Large Scale Visualization

Today’s Class

• Mini-presentations
  – Mark, Jazmine, Ian

• Reading for Today
  – “An Image-based Approach to Extreme Scale In Situ Visualization and Analysis”

• Crayon Exercise on User Feedback
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"An Image-based Approach to Extreme Scale In Situ Visualization and Analysis", Ahrens, Patchett, Jourdain, Rogers, O'Leary, & Petersen, Supercomputing 2014
• “in situ” definition: “in its original place”, “on site”, “in position”, “locally”, “in place”

• In computer science:
  – An in situ operation is one that occurs without interrupting the normal state of a system
  – Without taking the system down, while still running, without rebooting
  – In place algorithm (no extra memory)
  – UI: without going to another window
  – For Big Data: Doing computation where the data is located

  [ From http://en.wikipedia.org/wiki/In_situ ]

• Motivation: power & I/O constraints
  • Without in situ: write huge files to disk (size: ?), then later input those files for interactive exploratory visualization & analysis
    – However, storage bandwidth is significantly falling behind processing power & data generation
  • Instead: compute & save many images to disk (size: 1 image $10^6$, set of images 24 TB=$10^{13}$), then later explore & analyze by viewing those images interactively
    – Preserve important elements from simulations
    – Significantly reduce data needed
    – Be flexible for post-processing interactive exploration
    – Perform predefined (by expert scientist) set of analyses & predefined data bounds of interest
    – (Rarely) make automated decisions about what visualization & analyses to perform
Requirements/Features

• Animation & Selection of objects
• Control over Camera & Time
  – Temporal exploration encouraged
• Responsive, Interactive System (constant time retrieval & assembly/compositing of images)
  – Computationally intensive analyses (precomputed) encouraged
• Enables Metadata Searching
  – Image-based visual queries
  – prioritize exploration of matching results
• Provides interface for scientists to make decisions for the production of this in situ visualization

• When designing in situ visualization (preprocess) use Paraview
  – provides cost estimate (# of images, total size of image dataset, time to produce)
• No penalty/disincentive/bias against exploring “expensive” visualizations, because they have already been computed and saved as images
• Query image database for all images that match XXX, then sort by YYY
  • Where is the largest visible mass of low salinity in the northern hemisphere?
  • What is the “best view”?
• Composi3ng allows user to reason about simulation results from visualization space, not just image space rendering & sampling
• Interactive tool for displaying & compositing items from the image database with interface very similar to Paraview – simulates experience of exploring simulation data
  – Interactive, at least 12 fps (surprisingly slow? What’s the bottleneck? Could some quality be sacrificed for speed?)
• Data saved per image for compositing (2X normal image)
  • color (rgb) + depth (z-buffer)
  • sprite layers
  • For opaque layers: save simulation data (geometry?) which allows recoloring/relighting
  • Image provenance (how image was created, parameters, etc.)
  • Images can be compressed into video format

• Well-written, good illustrations
• Good motivation & good explanation of features...
  but lacked detail on how things worked
• Impressive use of real-world datasets
• Niche but critical audience for this tool
• How powerful are their camera settings? Can you rotate about an arbitrary point or limited to the initially chosen rotation center?
• What hardware is needed to run the simulation? A supercomputer.
• What hardware is needed to analyze/visualize the resulting data? A fancy desktop or a supercomputer
• What hardware is needed to display/composite the pre-generated visualization images? A fancy desktop
• Image based (feature based) search of simulation results is inspiring for my final project
• MPAS: Model for Predication Across Scales
• 24 TB, $2^{15}$ is “reasonable”. Impressive. Ridiculous.
• Each image 1 MB. Will increasing the image size help scientists better explore the data? Or is this the limit of the simulation resolution?

Dataflow in scientific visualization applications. In scenario 1, images are streamed from server to client. In scenario 2, part of the rendering calculations are done on the server. Scenario 3 allows the client to do all rendering calculations. Scenario 4 uses the server for data storage only; all calculations are done on the client.

<table>
<thead>
<tr>
<th>Less geometry</th>
<th>More geometry</th>
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<tr>
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Figure 1: Categories used in this paper, with representative members.


(a) (b)
Light Fields

Plenoptic Modeling: An Image-Based Rendering System, McMillan & Bishop, SIGGRAPH 1995


Light Field Rendering, Levoy & Hanrahan, SIGGRAPH 1996

Unstructured Lumigraph Rendering” Buehler et al. SIGGRAPH 2001

Figure 1: When available, approximate geometric information should be used to determine which source rays correspond well to a desired ray.

Figure 2: When a desired ray passes through a source camera center, that source camera should be emphasized most in the reconstruction.
“Unstructured Lumigraph Rendering”
Buehler et al. SIGGRAPH 2001

Video at: http://gvi.seas.harvard.edu/paper/unstructured-lumigraph-rendering

Light Field Camera

• After taking the photograph, we can:
  – Adjust focus
  – Change viewpoint
  – Change illumination
  – & more?

Light Field Photography with a Hand-Held Plenoptic Camera,
Ng, Levoy, Bredif, Duval, Horowitz, & Hanrahan,
Stanford Tech Report, 2005
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Today’s Crayon Exercise & Assignment # 12: User Feedback

• Show your final project visualization, in its current form, to:
  — at least 5 people in this class, and
  — at least 5 people outside of this class
• Get feedback on all aspects of the design
  — visualization style, color, layout, interaction, presentation, etc.
  — Is your intended message conveyed? Does the user draw a correct and logical analysis or interpretation from the data?
• Ask for suggestions for improvement for:
  — short term: can be implemented before the deadline
  — longer term: if you continued working on this visualization, what big visualization implementation challenges or other related datasets could you tackle?
• Engage in the discussion & take detailed notes of feedback
  — Teams are encouraged to split up to gather feedback
• When giving feedback to your classmates, you are encouraged to sketch your suggestions for design revision
• Focus: Visualization Revision & Presentation
How to Solicit Useful Feedback

• Welcome criticism
  — Avoid becoming defensive
  — Remember you’re looking for feedback, not just approval
• Listen carefully & Listen actively
  — Seek to understand accurately
  — Ask for clarification
• Don’t decide [accept/dismiss] the feedback right away
  — Write it all down, and sort through it after you take a break
• Have a hypothesis
  — Be prepared for feedback
• Consider having a focus for feedback
  — Direct the conversation

Some material from: http://oregonstate.edu/instruct/comm440-540/criticism.htm

How to give Constructive Feedback

• Understand why and on what you are giving feedback
• Be direct & sincere
• Emphasize observation, rather than evaluation
  — Describe what you see, use “I” statements
• Invite collaborative discussion rather than just giving advice
  — Present criticism that allows the other party to make decisions
• Avoid overload the person, don’t give more feedback/criticism than he/she can handle at this time
• Include positive feedback and areas for improvement

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