Using the X3D Language for Adaptive Manipulation of 3D Web Content

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Abstract. Web sites that include 3D content, i.e. Web sites where users navigate and interact (at least partially) through a 3D graphical interface, are increasingly employed in different domains, such as tutoring and training, tourism, e-commerce and scientific visualization. However, while a substantial body of literature and software tools is available about making 2D Web sites adaptive, very little has been published on the problem of personalizing 3D Web content and interaction. In this paper, we describe how we are exploiting a recently proposed 3D Web technology, i.e. the X3D (eXtensible 3D) language, for adaptive manipulation of 3D Web content.

1 Introduction and Motivation

Recent advances in graphics computing power and network bandwidth have made it possible to increasingly employ 3D Web content in different domains, such as e-commerce, tutoring and training, tourism, scientific visualization, and entertainment. However, while a substantial body of literature and software tools is available about making 2D Web sites adaptive, very little has been published on the problem of personalizing 3D Web content, navigation and presentation.

As pointed out by [1], 2D Web sites are mainly a collection of connected information items that allows users to navigate from one item to another by simply selecting the desired one from a set of links. With 3D Web content, the situation is more complex. Content (3D models, images, text, audio, …) is organized in a 3D space, following a possibly complex spatial arrangement (e.g., the 3D model of a building or an entire city in tourism-related sites). The user navigates through 3D space by continuously controlling the position of her viewpoint (assuming, as in most cases, a first-person perspective) through mouse, or arrow-keys, or 3D pointing devices (when available). Moreover, users of 3D virtual environments do not only navigate and look at, but point, click or drag 3D objects (e.g., to activate some object behavior, such as opening a door). As a consequence, the space of possible adaptations in the case of 3D is more complex than in 2D Web sites, and largely unexplored. Consider, for example, the problem of adaptive content presentation: while in 2D Web sites one possibly prioritizes and then juxtaposes the (adapted) information fragments, with 3D Web content one would need also to properly arrange the content in 3D space (e.g., objects need not to overlap, must be adequately seen, free space must be enough for the user to navigate, …).

One possible strategy to introduce adaptivity in the 3D context could be to re-formulate or extend adaptation techniques and tools developed in the AH field, as suggested by Brusilovsky [2]; for example, Hughes et al. [1] have developed methods for personalized navigation support in 3D virtual environments by re-formulating well-known AH adaptive navigation support techniques. However, using current AH techniques and tools for the 3D case is not straightforward. While some of the obstacles are related to the intrinsic features of 3D content (e.g., users' navigation and interaction is more complex), others arise from the fact that the languages for representing 3D content (the most common of which is currently VRML, the Virtual Reality Modeling Language) are very different from HTML.

These obstacles force one to develop 3D-specific methods and tools. For example, in [3,4] we have proposed an architecture for delivering adaptive 3D Web content, called AWe3D (Adaptive Web3D), and applied it to an e-commerce context. The AWe3D architecture, while successful for experimenting with adaptivity of 3D Web content, suffers from two limitations: (i) it only deals with the personalization of 3D content written in the VRML language (and does not take into account other types of content); (ii) it is not easy to integrate existing AH technologies and tools.

Recently, a novel 3D Web technology, i.e. the X3D language [5] has been proposed (and submitted to ISO) by the Web3D Consortium as a replacement of the VRML language. One of the main differences between X3D and VRML is the definition of an XML encoding for the language. This feature opens the way for easier integration of 3D content with other Web content, technologies, and tools, including adaptive ones. As an example, in this paper we describe how we are exploiting the X3D language for implementing, in the context of 3D Web content, some well-known AH techniques, i.e., adaptive manipulation (insertion, removal, choice, alteration) of information fragments. Furthermore, the proposed method works with any XML-based language, making it suitable also for other media, e.g. text (XHTML), images (SVG) and multimedia (SMIL).

2 Exploiting the X3D language for Adaptive Manipulation of 3D Web content

Adaptive manipulation (e.g., insertion, removal, choice) of (textual) fragments is a well-known technique used in AH systems. For example, the AHA! architecture [6] implements it with *adaptive objects inclusion*, i.e., by using special XHTML `<object>` tags where adaptive content is to be inserted, and letting the adaptation engine select the proper content on the basis of the user model and adaptation rules. This solution has some nice properties: (i) it makes the enclosing file a regular XHTML file, which can be viewed without the adaptive engine, and (ii) if a fragment is needed in different places, it can be stored just once and conditionally included where and whenever needed.

However, this technique is not well suited to the case of X3D, since the language does not include the `<object>` tag (or a similar element): thus, using it would make a

X3D file impossible to both validate and display/edit with visual authoring tools (note that authoring 3D content writing code is hard). Moreover, the adaptive object inclusion technique works at the level of entire XHTML files, and does not allow one to manipulate *only* specific elements or attribute values; note that many useful properties of X3D content (e.g., position, color and texture of 3D objects) can be altered by simply changing the values of some XML attributes. Furthermore, adaptive object inclusion does not allow removal of content.

To take into account these concerns, our solution to adaptive manipulation of X3D fragments is based on associating with a X3D file (whose content has to be adapted) a *Content Personalization Specification (CPS),* in the form of a separate XML document composed by a list of `adaptiveContent` elements. Each `adaptiveContent` element specifies that a specific fragment (element or attribute) in the corresponding X3D file will depend on the user model and adaptation rules.

We will explain the mechanism in detail by using the following example: consider an adaptive 3D store in which, according to the user's shopping interests: (i) the level of exposure of each product should vary (e.g. each product should become more/less visible by varying the size of its 3D model); (ii) some products should be removed, while other added (e.g., personalized special offers). A simplified version of the X3D file of the 3D store could be as follows:

```
<X3D>
  <head> … </head>
  <Scene>
        <Transform DEF="prod_1" translation="…">
          <Shape>…</Shape>
        </Transform>
        <Transform DEF="prod_2" translation="…">
          <Shape>…</Shape>
        </Transform>
        …
  <Scene>
</X3D>
```

where each `Transform` element defines the position of a product in the 3D store, and the enclosed `Shape` element defines its 3D model. The following CPS defines the required adaptive manipulation of content:

```
<CPS>
<adaptiveContent DEF="prod_1" name="specialOffer_1"/>
<adaptiveContent DEF="prod_2" attribute="scale" name="prod_2.size"/>
…
</CPS>
```

The first `adaptiveContent` element specifies that the element in the X3D file whose `DEF` attribute is equal to `prod_1` (`DEF` works in X3D as the `id` attribute in the XHTML language) must be substituted with content derived by the adaptation engine (including the possibility of no content, which enables adaptive removal of fragments, or content composed by multiple elements, which enables adaptive insertion of fragments); The second `adaptiveContent` element specifies that, in the element of the X3D file whose `DEF` attribute is equal to `prod_2`, the attribute `scale` (which controls the size of a 3D object) must take a value provided by the adaptation engine. The `name` attribute is a reference to a specific part of the user model.

When a X3D file is requested, by means of XSL transformations, we first translate the `adaptiveContent` elements into queries to adaptation engine, and then insert the returned fragments into the proper positions in the X3D file.

Since the proposed method does not rely on specific features of the X3D language, it may be also used with other XML-based languages (such as XHTML, SVG and SMIL).

5 Conclusions

The proposed method, besides extending our AWe3D architecture to the adaptation of non-3D content, allows one to integrate 3D content into existing AH architectures. As a proof of concept, we are currently developing an adaptive tutoring Web application (which uses 3D content) using the AHA! architecture. This will allow us also to more easily investigate the effectiveness of other AH methods and techniques in the context of 3D content.

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References

1. Hughes, S., Brusilovsky, P., and Lewis, M.: Adaptive navigation support in 3D e-commerce activities. In: Proceedings of Workshop on Recommendation and Personalization in eCommerce at AH 2002 (2002) 132-139.
2. Brusilovsky, P., and Maybury M. T.: From Adaptive HyperMedia to the Adaptive Web. Communications of the ACM **45** 5 (2002) 31-33.
3. Chittaro L., Ranon R.: Adding Adaptive Features to Virtual Reality Interfaces for E-Commerce. In: Proceedings of AH-2000: International Conference on Adaptive Hypermedia and Adaptive Web-based Systems, Lecture Notes in Computer Science 1892, Springer-Verlag, (2000) 86-97.
4. Chittaro L., Ranon R.: Dynamic Generation of Personalized VRML Content: a General Approach and its Application to 3D E-Commerce. In: Proceedings of Web3D 2002: 7th International Conference on 3D Web Technology, ACM Press, New York (2002) 145-154.
5. Extensible 3D (X3D) International Draft Standards, ISO/IEC FDIS 19775:200x http://www.web3d.org/x3d/specifications/index.html
6. De Bra, P., Aerts, A., Berden, B., De Lange, B., Rousseau, B., Santic, T., Smits, D., Stash, N.: AHA! The Adaptive Hypermedia Architecture. In: Proceedings of the ACM Hypertext Conference, ACM Press, New York (2003) 81-84.