



The 7th International Conference on Emerging Ubiquitous Systems and Pervasive Networks
(EUSPN 2016)

A Review of Latest Web Tools and Libraries for State-of-the-art Visualization

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Abstract

Most of the existing visualization and simulation applications run on the client machine and require an installation process. Browser based interactive visualizer for scientific and medical applications remain an unheard concept despite all advancements in computer and software technology and it remains a fairly difficult process to quickly prototype a visualization on a PC or a smart device. In this paper, we review and employed state-of-the-art web technologies, third-party libraries and frameworks to compare and develop some interactive browser-based, mobile friendly web applications. These latest web technologies have the potential to fulfill the promise of interactive browser based custom visualization applications. We presented and compared some of the latest web based tools available today. We also introduced couple of lightweight and interactive web based visualizer and simulator tools which are under development.

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Peer-review under responsibility of the Program Chairs

Keywords: Browser-based Visualization; Web based Application; JavaScript; Simulation

1. Introduction

There is a greater demand for custom on-demand high performance visualization and simulation applications for medical, engineering, scientific and industrial problems. Existing visualization and simulation applications run on the client machine and require an installation process. Browser based interactive visualizer for scientific and medical applications remain an unheard concept despite all advancements in computer and software technology and it remains a fairly difficult process to quickly prototype a visualization on a PC or a smart device. The development of a reliable and robust large-scale system requires that design concepts are visualized in some digital form, before implementation. Simulations provide a cost effective and feasible method of examining the correctness and scalability of the system

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before deployment. Similarly, educational and Science, Technology, Engineering and Math (STEM) Visualization allow smart and interactive teaching in classrooms or for web based tutorials.

In the past, we have developed few visualization and simulation tools. Pymote 2.0 is an extension of Pymote which is a high level Python library for event based simulation of distributed algorithms in wireless networks¹. We implemented modules for propagation, energy consumption and mobility models. We also added graphing and data collection modules to enhance the Pymote base functionality and modified existing modules for node, network, algorithm and logging to support the extended framework.^{2,3} The extended framework utilizes the python Matplotlib package⁴ and the innovative charting library provided by Highsoft⁵, which is free to use for personal and academic purposes. The output format includes Comma-Separated Values (CSV), Portable Network Graphics (PNG), high-quality Scalable Vector Graphics (SVG) and Portable Document Format (PDF) which can directly be inserted into Latex and other publishing applications. HyperText Markup Language (HTML) files are also created with embedded JavaScript (JS) and Cascading Style Sheets (CSS) for interactive plotting which is needed for presentations and on-line content.

In this work, we review the following state-of-the-art web technologies, third-party libraries and frameworks that can be utilized to fulfill the promise of interactive browser based custom visualization applications. These libraries use SVG standard libraries for appending and manipulating SVG elements, which is supported in almost all modern browsers, smart phones and tablets. These libraries and frameworks are developed using pure JavaScript, so users get interactivity without requiring round-trips to servers and without any additional plugins.

- **HTML5** is a larger set of technologies (including CSS3) that allows more diverse and powerful Web sites and applications.
- **jQuery** is a fast, small, and feature-rich JavaScript (JS) library which allow write less, do more⁶.
- **D3.js** is a JavaScript library for manipulating documents based on data⁷.
- **GoJS** is a JavaScript library for implementing interactive flowcharts, organizational hierarchies, trees and other complex displays⁸.
- **JSmol** is an open-source JS library and HTML5 viewer for chemical structures in 3D⁹.
- **Highchart** makes it easy to set up interactive charts in web pages⁵.
- **Bootstrap** is the most popular HTML, CSS, and JS framework for developing responsive, mobile first projects on the web¹⁰.

The idea is to employ these state-of-the-art visualization, presentation, animation, and simulation technologies to create a desired custom solution. Software and application developers under the guidance of domain experts in medical, engineering and scientific profession, together can create some great visualization and simulation solutions in areas as diverse as organism/molecular simulation, Nano-technology, Material Sciences, Medical visualization, Astrophysical visualization, and Chemical or Biological visualization.

We also present the design and implementation of a generic topology generator, as part of an interactive browser-based network visualizer and simulator called *Visual-Netsim*. We also introduce an innovative web-based visual flow chart drawing application. These are lightweight utilities that allow quick and powerful web-based custom visualization and drawing.

2. JavaScript Libraries

In this section, we review some of the JavaScript libraries which are designed for modern browsers and smart devices. These libraries exploited the advancement in HTML5, CSS3 and SVG and provide an Application Program Interface (API) for developer to create web-based mobile-friendly 2D/3D diagrams and animations.

2.1. HighChart

Highcharts is a pure JS charting library, offering an easy way of adding interactive web-based charts. It is designed from ground up with mobile browsers in mind, everything from multitouch zooming to touch-friendly tooltips responds great on mobile platforms. In modern browsers graphs are rendered in SVG, with VML support for legacy

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