Computer Standards & Interfaces 50 (2017) 65–75

Contents lists available at ScienceDirect

Computer Standards & Interfaces

journal homepage: www.elsevier.com/locate/csi

CSS3 extensions for setting web content in a 3D view volume and its stereoscopic 3D display

Soon-Bum Lim, Hee-Jin Lee, Wen-Yan Jin, Seung-Min Shim *

Dept. of Multimedia Science, Sookmyung Women's University, Cheongpa-ro 47-gil 100, Yongsan-gu, Seoul 04310, Republic of Korea

ARTICLE INFO

Article history:
Received 10 September 2015
Received in revised form 30 April 2016
Accepted 5 June 2016
Available online 7 June 2016

Keywords:
Web contents
3D
View-volume setting
Stereoscopic
Preprocessor
HTML5
CSS3

ABSTRACT

Over recent years, the development of electronic devices such as mobile devices and smart TVs has been remarkable; meanwhile, the emergence of 3D TV has given rise to a rapid increase of the demand for 3D expressions. The objective of this study is the use of a CSS stylesheet for the reconstruction of the web content that is typically expressed in formats like HTML into 3D space. To this end, the basic information that is required for the defining of the 3D graphics of 3D space must first be identified, and the remaining information that cannot be covered by the genuine CSS3 specifications can be set in the view volume through the extension of the 3D-viewpoint and 3D-view-volume specifications; therefore, the specifications were extended so that the contents of the 3D view volumes can be placed at any user-selected location. A preprocessor that can convert the genuine specifications into the extended specifications could then be implemented using the javascript, enabling a viewing of the extended-specifications contents on the current browser. A rendering-engine emulator was also implemented for the checking of the demonstration results and for the evaluation of the stereoscopic-display expression that is one of the various 3D-content-application fields. If the extended CSS3 specifications that are proposed by this study become the W3C standards, the 3D expression of web content will become more unconstrained and more convenient.

1. Introduction

Thanks to phenomenal technology advances over recent years, 3D-related studies are being actively carried out in a variety of fields including 3D video/imaging, 3D display, and 3D printing. The ongoing emergence of 3D TV, HMD etc. is especially significant, and is accompanied by an increasing number of studies regarding the way that additionally-provided data is expressed with browser-based declarative contents. Languages like XML, HTML, and CSS are often used as browser-based declarative contents that can be described independently of the platform and regardless of the device type if the Web standard is used.

HTML5 and CSS3 are browser-based and declarative-content technologies that are the most visually arresting; in particular, CSS supports various profiles in consideration of different device environments. For example, the CSS TV Profile is defined in consideration of the operational requirements and the limitations of TV devices, and it is used for the expression of browser-based TV content. The current CSS TV-profile specifications were, however, defined before the emergence of CSS3, so the 3D-space concept was not included; also, the HTML5- and CSS-related specifications that have been or are being developed do not contain contents that can be projected in 3D space and expressed as a stereoscopic 3D image. Therefore, the research to express the received contents, including not only the declarative contents but also web contents from TV, HMD and various 3D devices and express them into 3D stereoscopic by placing them on the 3D space is required.

Given the existing gaps, the genuine CSS3 specifications were extended in previous studies for the defining of the 3D space, whereby the projection of HTML5 contents in 3D space offers a way to express the contents in a stereoscopic-3D-display Web environment. An emulator for a stereo-projection mode was also implemented along with these studies, followed by an evaluation of the demonstration results.

The following limitations, however, hamper the results of the previous studies: An in-depth study regarding the extended view-volume specifications was not conducted, and a verification of the preprocessors and emulators was not sufficiently completed. This study therefore extended the CSS3 specifications with a focus on the view-volume setting and implemented a preprocessor and an emulator, so that analysis results that compensate for the shortcomings of the previous studies could be produced. The specific goals of the present study are as follows:

- Design of CSS3 specifications: The extended CSS3 specifications that are necessary to set the view volumes were proposed so that users could freely define the 3D space. Also, the properties that are used

* Corresponding author.
E-mail address: undervine@naver.com (S.-M. Shim).

http://dx.doi.org/10.1016/j.csi.2016.06.001
0920-5489/

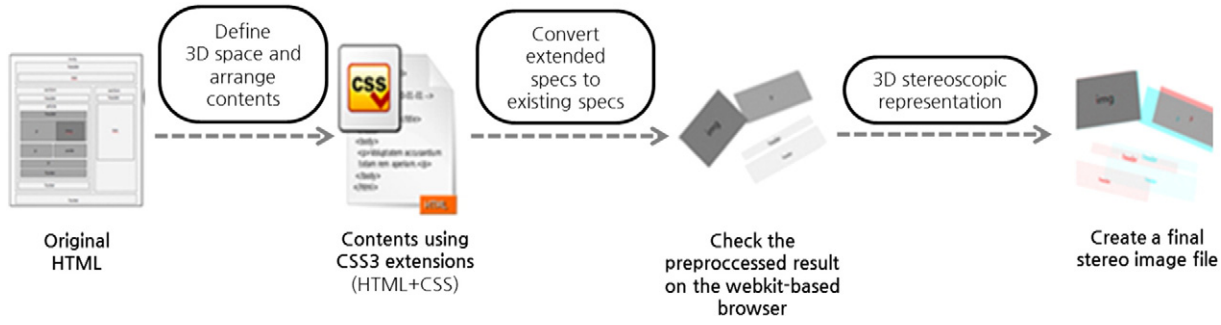

Fig. 1. Research objective.

Fig. 2. Integration of hypertext and 3D-data information.

for the placement of the contents in the view volume and the expression of the contents in the stereo mode are suggested.

- Implementation of preprocessor and analysis of execution results: The preprocessor was implemented to translate the extended properties into the genuine properties, making them visible on the current browser. The sample contents were written and used to evaluate the accuracy of the preprocessor-execution results.
- Implementation of emulator and analysis of execution results: When the projection mode was set as "stereo," the rendering-engine emulator was implemented for the checking of stereoscopic images. Also, to verify the system, users were shown stereo images that were displayed on a 3D TV for the evaluation of the execution results (Fig. 1).

2. Related research works

Although a variety of 3D graphic-file formats such as VRML and X3D are currently available, they are not fully utilized due to a lack of 3D interaction-related technology for hypertext-based web interfaces. To solve this problem, Jankowski and Decker [1] introduced a 3D dual-mode user interface that enables users to switch from hypertext to graphic data, and vice versa; here, users can choose one of two interface modes, and Fig. 2 shows that the dual-mode user interface allows the same information to be expressed in two modes.

Next, declarative languages such as X3DOM and XML3D, which use major web technologies including HTML, CSS, and Javascript to describe interactive 3D content, are used to mix 3D-scene definitions and standard HTML markup so that 3D content becomes part of the document object model (DOM); however, both XML3D and X3DOM support CSS only in a 3D-transformation module. But, without the support of full

```
#camera {
    camera-model: url("urn:camera:perspective");
    --vfov: 61deg;
    --clip-planes: 0.1 auto;
}
```

Fig. 3. Using CSS for the defining of a camera.

Fig. 4. Web page for stereoscopic 3D-TV GUI for which HTML-S3D, CSS-S3D, and JavaScript-S3D are used.