Tools for Presenting 3D Objects and Virtual Collections Online

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Abstract. With the emerging Internet technologies, the need for rich and interactive web content has drastically increased. The presentation of information in an attractive way is extremely important for fields like digital libraries, e-Learning and e-Commerce. This paper describes a set of tools we developed for adding visualization of 3D content to new and existing web pages, which can be used by authors with various expertise and skills. Once embedded into a web page, this functionality becomes available on all modern devices and web browsers, without the need to install any additional software.

Keywords: 3D Rendering, Online Exhibitions, Virtual Collections

1 Introduction

The recent development of Internet technologies lead to an increasing demand for richer and more interactive content. Web applications and systems in various areas like digital libraries, e-Learning, e-Commerce and social environments are adding more 3D graphics to their functionality. By integrating single three-dimensional models or complex scenes, comprised of many objects, in a way which allows the user to interact with the environment, authors achieve a unique presentation of their work. Representing objects in a 3D format offers many advantages compared to the traditional presentation materials such as text and images [1]. It allows Internet viewers to perceive the real properties of the objects, like form and dimensions, in a better way. Achieving such a high level of visualization is a priority not only for new, but also for the existing web applications.

In the field of digital libraries, where the presentation of information is crucial, the need for three-dimensional graphics is clearly seen. Users nowadays are expecting newer and more interesting ways of viewing historical, archaeological and architectural objects [2]. The presentation of 3D models of digital objects is an important alternative of the two-dimensional images and video, because the combination of different objects into one interactive scene allows a better reproduction of the visual and spatial characteristics of the artifacts, more visible comparison of their properties, and creating interactions between the models and other real world objects. The latest digitalization initiatives lead to new research and development that can be applied in the field of virtual museums [3]. To be able to expose real physical objects, the real

museums need time, space and personnel for the exposition, as well as storage spaces for preserving the artifacts. If the objects are too fragile, valuable, expensive, incomplete or even missing, they cannot be shown to the general public, but only behind closed doors. These disadvantages reveal the need for systems that allow authors to create virtual collections and show them online.

The e-Commerce is also an area, in which 3D graphics are emerging quickly. The simplest scenario involves showing the items of an online catalog in a 3D format. Most customers are not fond of online shopping, because the product is not physically present. By giving the opportunity to view a three-dimensional model of their products, from any point of view and distance, the e-Commerce organizations on the Internet can stimulate more trust in their users and increase their sales [4]. Another application of this technology in online shopping is the option to change a product's color and combine it with other products and individuals, in order to see how the real goods would look like in reality. The latest research in this area involves the development of web platforms for managing online shopping centers. These virtual environments allow the user to visit three-dimensional outlets in a new and revolutionary 3D shopping experience, involving social interactions with goods and other users by using only a web browser. Web platforms for 3D e-Commerce allow the online goods to be arranged in a creative and original manner, in a custom-made setting, architecture and style. Substituting the static approaches for presenting products on the Internet, the social three-dimensional online shopping is part of the next-generation e-Commerce technologies.

Three-dimensional technologies provide flexibility and dynamics to learning activities, which are not possible in real life. Modern e-Learning platforms are introducing virtual worlds which stimulate constructivism and collaboration in the learning process [5]. Such environments are not intended to replace the current e-Learning methods – they are tools for preserving the users' interest and involvement. Second Life [6] is one such environment, used by more than 2000 companies, 600 universities, 35 national governments and several divisions of the US government for learning and cooperative work [7]. By using similar platforms, various organizations can develop complex learning programs through interactive simulations in environments, accessible from all over the world.

The increasing demand for 3D graphics in applications from different areas, requiring online presence, is a clear indication for the need of research and new developments in this field. With the advance of these technologies, the object presentation and visualization in digital libraries, e-Commerce and e-Learning will achieve a unique progress and new opportunities for development.

2 Latest Internet Technologies for 3D Graphics

The latest technologies for showing 3D graphics in web pages are based on the new canvas element, introduced with the new HTML5 standard. This element allows developers to add complex three-dimensional graphics in the web browser, through an Application Programming Interface (API), called WebGL [8], without installing any

additional software. WebGL is a JavaScript API, which means that it is controlled by JavaScript programs, executed by the web browser on client events like mouse or keyboard clicks. It provides a very rich set of features and can be used to implement any 3D animation scenario. The 3D graphics can be freely embedded into and appear alongside the elements of new and existing websites. WebGL uses the devices' video hardware directly, which allow for very fast animation and effects. At the same time, its interface is very complex and simple operations like showing pre-built 3D models, adding lights or changing the point of view, require specific knowledge and take a great amount of time. To simplify this process, several JavaScript libraries have been developed.

The JavaScript libraries for leveraging the work with WebGL provide standard functionality for showing 3D models, cameras for viewing them from a different perspective, lights and other effects. One of the most popular JavaScript libraries for 3D graphics in the web browser is Three.js [9]. It is a very powerful framework, designed for all kinds of computer animation scenarios. It includes support for multiple 3D file formats, standard for the industry, different lights and shadows, cameras and controllers for their movement on the scene using the mouse and keyboard, and other instruments. But even if such a library is used for rendering 3D graphics in the web browser, a great amount of JavaScript code will be required for configuring and controlling the animation. The first thing that needs to be done is initializing the scene – it defines the environment containing all the resources involved in the animation and their spatial characteristics like size and location. Then the three-dimensional models, textures and materials are added. Lights are used for lightning the scene and the objects inside it, and showing shadows and reflections. For displaying the 3D environment onto a two-dimensional screen, a camera must be initialized, specifying the perspective and location of the viewer. Finally, the rendering process is started, which converts the scene in a two-dimensional image, shown on the user's screen, in real time. In addition to drawing the 3D scene, a web application must also respond to different events and reflect them in the environment. This can include changing the location and direction of the camera, or showing additional information for a given object, when the viewer uses the mouse and the keyboard.

Even with the use of JavaScript libraries for WebGL, the work for adding 3D graphics in web pages takes a lot of time and requires web developers with specific knowledge in the area. To solve that problem, we built several software components and an environment, which allow people with beginner and even no knowledge in web development, to add interactive 3D visualization to their existing and new web pages.

3 A Software Component for Visualizing 3D Objects Online

The first component that we created for assisting content creators is for visualizing 3D objects in web pages [10]. It uses the C3DL library for drawing 3D graphics in the browser, and jQuery and jQuery UI for DOM manipulation, effects and browser compatibility libraries. The component is implemented as a jQuery plugin, which makes it

independent and easy-to-use in any website. Because of that, its integration requires only a few lines of code to describe the models to be displayed and configure the component before it starts working. After it has been initialized, the software watches for mouse click events on the HTML elements, for which it was configured for, such as buttons and links. And when such an event occurs, it opens a new popup window that shows the 3D model associated with that element. The visualized model can be examined from a different angle and distance by using the mouse. The configuration of the component, like what models are displayed and which elements must be observed for click events, does not require any specific knowledge and is done by adding a few changes to the existing HTML markup. With its help, the authors of Internet pages can enrich their content by adding three-dimensional models of real objects and give their visitors a more realistic presentation than traditional two-dimensional media offers.

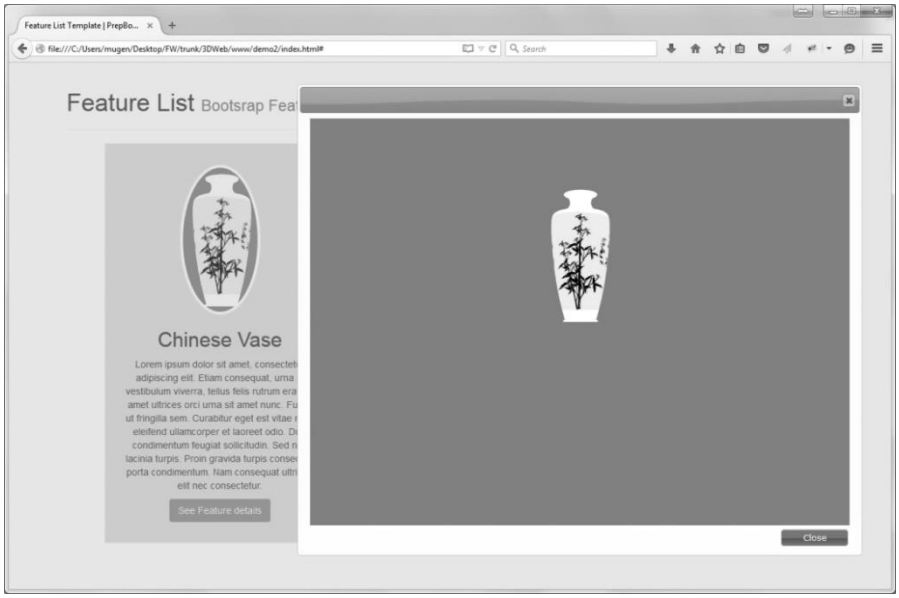

Fig. 1. Visualizing 3D models in the web browser

The described jQuery plugin is a general purpose component, which can be used in many different scenarios – from static web pages, visualizing single objects to complex web applications, containing information for thousands of objects. A typical scenario for using this functionality is an existing website, showing a list of items with specific information for each one. To add 3D views for the items, an author can create three-dimensional models in advance, using a professional software like 3D Studio Max or Maya. Then those models must be uploaded on the network and made accessible to the visitors of the website. Finally, when the few updates to the HTML code are applied, the 3D presentations become available to the viewers.

4 A Software Component for Exploring Virtual Collections of 3D Objects

Another tool we developed is a JavaScript framework for composing exhibitions of digital objects and presenting them in an interactive 3D environment in the user's web browser [11]. As illustrated on Fig. 2, the component allows the user to view a collection from a first person's perspective, while walking around between the objects and examining each one in detail from a different angle and distance. In addition to the visual and spatial characteristics of the objects, the viewers can see supplemental information added for each object by the author. The software uses the Three.js library for drawing 3D graphics in the web browser and jQuery for working with the DOM. Its usage requires basic knowledge in JavaScript development, needed to configure the component and the collection of objects it should display. The developed component saves web programmers the work needed for implementing the 3D graphics in their virtual environments, like adding the models, lights, cameras, and handling the movement with the mouse and keyboard.

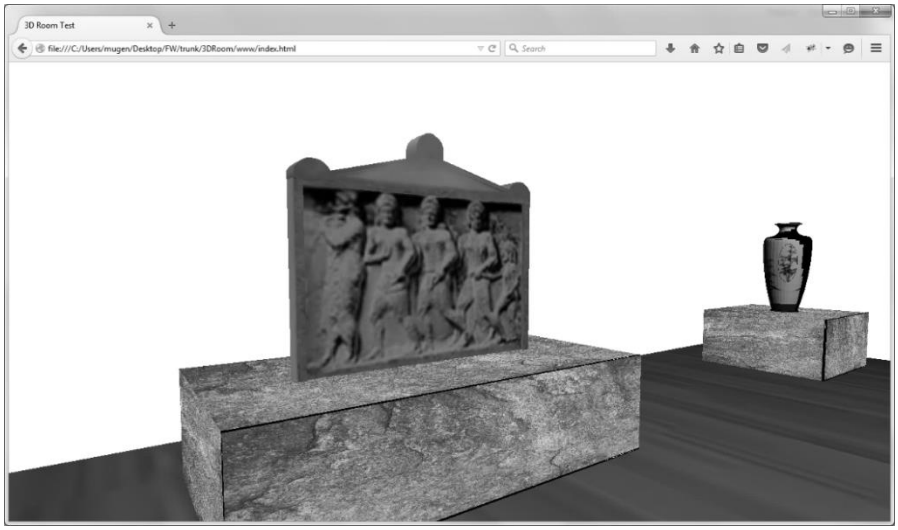

Fig. 2. Examining an exposition of 3D objects

The component for presenting collections of 3D objects is also a general purpose module – it can be used to show all kinds of a single as well as multiple objects. It is also useful not only to users that want to visit and examine a virtual collection, but also to authors who want to prepare a collection of objects of all kinds and present it to the general public, or a smaller group of people like students and tourists. The ability to prepare a virtual collection of objects of various types, without any limitations, gives authors the freedom to choose and present the right content for any given event or a target group.

5 A Web Platform for Managing 3D Virtual Collections

Using the component for visualizing collections of three-dimensional objects, we developed a web platform for creating and publishing expositions of 3D objects on the Internet [12]. It provides a full set of functionalities for managing their online exhibitions, like creating, editing, deleting, publishing and unpublishing them. The web application is a multi-user system imposing different access restrictions and showing different parts of the user interface based on the current user's roles. There are three groups of users in the system - administrator, author and everybody else. Unregistered users can only access the public sections of the application like the list of published collections, the virtual presentations of each collection and other utility content like informational and help pages. Authors can create expositions comprised of a single object, like a building or an automobile, or add multiple objects, intended to be viewed as part of the same collection. Administrators have full management access for all collections.

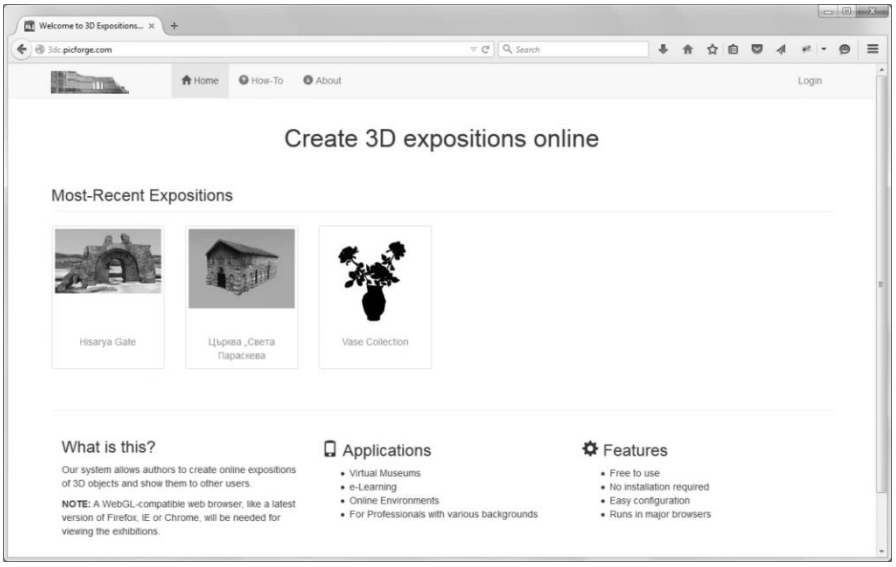

Fig. 3. Online platform the creating 3D expositions

The user interface of the application conforms to the latest HTML5 standards. It uses Bootstrap for responsive and mobile-first layout, jQuery for a helper library and ShieldUI for special widgets and effects. The server-side part is built using the Perl Catalyst MVC framework using SQLite for database storage, hosted as a Plack application and served by an Nginx web server. In addition to the end-user functionalities, the system provides a set of RESTful APIs for managing different objects, part of it. They can be consumed by external systems for retrieval of various information about published collections, managing them, search by different criteria, etc. The developed system is a flexible and unique environment for managing and presenting virtual ex-

hibitions on the Internet, which does not require any specific knowledge from its users and at the same time offers a complete application programming interface for the use of experienced developers and other systems.

6 Conclusions and Future Work

This paper presented several applications whose purpose is to simplify the process of adding 3D graphics to web pages and make that available to people with no software development skills. They can be used in many different scenarios requiring 3D object display. Being among the first applications of this kind, there are still a lot of improvements and enhancements that can be done to the presented solutions.

One area for improving the modules for visualizing three-dimensional materials is adding sound. By adding a voice, describing the details about a particular object, or the sound it makes, the user's experience becomes more realistic and he perceives more information. Another significant upgrade will be the display of some figures or silhouettes of the users currently examining a certain collection. This will give the viewers more information about their surroundings and allow social activities between them, such as exchanging messages, adding in groups, sharing common interests and basis for communication in the real world.

The online platform for managing 3D exhibitions can also be refined. One possible improvement is expanding the metadata, stored for the 3D objects. We can add properties like author, origin, date, and others, defined by the Dublin Core Metadata Initiative [13]. The storage layer of the system can also be upgraded and made more scalable and flexible by using a NoSQL solution for handling big data [14]. The API provided by the platform can also be extended by adding more services for extracting the data in RDF format and advanced search. Finally, a new section can be added to the user interface, which will enable the advanced search and allow the visitors to query the data in the system in a more efficient way.

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