3D Volume Visualization of Environmental Data in the Web

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Motivation: Data

Internet of Things
Big Data
faster Internet access
visualizations needed
Motivation: Web Visualization

- should work on all devices
- operation system independent
- no installation required
Motivation: Existing Visualizations

chart, map visualizations…
JavaScript libraries: Highcharts, amCharts…

New requirements:

3D data sets
3D visualization
interactivity
customizability
Analysis: Project BodenseeOnline

- research project 2005 – 2008
  - visualize information about the Lake Constance
- **LUBW** hosts the website
- **Kobus and Partner** runs the simulations
- additional project partners

https://www.lubw.baden-wuerttemberg.de/wasser/bodenseeonline
Analysis: Project BodenseeOnline

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× 1D/2D visualization
- e.g. temperature at a specific point (1D)
- e.g. temperature at a specific depth (2D)

× static colors
- not suitable for every user

× limited interactivity
- multiple layers or comparison of data at different points
Requirements

- 3D data sets
- 3D visualization
- interactivity
- customizability
Concept: Architecture

Server

Python web server

Client PC

GPU Shaders

Web Browser

3D visualization

JavaScript (Three.js library)
Concept: 3D Volume Visualization

- technique: ray marching
- for every pixel
  - cast ray through the volume
  - collect values along the ray
  - compute resulting color
Concept: WebGL

- OpenGL in the browser (currently: ES 2.0 2007)
- supported by modern browsers and devices with GPU
- 3D textures not supported yet
Prototype: First Screenshot
Prototype: First Screenshot
Prototype: Different Substances

- Temperature:

- Salinity:
Prototype: Different Substances

- Tracer (River Rhein):

- Phosphate:
Prototype: Different Substances

- Suspended Matter
- Flow of Water
- Chlorophyll
- Dissolved Oxygen
Concept: Data Management

- NetCDF file as exchange format
- precompute into binary files
- data is served by a Python web server

![Diagram showing server communicating with client PC through NetCDF file and binary files]
Concept: FlexVis

- visualization framework
- easier to customize
- simplifies connection to data sources
- no programming required
Summary

- BodenseeOnline project
- 3D volume visualization using WebGL
- Visualization of different substances
- Special data management needed
- FlexVis supported
Outlook

- improve algorithm
- user-friendly version of the color mapping UI
- updated data management
  - different data resolutions
  - maybe even adaptive resolutions for an area of focus
- implement animation
Thank you for your attention.

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Sources

- Icons made by Freepik from www.flaticon.com
- Icons made by Madebyoliver http://www.flaticon.com
- Icons made by Eleonor Wang http://www.flaticon.com
- https://www.python.org/community/logos/
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