

Development of Web-Based Information System for Visualization of Three-dimensional Models of Museum Exhibits

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Abstract. In the following article main results are going to be summarized about three-dimensional web development and technologies. An introduction to 3D representation methods that are applied on the featured three-dimensional webpage is going to be presented. Transformation techniques will be described, which convert a traditional two-dimensional webpage into a fully functional three-dimensional platform. The methods and concepts used are based on technologies such as HTML, CSS, and JavaScript. The principle of automatic conversion is going to be showed, upon which almost any two-dimensional webpage can be converted into a 3D website, including minimal manual interaction. Future concept and conclusions are also described.

Keywords: 3D visualization, 3D website, Stereoscopy, 3D web development, Computer graphics, Web, Museum, Information system, HTML, CSS, JavaScript.

1 Introduction

The topic of this paper is an important task of Development of web-based information system for visualization of three-dimensional models of museum exhibits project which main goal and research is to create a 3D website which shows spatial three-dimensional real space user experience¹. There are several ways that are applied for three-dimensional visualization throughout the project. The website gives a different and more realistic idea, because it displays spatial effects of both text and images in a web space.

Several key tasks are included like exploring methods and new approaches for 3D visualization of three-dimensional images and geometric patterns on the Internet,

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ways for digitizing 3D objects, processing, editing, storage of museum exhibits as three-dimensional images in WEB and displaying them in a high level of detail and realism. Another option considered is the stereoscopic 3D effect, red-cyan technique, where changes are applied to the original HTML code of the presented web platform. Initial cascading style sheets are extended in order to convert a standard web page into a fully functional three-dimensional web platform, displaying museum exhibits [1].

The use of three-dimensional and virtual reality technologies is still relatively limited, tending to be used by large engineering companies in design processes or in the entertainment industry. 3D webpages nowadays are becoming more popular, as they add an extra dimension and depth to a website which is one of the important goals of the featured website. Information and more meaningful manner are conveyed and offer a better interaction or visualisation throughout these technologies. Other main task to resolve is one of the most important usability issues, thus combining 2D and 3D elements. Some of the three-dimensional elements are largely being controlled by a 2D interface on this webpage. The resolution to the issue can be a greater interaction within all these elements at the created web platform [2].

Reports are given that give good and interesting ideas of how to present 3D content in a proper visual and realistic way. „Tools for Presenting 3D Objects and Virtual Collections Online“ report describes a set of tools, developed for adding visualization of 3D content to new and existing web pages, which can be used by authors with various expertise and skills. “Using Document Store for 3D Virtual Collections” paper shows the latest improvements to a recently developed online environment for managing virtual collections of 3D objects thus “3D Laser Scanning for Digital Preservation and Dissemination of Cultural Heritage. Main scanned objects – Four Temples of Different Religions in Sofia” report demonstrates a way to create a database platform of cultural and historical heritage sites, applying three-dimensional laser scanning technology and a combination of geodetic and photogrammetric methods and shooting techniques.

3D representations are used in this web platform that does not require any special tool to show web content on the Internet. First of all, stereograms, upon which certain three-dimensional images can be rendered, are using a special technique for visualization. Stereograms do not support long text or small details. This is the main reason why this way of visualization is used only in certain parts of the entire web platform. The web page also proposes a different usability method aiming at solving issues like using less interaction and plugins while viewing a 3D web page [4].

2 Rendering methods

3D representation nowadays is available for devices like TV sets, monitors and laptops, computers. There are several methods for 3D rendering, some of them will be briefly introduced in the next section [9].

Side-by-Side representation .

Widely spread technology is the stereoscopic view of 3D content, where the entire content is doubled, one side to the left and other side to the right eye. Special rendering software of active 3D monitors or TV sets puts the images together and controls the 3D glasses that separate the image for the left and right eye, presenting the 3D view effect.

Anaglyph method .

The stereoscopic technology, red-cyan method, requires special glasses with red and cyan colour filters, respectively in front of the left and right eye. The colour filtered content is sent dedicated to the left and right eye, which results in 3D user experience. Usually the glasses used for viewing this kind of technology are paper framed and not expensive. This method is applied in the current version of the website for the museum of St Cyril and St Methodius University of Veliko Turnovo.

Animated GIF images .

These images can also provide a close 3D effect, where the image to the left and right eye alters each other in a certain speed. The human brain can put the image together and sees it as a slightly moving 3D object. The main advantage of this method is that it doesn't require any special equipment for displaying 3D image, however the 3D content is limited to big objects only.

Stereograms.

Other 3D imaging method that doesn't require any special tool is the stereograms. This technique however expects some training for the eyes and the human brain until the 3D image becomes visible.

3 Development process and techniques

Transformation of cascading style sheets is applied through the development of this web platform. HTML, CSS and JavaScript are used in order to make changes among the cascading style sheets. Several cases may occur during the development process. 3D website can be created from starting point, or an existing two-dimensional website can be converted into three-dimensional web platform. In the first option a fully featured HTML website can be created [5]. From this point the method of adding three-dimensional effect to the web page is similar. Among the methods described in this paper, the anaglyph and side-by-side way are most appropriate in order to turn all elements in a web page into three-dimensional user experience. These two solutions are going to be used in the following project.

Anaglyph transformation .

The original HTML code has to be analysed, and also set the position of the elements for the web platform on the Z-axis (orthogonal side to the plane of the screen). The protrusion of different website elements has to be measured. Along the Z-axis, several discrete planes are distinguished. The planes extend from class="z-2" to class="z+3", among which the "z-2" and "z-1" sink compared to the plane of the screen, the "z-0" settles at the plane of the monitor and the remaining three planes are raising from the plane of the monitor screen. The main result is that titles with the largest font size are highlighted the most. An example can be given: `<h1 class="z+3">main title</ h1>`.

Next step in the development process is to double the original assemblage of the body content. The original collection is supplied by a left ID tag, indicating that visual components for the left eye are included. The copied content is supplied with the right ID tag as it shows the right-eye view. The diversity of the ID tags can be assured so that all right ID tags are augmented with a prefix of "right_". The HTML code conversion is finalized with these steps included in the development process.

The original cascading style sheets are copied and renamed, afterwards supplement with a "right_" prefix relevant to the IDs definition and with #right space definitions concerning classes. The "left" and "right" content is positioned exactly to overlap with each other in order to get the required result. The final goal is to turn the elements of the webpage to be visible for both eyes, thus the result is removing the background of the upper content. The offset is usually resolved with a "margin-left" CSS statement. A right amount of shift determines the distance from the plane of the monitor, while the direction of the offset decides whether the components of the website will sink behind or stand out from the plane of the monitor screen [6].

Style sheets also make definitions of colors. In a black and white website template the result is black letters on a white background. The color of the left content is replaced by cyan, as well as the right content is replaced by red color. In order for both colors to be visible simultaneously, opacity of the top layer's right content is reduced by half of the value.

Websites are usually not black and white. In this case, letter's colors are divided into red and cyan channels. The background of the website usually has a color. In this case, we also have to split the color of the background into color channels. If the background of the text is a picture, we have to take a sample from the direct environment of the letters and continue to work with it like a background color. Three-dimensional representation of pictures and text gives a special feeling, depth and a perfect emphasize on specific areas which is one of the important goals of the presented website.

Images are like a matrix, pixels can be found in all cells, to which it can be referred to by row and column number. Each pixel includes four pieces of information, three colour channels and alpha channel (RGBA). In case of pictures colour channels are used to exchange in order to create cyan and red pictures, then by offsetting the red pictures an anaglyph three-dimensional picture is received, which can be seen as three-dimensional by red-cyan colour-filtering glasses [7].

If two images are available which are photographed from different angles, for the left and right eye separately, then the cyan version can be used for the left-eye image and red version for the right-eye image.

Side by Side transformation .

This major part of the 3D conversion method is identical to the anaglyph transformation. Left and right contents are not placed on each other, rather placing next. Since left and right images do not overlap, there is no need to delete the background of the right section.

This web platform is also designed for 3D television which automatically detects two similar parts and combine them into three-dimensional experience. Nowadays a special feature of 3D television is the unification that pulls the screen apart to a full width experience. The offset, reviewed at the anaglyph conversion, is valid in this case as well. There is no need to replace the colour channels, the website keeps its original colours, because of the three-dimensional solution.

4 Automatic conversion

The result of the development process is a lightweight and fully responsive HTML5 web platform. The website has a modern online presence for handheld devices and desktops. It uses a JavaScript grid layout library. All of the home page posts fit on screen in all viewable sizes. There are also 3D hover effects on the home page concerning the main buttons. All sizing and styling of items is handled by cascading style sheets [8]. Item sizes can be set with percentages in order to set the responsive layout, as it can be seen in figure 1.

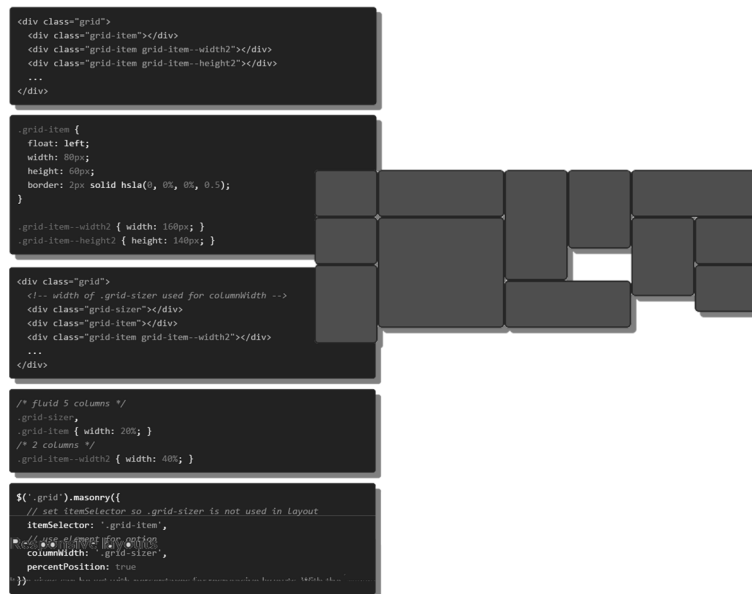


Fig. 1. Responsive JavaScript layout

The manual 3D conversion of a website takes long period of time, therefore an automated significant proportion of steps, in case of stereoscopic technology, needs to take place. The result is that the number of errors is minimized and the process is cost and time-effective. JavaScript technology was applied in the course of the automation process. This technique gives the overall interaction and a better user experience.

The original HTML code, with attributes like class="z-2", defining depth, is the only thing which is supplemented in a manual way. The rest of the process is made by jQuery functions which insure the automation and development process.

Body content is duplicated using left and right IDs, thus extending the original IDs in the right section with "right_" prefix, since an ID can occur only once in an HTML document. The offset is also solved by jQuery, compared to its original value. In order to achieve the desired depth and detail, the value of margins is increased or decreased. The automatic positioning of pictures is also taken into account.

When only one image is available, and 3D effect has to be added to the image, only the Z-axis position of the picture can be changed. If two images are available, as in a real life situation, when two images are seen simultaneously, the three-dimensional picture has a spatial effect.

With the use of jQuery functions, cyan and red colour channels of the images can be filtered. If only one picture is available, therefore this picture will be used twice [3]. When the conversion is not necessary, we can use an anaglyph image. On figure 2 a responsive website layout can be seen, visualizing the home web page of the museum of St Cyril and St Methodius University of Veliko Turnovo. The left hand side of the image shows a normal mode while the right section displays 3D effect on

the website. The red cyan glasses symbol is actually an interactive JavaScript button which toggles between 2D and 3D display mode for the web platform. 3D web page display mode is automatically selected when viewed on 3D television.

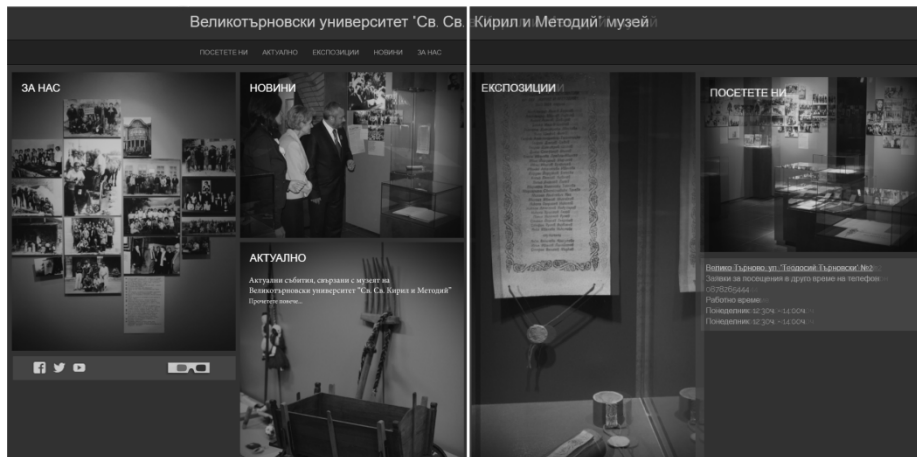


Fig. 2. Responsive website layout and 2D/3D display mode of the museum's web platform

A three-dimensional web page is created in which all three-dimensional techniques are melded. The user can really experience the application and usability of the described methods, implemented on the created website.

With the help of view changer buttons, the user can choose from a variety of three-dimensional representations. For example, if a user selects the anaglyph 3D view of the entire website, the web platform with all of its subpages changes into stereoscopic view.

5 Conclusion

3D visualization methods were examined and tested on 3D website environment. After testing all techniques, the stereoscopic technology seems to be the most promising and realistic, the technical benefit that gives the most in-depth and detail feeling. The visualizations are created as a three-dimensional image – picture of the website is captured, afterwards it is divided into colour channels. The final step is constructing accents and highlights concerning the overall web design.

Methods are also searched for more possibilities of 3D visualization compared to 2D websites upon which 3D side-by-side webpages on 3D devices can be viewed directly on display. The main result is a functioning 3D website, which is cost effective, useful and has user friendly interface. All the tools a user needs are a traditional 2D monitor display and red-cyan glasses, thus 3D webpages can be a widespread technology. Next main purpose is to improve automation techniques and undertake a

transformation for more 2D elements of the website into 3D user experience, and be more a part of the three-dimensional environment.

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