Hybrid Web visualization of urban GIS models with dynamic environmental volumetric data

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Outline

1. Motivation
2. HTML5 + WebGL
3. Volume Rendering
4. Methodology
5. Conclusions / Future Work
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Motivation

• Air Quality Models
  – From monitoring network
  – Measure meteorological variables and pollutant levels
• ... conceptualized as 2D at large scale
• But ... at urban scale
  – It is essentially a 3D dataset
  – X–Y plane ~ Longitude Latitude
  – Z direction ~ Height
  – Mapping or analyzing the atmosphere
• ¿Visualization of such 3D scalar fields?
AIR POLLUTION VISUALIZATION GVSIG-3D

3D GRID CELL = SPHERE
COLOUR SCALE
TRANSPARENCY

Temperature 3d data
1Km * 1Km Madrid

Red ➔ Highest values
Green ➔ Lowest values

gvSID – 3D

3 vertical levels
surface

No transparency
Zoom-in

Environmental Software and Modelling Group
http://artico.lma.fi.upm.es
AIR POLLUTION VISUALIZATION VRML

Example of visualization with VRML of buildings and isosurfaces of temperature over Madrid area

Example of interaction of the user with VRML

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Why HTML5 and WebGL?

- Users can access Web application from anywhere
- No installations, just go to the web address
- Automatic and transparent app updates
- Huge amount of mobile devices and growing

- HTML5: develop/write once, run everywhere.
  - Implemented natively in the latest versions of Firefox and Chrome. Also in mobile devices.
Volume Rendering (I)

- Scientific Visualization
- Medical Datasets
- Weather visualization
- Web advantages:
  - Homogeneous visualization from any device
  - No server computation
• **Ray-casting** is an expensive render algorithm for volume rendering.

• **WebGL** allows the graphics rendering pipeline to be used from the Web.

• **Several proofs of concept**
• Traditional Volume Rendering methods use orthogonal/cartesian coordinates

• Other scalar fields are represented with different coordinate system
  – e.g. Weather Radar datasets
  – Concentric cones, with the radar in the centre of them
    • Spherical coordinates

• What about AQM datasets at urban scale?
Objective

• Apply Volume Rendering techniques to AQM datasets
  – Provided by Madrid Technical Univesity (UPM).
  – Temperature at urban scale (Madrid, 1 km x 1km)
    • Obtained from numerical experiments to simulate turbulent fluxes for urban areas.
    • Modified EULAG micro scale model (CFD) used to obtain the urban atmosphere/biosphere energy exchange.
  – Each sample: 250 × 250 × 25 scalar values, in K.
    • With special values for NaN: -1.E+34
Methodology (I)

- Raw data provided in big ASCII Files (X Y Z V)
- Create PNG images from X-Y values
  - Map values (*float*) to (0 – 255) range (greyscale)
    - 298 K – 313 K (~15 K) → 0 – 255 values (1 byte)
    - Defining a “good” **Window Level** is experimental
    - It depends on what the user wants to achieve
Methodology (II)

• Create set of **Z-aligned** PNG images
  – Do the same process for each Z slice
  – Without modifications of the Window Level
  – So, choosing the Window Level should take into account all the dataset values
    • As “interesting” information is near the ground, the Window Level could be biased to optimize the mapping of such layers

• Some colouring can be applied
  – Applying some Transfer Function (standard or random)
Results – WebGL AQM Volume Rendering

- The set of Z-aligned greyscale images is loaded into a WebGL powered Volume Rendering Web Application
  - HTML5 + jQuery for interaction controls
- Initial values for a correct visualization have to be chosen experimentally
  - Load, modify till get a good result and write down the values
  - Read values from a JSON file when the application is run

http://artico.lma.fi.upm.es/demo_TF_volren_upm/aqm-test-tf.01.html
Results – WebGL AQM Volume Rendering

• **Interactively:**
  – Free View - Camera Rotation
  – Dataset Inspection - Zoom Level
  – Color Mapping and Transparency
    • Set of slides
  – Global transparency and Light Factor are applied to the whole Volume

• **Individual control for value 0 and 255**

• **Rest grouped in 16 values per slider**
  – Each slider modifies the color and /or transparency of 16 values
  – More sliders more control
  – But less usable
Conclusions

• Volume Rendering techniques can be applied to AQM datasets
• Asymmetry is challenging
  – Less levels in height (250 x 250 x 25)
  – Interesting “details” are near the ground
• Better Transfer Function editor in HTML5 is required
  – Transfer classical TF editor controls to Web
• Georeferenciation has to be taken into account when working with “images”.
Future Work

• Next steps?
  – Window Level should be interactive
    • Realtime images generation from RAW data
  – Add 3D models (terrain + buildings)
  – Temporal Series
  – Extend to Vector fields (wind currents)
  – Manage several AQM variables
• ¿Different Pollutants (scalar, vector fields) + time + 3D models + “at the same time” + proper UI?
  – Usability problems
  – Further research
Volume Rendering Demos

http://demos.vicomtech.org/
http://www.volumerc.org/

Make sure that you’ve got the very latest versions of the drivers for your graphics card

and

use new versions of Firefox or Chrome
QUESTIONS?

Thank you for your attention...