Development for Archiving and Viewing Cultural Artifacts in 3D Using WebGL

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Abstract

This paper proposes the prototype of a system for archiving and viewing cultural artifacts using WebGL technology. The 3D Museum Thailand Project is a digital museum for archiving 3D cultural objects in Thailand. The project employs metadata technologies for modeling cultural artifacts and the digitization process in digital archive museums. In essence, researchers develop a data model based on notable metadata standards that can annotate all museum content management processes including 3D object digitization, model refinement, metadata description, search, and visualization. Integration of digital objects among different museums in a network is also supported. Thus, users (both cultural content experts and public entities) can seamlessly create a virtual, customized high quality 3D cultural object collection to meet their interests.

Keywords-component; digital museums, cultural artifacts, webGL

I. Introduction

For the situation of cultural heritage areas in Thailand, there are now many cultural sources including national and local museums as well as art galleries spreading around the country. In order to promote, enable, and share cultural heritage collections by using ICT technology, a system for archiving cultural information and integrating 3D digital object collections among various museums in a network is highly demanded and this research aims to fill this need. 3D Museum Thailand Project is a digital museum for archiving 3D cultural artifacts in Thailand. The project currently hosts three pilot sites in Chiang Mai National Museum, Hariphunchai Nation Museum, and Chiang Saen National Museum, Thailand.
Fig. 1 illustrates an overview of the proposed archived system to support the 3D model digitization, storage, and metadata

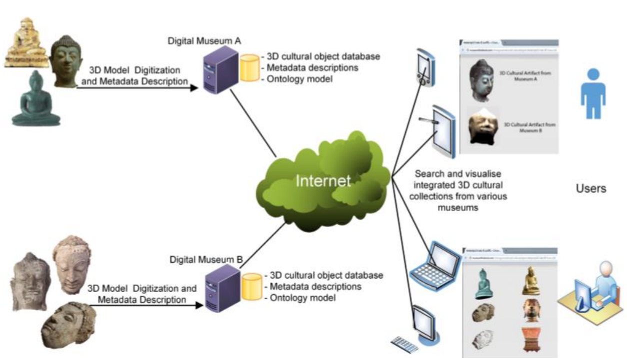


Fig. 1 The proposed digital archive museum system for preserving, searching, and visualizing 3D cultural collections.

description of each cultural artifact. The database maintained by each digital museum thus comprises 3D digital objects and metadata descriptions conforming to the developed data model to be able to exchange metadata across various museums. Therefore, a user is able to visualize, search, and integrate high quality 3D digital contents from several museums to match user's interest using web browsers or mobile applications. For instance, consider a user who is interested in Buddha images in Thailand with Lanna Arts Style; (s)he can simply use a web browser to visualize such a digital collection that automatically and seamlessly integrate cultural objects together with the associated metadata descriptions from many museums in the network without manually visiting each digital museum one by one. The project employs metadata technologies for modeling cultural artifacts and the digitization process in digital museums. In essence, researchers reuse an metadata model based on notable museum metadata standards that can annotate all of the museum content management processes including 3D object digitization, model refinement, metadata description, search, and visualization. Thus, users (both cultural content experts and public entities) can seamlessly create virtual museums, and customized high quality 3D cultural object collections to meet their interests.

II. Reviews related works

This section reviews notable projects in the cultural heritage domain that relate to this project. Augmented Representation of Cultural Objects (ARCO) project has developed technology to create, manipulate, manage, and present digitized cultural objects in virtual exhibitions to be accessible for people to access information both inside and outside museums. The ARCO system consists of three main architectural components: content production, content management, and visualization [1]. MuseumFinland project has developed a semantic Web portal, which contains an inter-museum exhibition of over 4,000 cultural artifacts, such as textiles, pieces of furniture, and tools. In addition, metadata concerning around 260 historical sites in Finland were incorporated into the system [2]. Science and Technology in Archaeology Research Centre (STARC) project has developed the metadata schema for the documentation of archaeological assets. The goal of the project is to enable data interoperability and access to the digital resources stored in the local repository. Its structure allows retrieving models, activities, decision, and answers the research question on how data can be used for data interpretation. The datasets stored in STARC repository refer to 2D and 3D archaeological data as museum objects [3]. 3DSA project has been created under the cultural heritage institutions with an aim to develop simple, semantic annotation services for 3D digital objects that can facilitate the discovery, capture, inference, and exchange of valuable cultural heritage knowledge. The focus is annotations of 3D models for efficient indexing, search, and retrieval of 3D artifacts from large-scale museum digital libraries [4].

III. Proposed System Architecture

Fig. 2 illustrates the architecture of the Museum Thailand system which extends from the ARCO system architecture [5].

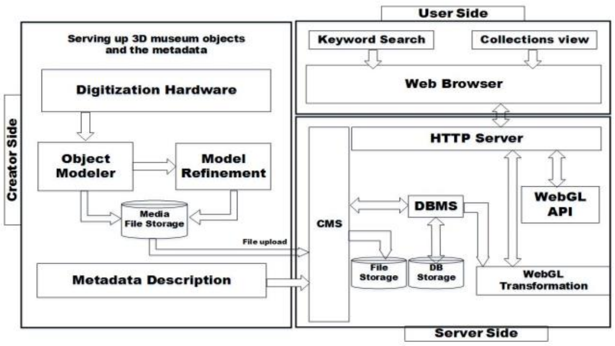


Fig. 2 Major components of the 3D Museum Thailand system.

It is divided into three conceptual areas according to the interaction of the user with the data. The creator side, which is responsible for creation of the multimedia content. The server side that is responsible for both storing the multimedia representations and associated metadata as well as preparing dynamic presentations to be displayed on the user side.

Fig. 3 presents this research proposed data model for archive the digital cultural artifacts, digitization process, 2D, and 3D

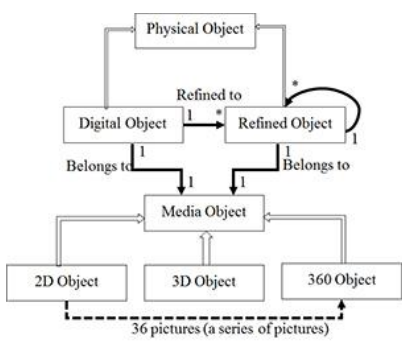


Fig. 3 The proposed data model for digital museums.

models in digital museums, which comprises various related classes. It also enumerates metadata elements (aka. properties) used for annotating each object in the data. Such metadata elements are customized and extended from the important standards (DCMI: Dublin Core Metadata Initiative [6], SPECTRUM: The UK Museum Collections Management Standard [7], VRA: Visual Resources Association Core [8], SEPIADES: SEPIA Data Element Set [9]) based on the requirements captured from cultural heritage experts, curators, museums, and general users under the 3D Museum Thailand Project. A Physical Object represents and describes a real-world cultural artifact created by a Person (aka. creator or artist). A Digital Object is a digital surrogate of (aka. a digitization of) a particular Physical Object, and is digitized by a Person (aka. a modeler). Each Digital Object has an associated Media File for visualization on a client machine which can be further classified into 3D Media File, 2D Media File or 360 Degree Media File, each with different MIME types. A 360 Degree Media File is a series of 36 2D Media Files with 10 degree of separation rotating in a horizontal or vertical plane. This technique can provide faster data transfer time when compared to a general 3D Media File. In addition, a Digital Object can be further refined for quality improvement, format changes, etc. For example, a museum curator may refine a certain Digital Object by adding a 3D Model or Description.

IV. Implementation and Evaluation

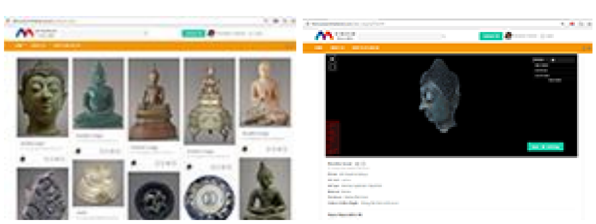
A. Implementation

Under the 3D Museum Thailand Project, a prototype system has been implemented on top of the PHP framwork, MySQL DBMS, HTML5, XML, and WebGL Middle API (Three.js). Refer to the system architecture in Fig. 2 which divides the system into three conceptual areas according to the interaction of the user with the data. (1) The Creator Side, responsible for the creation of the multimedia content: the process of digitizing 3D objects is done by using 3D scanners, and the refinement of the object is performed with 3D software (Blender), which is then exported to the object format file and compiled to JS format. After completing the 3D digitization, the object file is uploaded to the system along with the database and the associated metadata. (2) The Server Side, responsible for storing and organizing 3D objects and their metadata: maintains XML metadata records, authoring with PHP and MySQL. The WebGL middle API (Three.js) is provided for transforming the 3D object to the user side section, which is given in the next step. Additionally, this part includes Content Management System to manage content for frontend and backend such as user account, file categories, etc. (3) The User Side: responsible for preparing dynamic presentations to be displayed on the web browser. Important features include the search and WebGL renderer functions. WebGL API is used to implement in setting, displaying, and viewing 3D objects as a part of developing content management system. WebGL mid-level API is a JavaScript library that will make it easier to write 3D applications using WebGL. It provides a set of math, scene, and 3D object classes which make WebGL more accessible for developers who want to develop 3D content in browsers, but do not want to deal in depth with the 3D math to make it works [10]. As WebGL mid-level is opened and free of use today, a JavaScript 3D Library name Three.js is selected as a WebGL Library to develop the prototype for this project. Three.js has many materials to support 3D models for interaction, visualization, and presenting 3D cultural artifacts. The support materials of Three.js includes Camera, Core, Lights, Loaders, Materials, Math, Objects, Renderers, Scenes, Textures, Animation, Geometries, Fogs, Skinning, Shadow maps, Alpha tests, and Even morphing [11]. In this testing and developing, JSON file format is the appropriate format to use with 3D cultural artifacts. It is open-standard to exchange data, simple to use, able to map textures with 3D models, and compatible with the WebGL technology. The structure to load the JSON file and the textual file by using Three.js is following:

```
WebGL Archiving 3D Object
// Load Model
  var loader = new THREE.JSONLoader( );
     loader.load( "3DModel.js", function ( object ));
………
Loading Texture
// Load Texture
var texture =
THREE.ImageUtils.loadTexture('textures/texturefile.jpg');
Viewing 3D Object
// Renderer
    renderer = new THREE.WebGLRenderer();
    renderer.setSize(window.innerWidth,
    window.innerHeight);
..……..
```

Because of WebGL middle API is developed for developers who have programming skills, it is hard and not suitable for users, curators, media creators, 3D modelers or artists who have no programming skills to understand how to use this 3D library to present their 3D cultural artifacts on the web. As researchers found this problem, one part of this research is to develop the system and 3D Setting Editor to support no programming skill users and make them able to upload 3D, set 3D scale, position, lights, and present 3D cultural artifacts on the web as they want without any coding and no programing skill required to use the system. The prototype of upload and set 3D cultural artifacts by using 3D Setting Editor is presented in Fig. 4. It illustrates how user access to the system and uses 3D Setting Editor to set 3D rotation, scale, position, light, and wireframe for 3D model to make each 3D cultural artifact unique and proper display in the browser. The website allow users to access both 2D and 3D virtual collections containing digital representations of cultural artifacts. Fig. 5 illustrates the interface design and visualizes cultural artifacts with 3D models and annotated metadata.

Fig. 4 The process of how user accesses to the system and uses 3D Setting Editor.



(a) (b)

Fig. 5 (a) Sample web interface of the 3D Mmuseum Thailand website (http://3dMuseumThailand.com). (b) A cultural artifact with its 3D model and annotated metadata.

B. Evaluation

This research has conducted a preliminary evaluation and assessment of the 3D Museum Thailand prototype system with three small groups of users: (1) Curators, (2) Media Creators (Photographers, 3D Modelers), and (3) End Users (Cultural Scholars and Students). In overall, the users have provided very positive feedback and shown great enjoyment with the potential applications of the system. Two rounds of evaluations have been made during the prototype development so that the obtained feedbacks can be used to improve the system development properly. Each evaluation consists of conducted tutorials, hands-on exercises and an online questionnaire giving the museum users opportunity to comment on all aspects of the system such as functionality, user interfaces and potential applications. In order to evaluate the effectiveness of the proposed approach, researchers evaluated the three key criteria: (1) improvements to the search and discovery services, (2) usability of the system from an end-user point of view, (3) system design, efficiency, and deployment from an administrative point of view. In terms of searching, most users strongly agreed that the developed data model and metadata elements are suitable for 3D digital museums and can semantically annotate data collections properly; keyword searching and information exchange with other museums are well supported. Regarding the usability of the system, it was found that the designed interface is user-friendly and the presented 3D cultural artifacts are of good quality which can draw the user attention to a greater extent. Consider the system design and effciency; the system is well designed and can effciently publish cultural object collections using the current state-of-the-art technology.

V. Conclusion

This paper presents the 3D Museum Thailand project which currently hosts a few pilot sites in Chiang Mai to support museum to archive, preserve, and promote cultural artifacts and works of art collected in museums and galleries. The project founded developed ontology model for data annotation to share cultural objects within a digital archive museum network. The constructed metadata allows rich descriptive metadata for physical cultural objects with their creators/artists, 3D digitization process, storage, and management of digital objects for enabling interoperability and exchange metadata and 3D cultural objects among various museums. A user can seamlessly create a virtual, customized high quality 3D cultural object collection by specifying a metadata and keyword search over the provided user interface, which will then automatically integrate relevant cultural objects from different museums in a network. The future research direction includes an extension of the current work mapping to standard ontology as CIDOC-CRM [12] to exchange cultural information in global environment. Inaddition, the implementation of a framework for dynamic virtual exhibitions and virtual museums based on the proposed ontology and platform is envisaged.

Acknowledgment

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