Introduction to the 3D visualization of scientific data

Lecture 1 - 1/8/07
Today:

• What is 3D sci. vis.?
• Pretty 3D pictures (OpenDX)
• Review Syllabus + Schedule
• Class Survey
• Textbook ordering
What is visualization? (scientific visualization)


- transforms the symbolic (data, numbers, formulas, ...)
- into the geometric (shape + color + ...)
- enables researchers to observe their simulations and computations.
• a method for seeing the unseen
• empowers the process of scientific discovery (tools)
• may lead to profound and unexpected insights into data and processes
Why should I care?

• Very multi-disciplinary:
  Computer science (3D graphics), geology, biology, chemistry, physics, engineering, math, psychology, human-factors,

• Natural Scientists/ Engineers:
  Preparation for your thesis work?

• Computer Scientist:
  Lean about your potential “client’s” work

• Your opportunity to get exposed to a rapidly evolving field and find out what parts you like to work with!
Electron density gradient magnitude for a C60 Bucky Ball

Electron Density Gradient Magnitude and Direction
Pollution site data near the Gulf of Mexico:
Meta-fluorobenzoic Acid with computed electric field lines
Monthly Cloud Climatology
Gas Reservoir
Open Data Explorer - Visual Programming Environment (VPE)
HCI 558 X - Syllabus

• Tuesday 9-11 (lecture + exercises)
• Thursdays 9-11 (lab)
• 2268 Hoover Hall (Linux Lab)
• Instructor: Chris Harding
  charding@iastate.edu
  www.vrac.iastate.edu/~charding/hci558
• Office Hours: by appointment, send email first!
• on WebCT (check later, if I enrolled you)
Course Goals:

- Introduction (!) to the major concepts used in 3D scientific visualization (sci vis)
- How do these visualization techniques relate to concepts in human visual perception?
- Research into a single 3D sci vis topic ("report")
- Learn fundamentals of 3D sci vis using the Open Data Explorer (Open DX) software
- Optional 3D visualization student project
Grading

• Reading and class presentation of visualization papers (choice of topic) (30%)

• Several 10 min. quizzes (2 out of 3 questions, handwritten answers, open book) (20%)

• Final Exam (multiple choice and practical, using Data Explorer, open book) (30%)

• Class participation (20%)!

• Optional: class project (using DX, other 3D Viz software or CG system) (+30%)
Books

Required Text:

• “OpenDX - Paths to Visualization”,
• 207 pages, hands-on introduction to Open DX.
• Available via VIS, Inc. (http://www.vizsolutions.com/paths.html)
• printed book: $55.00 + shipping/handling,
• $50, if we pool our order – sign up after lecture

Supplemental Text:

• “Information Visualization – Perception for Design” (2. Ed.)
  Colin Ware, 486 pages, ISBN: 1-55860-819-2, $65 ($54 at Amazon)
Course structure

Tuesdays:

- 1 hour lecture: 3D scientific visualization, DX theory or relevant human perception background
- practical exercises depending on the lecture content (up to 1 hr).

Thursdays:

- 2 hr lab, work through the DX exercises in the textbook step by step.
- We will occasionally work on bigger DX exercises I have created.
• printout of the slides before the lecture
• the slides will also be on WebCT.
• lecture + lab: 2268 Hoover Hall
• also open at other times (see door)
• (unless there are other classes).
“Midterm”:
Reading and class presentation (report)

• Find topic in visualization (visualization techniques, case studies, etc.)

• Conduct individual (literature) research on this topic (I’ll be available for advice!)

• Deliverables:
  • 3 – 5 page written report (due at midterm)
  • 10 minute powerpoint presentation
List of potential research topics:

- Scalar Field visualizations (isosurfaces)
- Volume rendering (direct, GPU based, transfer functions)
- Vector field vis. (flow, vortex)
- Geometric modeling (meshes, compression)
- Virtual Environments & Visualization
- Large-scale Data vis. (distributed systems, parallel, time varying)
- Medical vis. (volume rendering, segmentation, transfer functions)
- Engineering vis. (vector, streamlines, stress, tensors)
- Geoscience 3D vis. (3D GIS, subsurface, hydrology, geophysics)
- Meterology 3D vis (time series, specific met vis applications)
- 3D visualizations at ISU
- Non-visual “visualization” (sonification, haptics)
- Color perception & rules for efficient use
- Non-realistic (artistic) rendering
- History of 3D visualization
Quizzes

• ~3 written quizzes during the semester
• 10 min. to answer 2 out of 3 questions
• not multiple-choice, open book
• written questions about the proceeding lectures
• Examples:
  • Write down the major steps in scientific visualization
  • show a graphic - explain what is going on.
Final Exam

• 15 min multiple-choice part
• 90 min practical part
• open book exam
• MC questions: material covered in the lecture-part during the entire semester
• The practical part: several small visualization tasks similar to the exercises in the textbook
Optional class project (+ 30%)

- Practical use of 3D sci viz skills and acquired in the course. (Open DX, programming API, ...)
- A (limited) 3D visualization project with data from your domain (i.e.: beyond the sample data)
- Data import / massaging is not the main point!
- Topics: Open to your suggestions but need to know in March
- Results: 10 min presentation + report
About you:

- Name / Major?
- Science/engineering background?
- Computers in general (user)? Linux OS?
- Computer programming / coding (OS? languages?)
- 3D computer graphics? Games?
- 3D Modeling software? CAD, 3D Studio, Maya?
- 3D sci vis software? VTK, AVS, Paraview, Amira?
- Other scientific computing software? Matlab?
- Reason for taking the course, expectations?
• Any questions?

• Textbook sign-up:
  • $50
  • I’ll order today
  • Should arrive before next Tuesday
  • You pay me later (cash only!)