Integration of X3D Geospatial in a Data Driven Web Application

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Overview

The Monterey Bay Aquarium Research Institute designed the Spatial Temporal Oceanographic Query System (STOQS) to create new capabilities for scientists to gain insight from their data. STOQS employs open standards and is a 100% free and open source project. It includes a web-based graphical user interface where X3D Geospatial has been integrated to enable 3D geospatial data visualization.

Architecture

STOQS consists of a PostgreSQL/PostGIS database, Mapserver, and Python-Django running on a server and client-side technology (HTML5, CSS, jQuery, OpenLayers, X3DOM, Bootstrap) running in a modern web browser (Figure 1). The web application provides faceted search capabilities allowing a user to quickly drill into data of interest. The X3DOM JavaScript library provides interactive 3D views of the data in browsers that support WebGL.

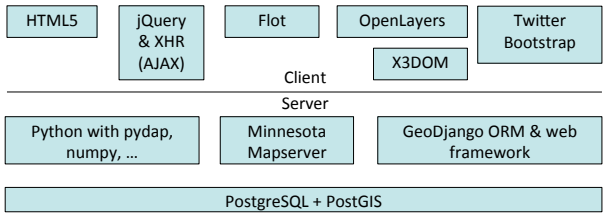

Figure 1: *STOQS integrates multiple open-source components.*

User Interface

The STOQS User Interface displays a map of the vehicle tracks and a time series of depth profiles of the vehicles (Figure 2). The bold blue letter text items are each sections that may be expanded revealing lists of items that may be selected for filtering, data selection, and plotting. If a parameter is selected for filtering then only the information from that platform are shown in the other sections of the interface. Any selection initiates an instant update of the other items that may be selected.

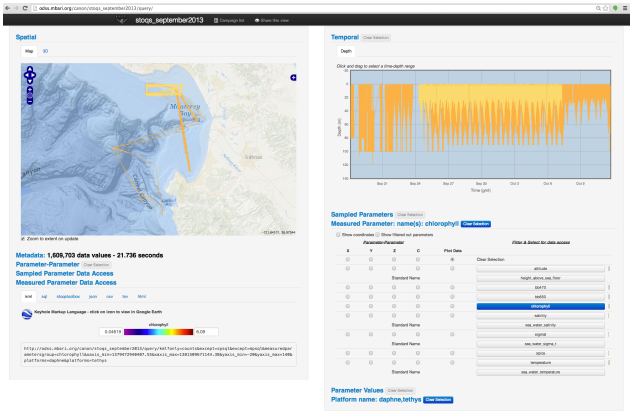

Figure 2: *STOQS User Interface – chlorophyll is selected showing overview of when, where, and what platforms measured it.*

Web Integration

Selected data are delivered to the Spatial 3D display when a radio button in the Plot Data column is selected and when the checkbox in the 3D panel is checked. The process for the update of the display is:

1) HTML contains X3D scene graph elements for the web page (Figure 3)
2) Data are received by the browser from an XHR request in JSON format (Figure 4)
3) jQuery code writes JSON datato the scene graph elements (Figure 5)

```
<div>
<X3D id="spatial-3d-x3d" style="width:100%; height:100%;">
    <Scene>
        <shape id="mp-x3d-track"></shape>
        <Viewpoint id="mp-x3d-viewpoint1"></Viewpoint>
        <Inline id="mp-x3d-terrain1"></Inline>
    </Scene>
</X3D>
</div>
```

Figure 3: *DOM elements and X3D scene graph for the Spatial 3D view.*

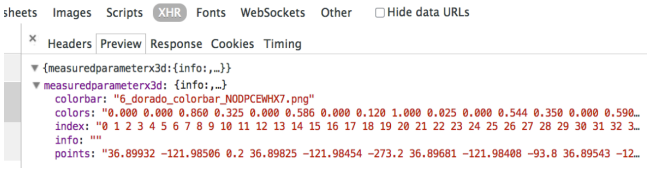

Figure 4: *XMLHTTPResponse (XHR) containing JSON formatted data.*

```
$('#mp-x3d-track').html([
    '<indexedlineset coordIndex="' + data.measuredparameterx3d.index + '">',
        '<color color="' + data.measuredparameterx3d.colors + '"></color>',
        '<coordinate point="' + data.measuredparameterx3d.points  + '"></coordinate>',
    '</indexedlineset>'
].join(''));
```

Figure 5: *jQuery code to update the scene graph with data from the database.*

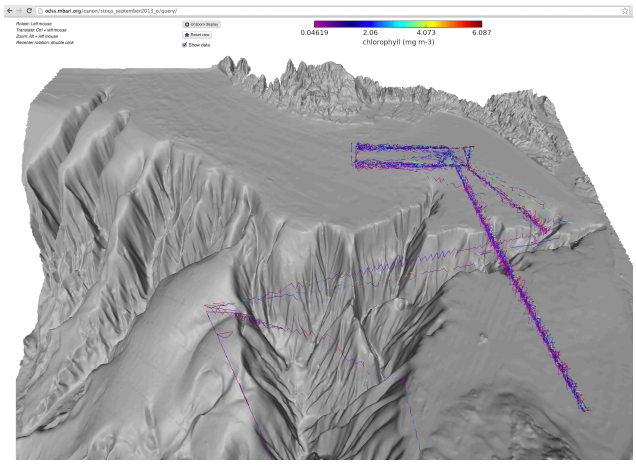

Figure 6: *3D view of Chlorophyll sensor data over Monterey Bay bathymetry.*

Discussion

STOQS is a good platform for experimentation with 3D portrayal and for understanding patterns of data access. Such experimentation helps identify needed protocols to support interoperable data access and 3D visualization. Data from the database can be connected to appropriate scene graph elements within the confines of the coupled Server-XHR-JSON-Client environment. For example, Figure 6 is a screen grab from the STOQS User Interface where the user has selected Autonomous Underwater Vehicle measurements of chlorophyll. The system retrieved the selected data from the database in a custom JSON data structure, JavaScript in the browser then updated IndexedLineSet GeoCoordinates in the scene graph with these data.

The Spatial section of the STOQS UI has both 2D (OpenLayers) and 3D (X3DOM) data viewing areas. OpenLayers supports the Open Geospatial Consortium's Web Map Service (WMS) protocol which allows content to be retrieved and "mashed up" from different servers. The WMS protocol enables this through its requirement that each GetMap request include a CRS field specifying the EPSG code for the coordinate reference system of the map. There is not yet an equivalent scheme to deliver 3D data to an X3D scene graph.

The OGC 3D Portrayal Interoperability Experiment (3DPIE) [OGC 2012] specifies that a GetScene request will return an entire X3D scene in whatever coordinates the server generates - there is no ability to mash up data from different servers. We think that this situation can be improved and are implementing the X3D Geospatial Component in X3DOM to explore ways to achieve fully interoperable 3D portrayal.

There are several use cases for 3D mashup capability. The 3DPIE identified sensor data as a source for portrayal but left the implementation of a sensor service capability for a future effort. Data representing such things as atmospheric pollutants could be retrieved from external servers and could be portrayed as a transparent cloud within a model of a city. Remote sensing and numerical model data could be retrieved from other servers and rendered in 3D along with the oceanographic sensor data in STOQS.

References

MBARI, 2014. STOQS: The Spatial Temporal Oceanographic Query System. https://code.google.com/p/stoqs.

OGC, 2012. Open Geospatial Consortium 3D Portrayal Interoperability Experiment - Final Report. http://www.opengeospatial.org/projects/initiatives/3dpie.

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