Study of 3D Technologies for Web

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Abstract. This paper presents solutions for objectives and presentation related to 3D technology exploration and three-dimensional web visualization, implementation of approaches for 3D reconstruction of museum exhibits, creation of models for three-dimensional imaging systems and geometric models of museum exhibits on web environment, development of web application for displaying three-dimensional images and geometric patterns of museum exhibits.

Keywords: 3D Technologies, 3D Visualization, 3D Website, Stereoscopy, Computer Graphics.

1 Introduction

Information system can be analysed on basis of common principles defining a dynamic and evolving environment. Synthesis and evaluation of a system are important components when using a systematic approach involving human interaction as a social mechanism. System architecture should integrate core components and principles of connectivity with other modules (Stanco, 2011).

Detailed classification of depth perceptions is defined. Various approaches and considerations have been accomplished when choosing technology for software solution implementation in order to create full-featured 3D visualization application.

CSS transformations do not incorporate functionality of rendering machines thus included in comparative technologies summary, associated with figure 1. Both O3D and Three.JS present content rendering option using WebGL. Only certain Java libraries and application programming interfaces have some of the features described. Unity3D is included in comparison as popular example of an interplanar solution used to develop video games for computers, consoles, mobile devices.

Scanning techniques use diverse approach for surface visualization. Since many detailed network surfaces are expensive for data processing and contain a lot of superfluous geometric information, an optimization phase should be established before project extension. An optimization algorithm can reduce number of triangular surfaces, while preserving overall object shape or other properties of network area.

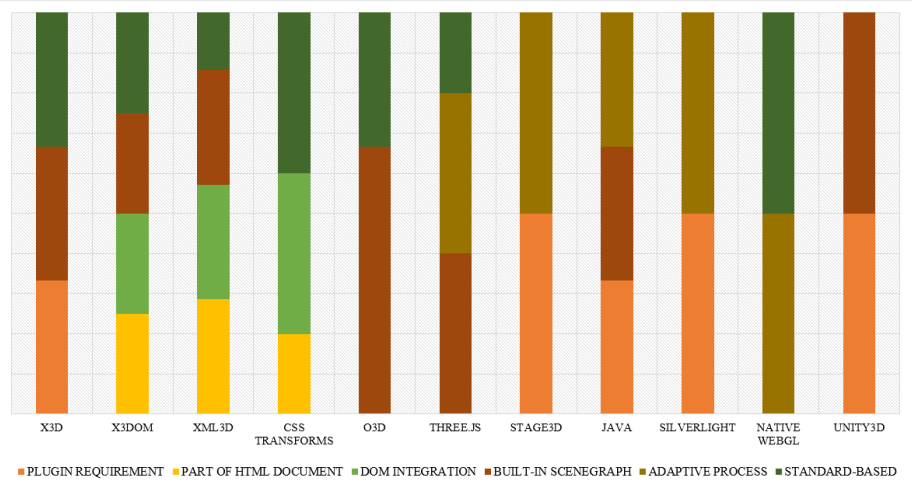

Fig. 1. Comparison of web-based 3D visualizations.

In order to achieve a detailed and accurate 3D presentation of museum exhibits, an advanced structured DAVID SLS-3 light scanning technology is used for assembling individual scans in a full-featured digitized 360-degree model.

2 Approaches for 3D Reconstruction of Museum Exhibits

Various methods have been explored regarding realization of a web-based infor-mation system for visualization of stereoscopic images and three-dimensional models of museum exhibits, ideas and approaches for three-dimensional presentation of images and geometric models on web, preservation of museum objects via digital approach, methods for digitizing 3D objects, processing, editing, storing museum exhibits like 3D images on web, 3D visualization in response to growing user expectations for creating virtual museums, including various methods and software applications for web visualization (Hristov, 2015).

Quality filtering module in DAVID 3D software implements functionality of removing inaccurate data in scanning process, representing probable edge-scanning and light-dark areas, with value of filter being changed for tracking result of model scanning, feature for recording colour texture, aligning each new layer with previous object scan.

Polylines can be used for geometric processes and applications, surface analysis and hardware rendering, as essential condition for achieving 3D real-time visualization, responding to high-level detail object and scene presentation. Three-dimensional models are widely used in various software applications related to virtual reality, CAD modeling, scientific simulations and e-commerce platforms. Mesh surfaces are particularly suited to modeling, due to algebraic optimization, for processing large portions of surfaces using graphical hardware - a critical issue, especially for end-users with limited network connectivity and technology storage capacity (Luebke, 2001).

3 Concepts of 3D Image Visualization Systems

Approach is proposed for complete 3D model interaction within a web browser since HTML 5 standard provides features of visualizing three-dimensional objects. Three.JS library is used in current project as an accessible 3D JavaScript library which renders 3D scene in 2D view: scene, camera, lighting. It provides three different components - Canvas, SVG and WebGL. Concept of information system architecture, illustrated in figure 2, has mobile functionality which supports progressive data loading and detailed object visualization (Hormann, 2008).

Main interface for verifying 3D models should provide as a minimum three processes - rotation, scaling and moving objects. Design of intuitive user interface should be according to certain principles in order for the visitor to assume functionality of created software application (Miller, 1992).

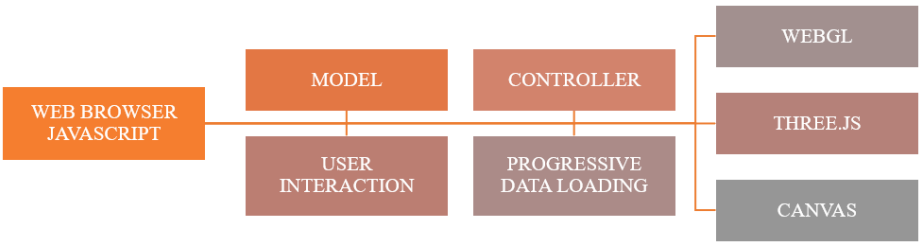

Fig. 2. Project scheme of information system architecture.

Java 3D application and programming interface present a wide range of 3D scene descriptions using graphical objects for elements - surfaces, transformations, materials, lights. Presented software solution includes integrated support for 3D input devices and spatial sound rendering. By combining above elements into a single application programming interface, Java 3D introduces design unification focusing on 3D content description and OpenGL, providing point, line and triangle representation interface.
Decision for choosing between HTML technology standard, such as Canvas and SVG, should also be evaluated according to project objectives, range of data, interactivity, animation support, DOM API control, separation independence for different devices (Xiaodong, 2002).

Canvas is pixel-based technology and performance should not be affected after rendering unless increasing graphics resolution. Another technology advantage is presence of repetitive elements, which makes copying and reuse of elements a possible option due to increasing overall productivity. When using Canvas, modularity related to interactivity of elements is not applicable. Depending on project, SVG and Canvas are possible preferences through functionalities of both technologies. Another standard for creating graphics, WebGL, is mainly used for 3D effects, but in 2D version: with optimized workflows. Modification of Document Object Model, in combination with JavaScript framework such as AngularJS, is a practical approach for im-plementing projects of similar nature (Remondino, 2014).

Virtual museums can be grouped into two categories based on mutual data content:

- platforms displaying non-digitalized works of art, mainly distributing museum collections via web portals, which present updates for temporary exposures, educational activities, location, schedule and cost information, ranging from digital version of a museum brochure to technology infrastructure that allows visitors to virtually explore museum space;
- platforms displaying digitalized works of art in a non-material environment, cyberspace, including specific technological and aesthetic features.

Virtual museums offer a way to culture access not only for users visiting museums or cultural centres located in other cities but also for people with disabilities experiencing difficulties in museum sites access. Thus, virtual museums are also a medium of social integration (Di Benedetto, 2014).

4 Software Applications for Displaying 3D Models on Web

In various cases, it is advisable to have a digital representation for 3D object surface which includes a list of spatial coordinates of vertices for connected network of numerous and relatively small in size triangles. Three-dimensional object visualization platform has been created that complies with requirements such as intuitiveness when using website, detailed 3D model of museum artefacts, in terms of shape, texture and resolution. Various 3D representations of museum exhibits are available:

- visualization of 3D museum exhibits using Three.JS JavaScript library and accelerated 3D animations without installing additional plugins;
- integration of 3D museum exhibits using X3D standard for describing 3D image sequences, extension, supporting multi-layer, lighting and real-time architecture rendering;
- stereoscopic visualization, using Java applet, J3D-VRML97 and 3DS Java3D Loader, related to geometric models and loading 3DS, OBJ and WRL file formats;
- visualization of anaglyphic images containing two differently filtered, chromatically opposite, red and cyan images, combined for a complete perception of three-dimensional scene and composition.

Model is designed for use with multimedia devices and screen projectors. This approach optimizes transition from screen-oriented to project-based model, where stereo rendering presents high level of detail and realism with object visualization.

One of project objectives is testing different software libraries used to visualize web application data, platform workflow optimization based on test results, data visualization as information control method. Most of software libraries used for various tests are suitable for realizing projects similar to assigned propositions (Brutzman, 2007).

Complete 3D visualization of cup model is illustrated in figure 3, with X3D standard for declarative representation of 3D computer graphics, a possibility for functional movement of object and detailed introduction with specifics of museum exhibit. Output file facilitates processes concerning short period for loading museum exhibit data and

integrating model and texture in a common file structure. This approach preserves all details and interactivity for 3D web visualization without installing additional applications and plugins. The functionalities represent 3D visualization of a model with optimal interactivity, detail and user experience (Behr, 2009).

Fig. 3. 3D visualization of cup model.

With X3DOM and Three.JS standards, two extensive ways for 3D content web integration are available. Nevertheless, these technologies differ significantly how 3D data visualization is applied. Choosing software application depends on specific objectives and presentation. X3DOM provides fast and sufficient results, making it a practical choice for integrating 3D content into an HTML page. Three.JS library presents a wide range of technological settings, options for customizing and visualizing 3D scene through DOM element. Compared to featured 3D visualizations, X3D delivers optimal performance in regards to compressed binary and JSON surface coding, three-dimensional image modeling architecture (Walters, 2010).

5 Conclusions

Detailed study has been presented, including overview, defining various statements, exploring 3D object visualization. Methodology has been developed which describes process of creating three-dimensional models using 3D graphics systems and specialized hardware, approaches for 3D object web visualization, models of web-based systems, software applications and implementation methods, mesh surface modification and optimization, concept models of virtual environments (Wünsche, 1998).

Web-based information system for three-dimensional visualization of models at the museum of St. Cyril and St. Methodius University, Veliko Turnovo, Bulgaria, is developed. Detailed analysis, testing, anaglyphic, stereoscopic, X3D and Three.JS visualization of museum exhibits and modules are accomplished.

Applications of three-dimensional models are practical in all spheres of life. Creation of 3D web models is becoming a necessity for high level detail presentation, related to technology development, use of graphic software libraries, standards, algorithms, introducing major part of exploration in this study.

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