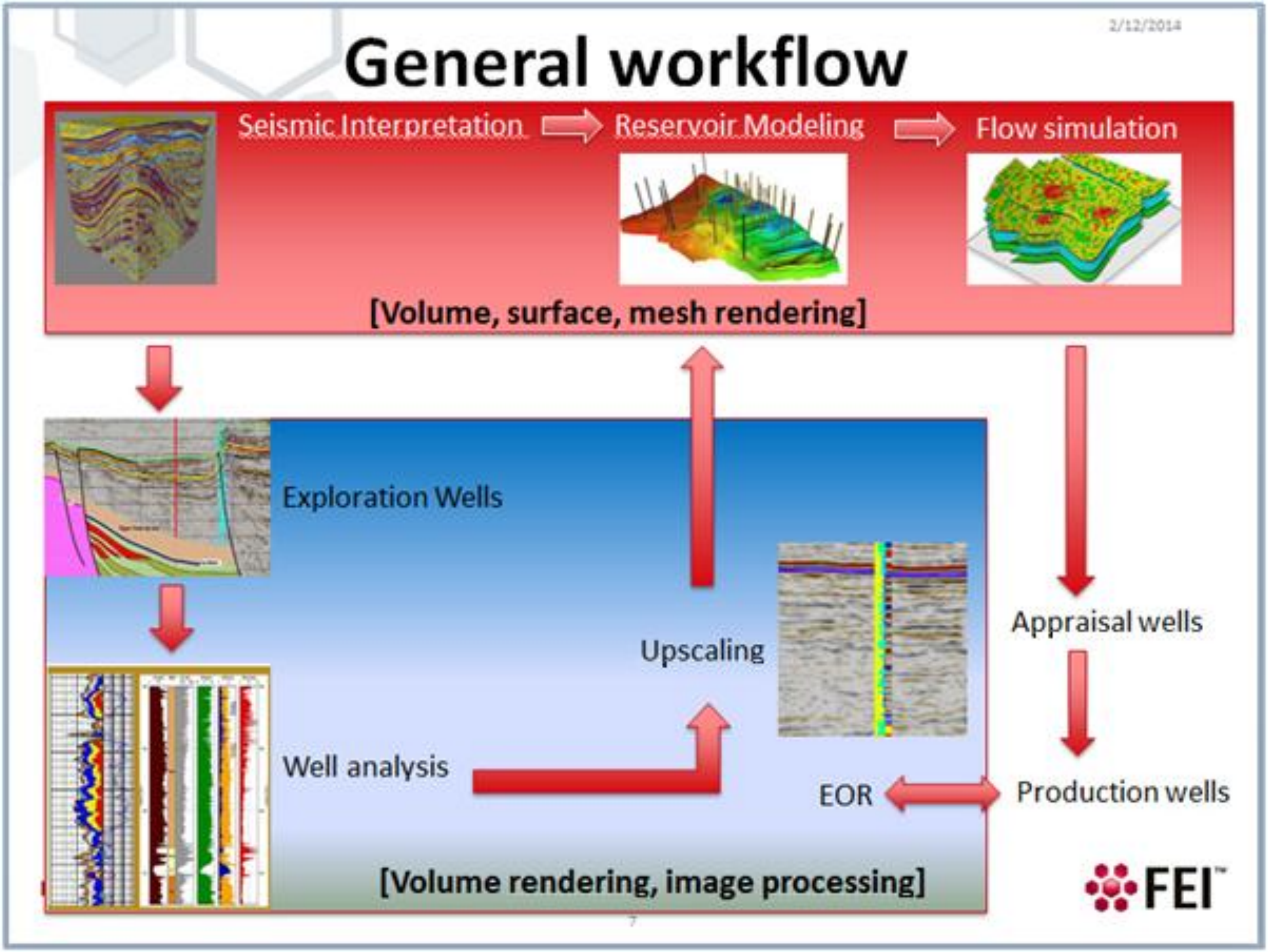

Figure 1. General Workflow.