Virtual Museum Exhibitions

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Virtual exhibitions let visitors interact with numerous artifacts cost-effectively.

Museums around the world hold countless artifacts that they cannot exhibit to the public due to limited space, the items' fragility, or the prohibitive cost of creating and managing appropriate displays. Traveling exhibitions or those that draw on multiple collections are even more problematic because of the expenses associated with transporting and insuring priceless objects, along with museums' reluctance to part with certain treasures. Yet such exhibitions typically have the widest appeal and generate the most revenue.

Virtual reality (VR) and augmented reality (AR) technologies offer an ideal presentation medium for museums and other cultural heritage institutions. Virtual exhibitions enable different audiences, including the disabled and students of all ages, as well as the general public to access and interact with vast numbers of objects scattered among various localities in an engaging and informative way.

However, in adopting VR/AR technologies, museums have trouble

- efficiently creating 3D models of artifacts, and
- building virtual exhibitions based on these models.

In recent years, 3D model creation has become faster, easier to use, and more affordable. Museums will soon be able to purchase and operate high-quality 3D scanners. However, they will also require efficient, cost-effective, and simple methods of creating VR/AR exhibitions based on existing collections of 3D models that curators and other museum staff without IT expertise can set up.

In addition, virtual exhibitions must provide museum visitors with an intuitive human-computer interface based on well-known metaphors. Users should be able to interact with digital contents as easily and naturally as they can with real-world objects.

ARCO

To address these issues, the Augmented Representation of Cultural Objects project (www.arco-web.org) has developed technology for creating and managing virtual museum exhibitions for use on the Web and in local interactive kiosk displays. ARCO provides a complete solution that lets museums decide which objects to present, and how and where. Exhibition designers can easily change a collection's contents and the mode of presentation to suit a target audience.

With ARCO's simple-to-use authoring tools, exhibition designers can set up virtual exhibitions in just minutes both inside museums—for example, on touch-screen gallery displays—and on the Internet. The system's VR/AR technologies extend standard Web presentations and allow visitors to interact with digital models of cultural objects in an intuitive and exciting manner.

Architecture

The ARCO system consists of three main architectural components: content production, content management, and content visualization.

Content production includes all of the tools and techniques used to create digital representations of museum artifacts. Each of these *cultural objects* is represented as a set of *media objects*—including images, 3D VRML/X3D models, QuickTime virtual reality movies, descriptions, and sounds—and associated metadata.

All cultural objects are stored in a database. Users design interactive virtual exhibitions by creating *exhibition spaces* and assigning cultural objects and *presentation templates* to those spaces. Users can also convert data from the ARCO database into XML format to move cultural objects between databases or to set up prearranged exhibitions.

Virtual exhibitions can be visualized as standard Web contents or Web-based VR/AR presentations displayed in an integrated end-user interface. Visitors can use the former to simply search and browse the database contents and the latter to examine and manipulate virtual reconstructions of selected objects in 3D environments.

Interface

Figure 1 illustrates both uses of the ARCO interface. The image on the left shows an embedded Web browser
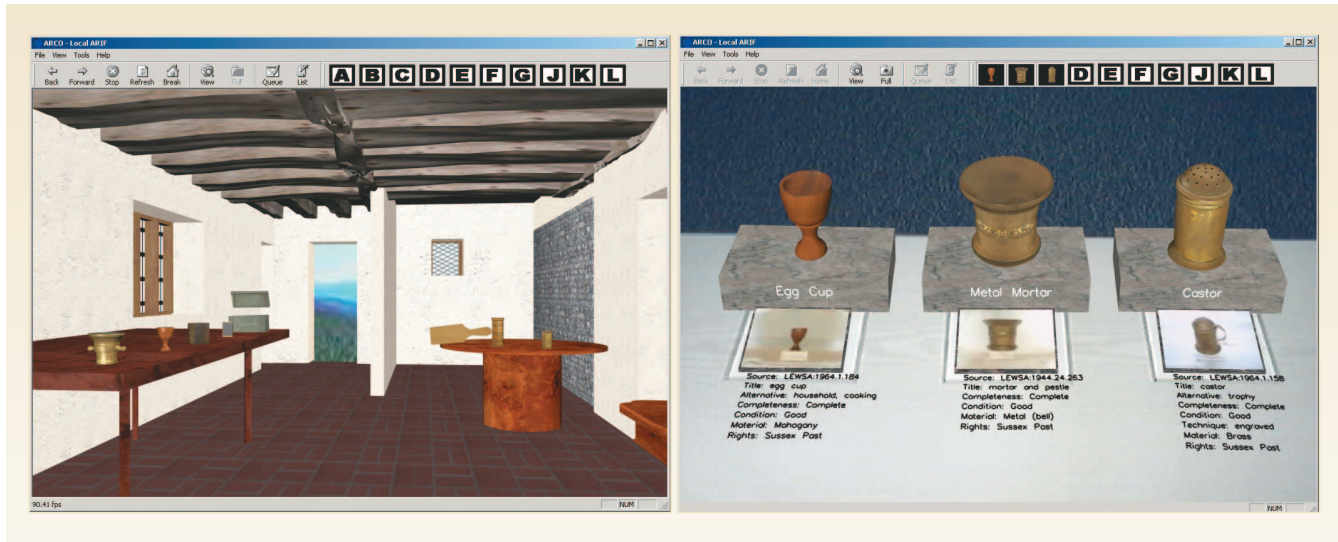
Figure 1. ARCO interface. Virtual exhibitions can be visualized as 2D/3D Web content (left) or AR representations (right).
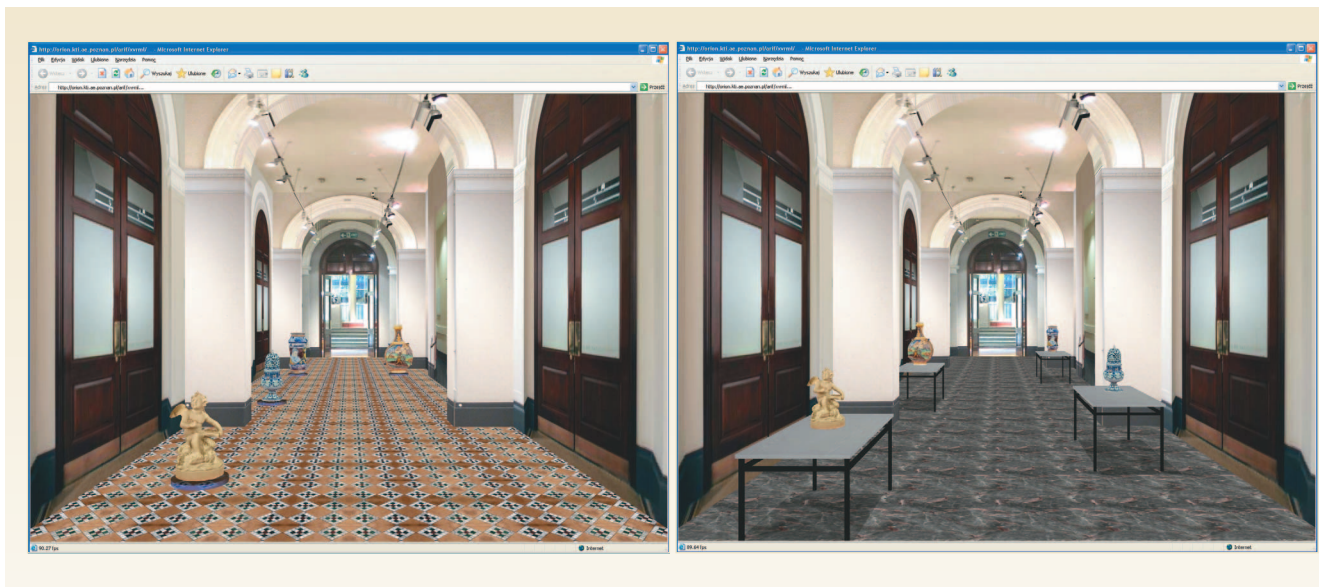

Figure 2. Web browser displaying virtual exhibition with different parameter values.

equipped with a VRML/X3D plug-in for visualizing 2D and 3D multimedia contents. The image on the right shows the interface switched to display the same contents in an AR mode that superimposes virtual objects on live video feeds of real places—in this case, tabletops.

The ARCO system dynamically generates VR/AR presentations based on the database contents—the exhibition spaces, presentation templates, and cultural object models. Different templates enable alternative presentations of the same content. Users can also create different instances of the same template and supply them with different sets of parameter values, as Figure 2 shows. These parameters make it possible to customize visual and interaction elements to particular users or generate them in response to user queries.

Templates

The ARCO system uses X-VRML (xvrml.kti.ae.poznan.pl) to create parameterized templates of virtual exhibitions. This high-level XML-based language is designed to let developers build parameterized mod- els of virtual scenes for VR applications; the application dynamically generates instances of those scenes based on the models, data retrieved from a database, current model parameters, user input, and user privileges or preferences.

In ARCO, the X-VRML templates define both visual and behavioral aspects of virtual exhibitions. The system performs the visualization using virtual scene description standards such as VRML and X3D; for the behavioral aspects, it uses high-level XML scripts.

Presentation templates separate the design of complex interactive virtual scenes from the creation of actual exhibitions, enabling museum staff to compose and modify exhibitions using a simple 2D application. All the necessary visualization and interaction rules are encoded in the templates. An exhibition designer needs only collect the object models from the database and set their visualization and interaction parameters.

DESIGNING VIRTUAL EXHIBITIONS

The structure of virtual exhibitions is based on the hierarchy of exhibition spaces stored in the database.

Exhibition spaces

Exhibition spaces are conceptually similar to folders and can contain three types of elements.

A *presentation template instance* is a template supplied with actual values for some of its formal parameters. A single template can have an arbitrary number of instances in different exhibition spaces; this facilitates design flexibility because different template instances, which imply different visualization and interaction parameters, can be set for every exhibition space.

A *cultural object instance* is a cultural object together with object presentation parameter values. Again, the same object might have instances in more than one exhibition space.

A *cultural object selection rule* is a search statement that retrieves from the database all objects that meet criteria defined in the rule. The selection occurs when a user accesses the exhibition space, which enables construction of up-to-date virtual exhibitions. Exhibition designers assign common parameters—not related to any particular presentation mode or contents—to exhibition spaces.

Parameters

An exhibition designer provides the template parameters and cultural object parameters while setting up an exhibition. When a museum visitor enters an exhibition space, the system displays all cultural object instances assigned to the space or retrieved by a cultural object selection rule.

If some required template instance parameters are not preset by the exhibition designer, the visitor must input those values—typically as search criteria—before the system can visualize the space. If all required parameters are preset, the system visualizes the space immediately. In some cases, the visitor can change some of the parameters, such as object selection criteria.

This flexible assignment of parameter values to template instances makes it possible to easily combine search interfaces, customizable browsing interfaces, and fixed exhibitions.

> **The system uses the appropriate template instance to dynamically visualize the contents.**

Presentation domains

The ARCO system can display the same exhibition space differently in different environments—local Web, remote Web, AR scene, and so on—via different presentation templates. Each presentation template is associated with a list of allowed *presentation domains*, but each template instance corresponds to a single domain. An exhibition designer can create multiple template instances for different domains in an exhibition space, but at most there is one instance for each domain.

While accessing an exhibition, the browser specifies which domain to use. The system then uses the appropriate template instance to dynamically visualize the contents.

Template instance inheritance

To expedite exhibition design and ensure consistent visual and behavioral presentation of objects in the exhibition spaces hierarchy, the ARCO system incorporates template instance inheritance. If an exhibition space does not contain its own template instance in the indicated presentation domain, the system uses the instance in its parent space by default (recursively).

This solution enables use of a single template instance for a given presentation domain in the entire tree of spaces in the exhibition hierarchy, which facilitates consistent presentation of large exhibitions. For example, the museum designer can use a different template instance for each augmented reality exhibition and—at the same time—a single template instance for Web-based navigation to "brand" the entire museum itself.

U sing ARCO, museums can build interactive learning and entertainment scenarios that can transform visitors from passive viewers and readers into active actors and players. Curators can easily prepare customized scenarios suitable for use in a classroom or home environment as well as in the museum. Because ARCO uses inexpensive hardware and software, even small institutions with limited financial resources can afford the system and exploit the tremendous benefits of virtual and augmented reality. ■

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