# A Distributed Platform for Archiving and Viewing Cultural Artifacts in 3D Using WebGL

Weeraphan Chanhom

***Abstract*—Cultural heritage is important for each society. History is defined by and studied through cultural heritage. An important problem is providing easy access to cultural heritage and presenting it in an easy-to-use manner for the layman. With the development of the internet and computer graphics technology, it has now become possible to display real-time interactive 3D content on the web. The aims of this paper are to study this technology and to design a web-based 3D platform for cultural artifacts, which includes capability for acquisition, archiving and display. Moreover, the platform will be distributed based upon WebGL Earth in order to link museums around the world.**

***Index Terms*—WebGL, computer 3D graphic, cultural artifact.**

## I. Introduction

The digital world has been growing and changing rapidly over the past few years. Nowadays, there are various technologies which are available for converting analogue information into digital format. Those technologies can respond to the needs in the creative economy. However, they must rely on the verification from experts to validate information. Digitization is the process of conversion of data from analogue to digital with electronic devices. At present, data of arts and cultural artifacts are popularly digitized not only into photography and video but also in the form of X-ray and 3D. The main reason to digitize the art works is to avoid the direct damages to cultural artifacts that may occur from time, natural disasters or even human beings themselves. These are the challenging tasks of the technicians to digitize a huge collection of cultural artifacts around the globe. In addition, if the museums where valuable cultural artifacts are collected can be shown on websites, it will greatly benefit education, research, and recreation. However, though users have experience from using interactive websites like 3D, it is rather a new innovation for users compared to the other digital media like texts, images, videos, and sound [1]. In view of web developers too, real-time 3D graphics is novel. Recently, WebGL 3D technology, as the open source, can create and present 3D graphics which now attract more and more attention from developers[2]. Nevertheless, to develop WebGL is quite difficalt because it must be developed from the WebGL, a low level API, which requires mathematical and programming skill. These are challenges for web developers, especially those trying to serve needs related cultural artifacts. In this paper, we shall present a platform called 3D Archiving and Viewing Cultural Artifacts using WebGL (CA3DGL) which can serve as the platform used by webs developers. The personnel in the museums can create their own web front-end regardless of their knowledge of API. Furthermore, web developers can use the platform to create a webpages in the Content Management System (CMS) provided by the researcher.

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## II. Background

### A. 3D Virtual Cultural Heritage Works

3D Virtual Cultural Heritage is the knowledge that analyzes the data studied by archaeologists and historians of art and architecture. These data include three-dimensional objects such as works of art, pottery, and cultural artifacts. There are three ways that digital tools support this kind of data (1) representation 3D capture with laser scanning, (2) modeled by hand with 3D software, and (3) hybrids (models and capture). From the past, accoding to Annual Conference of Computer and Quantitative Methods in Archaeology in 1985, Leo Biek presented article of stereo-video. After 1990, the professional organizations around the world were interested in virtual heritage. Association for Computing Machinery (ACM) is sponsoring publication of a new journal devoted to the field which is Journal on Computing and Cultural Heritage in 2007. In the next decade, as 3D modeling software and data capture systems are mastered and their price falls, some are free. For example, Google provides sketchUp for free 3D data capture[4].

### B. 3D Computer Graphics

3D Computer Graphics has become interesting in the world because it can represent the complex information. 3D modeling is used in environmental design and is applied in many technical and scientific fields such as the medical imaging techniques that give physicians a "more real" look inside the body and the cultural heritage 3D models can protect and study the history [5].

### C. The Virtual Reality Modeling Language (VRML)

The Virtual Reality Modeling Language (VRML) is a standard file format for representing 3-dimensional (3D) interactive vector graphics, designed particularly with the World Wide Web in mind. It has been superseded by X3D [6].

### D. ActiveX Technology

ActiveX technology is a framework for defining reusable

software components in a programming language independent way. Software applications can then be composed of one or more of these components in order to provide their functionality. ActiveX controls are not byte code but dynamic linked windows libraries which share the same memory space as the calling process (i.e. the browser), and so they are much faster to execute [7].

### E. OpenGL

During the early 1990s, Silicon Graphics, Inc.(SGI) was a leading manufacturer of high-end graphics workstations. Their workstations were more than regular general purpose computers; they had specialized hardware and software to be able to display advanced 3D graphics. As part of their solution, they had an API for 3D graphics that they called IRIS GL API. OpenGL has long been one of the two leading APIs for 3D graphics on desktop computers. OpenGL is a standard that defines a cross-platform API for 3D graphics that is available on Linux, several flavors of Unix, Mac OS X, and Microsoft Windows.

### F. OpenGL ES

OpenGL ES is a royalty-free, cross-platform API for full-function 2D and 3D graphics on embedded systems. It consists of well-defined subsets of desktop OpenGL, creating a flexible and powerful low-level interface between software and graphics acceleration. OpenGL ES includes profiles for floating-point and fixed-point systems and the EGL specification for portably binding to native windowing systems. OpenGL ES 1.X is for fixed function hardware and offers acceleration, image quality and performance. OpenGL ES 2.X enables full programmable 3D graphics [8].

### G. WebGL Low-Level API

The Khronos Group defines WebGL as a cross-platform, WebGL is a cross-platform, royalty-free web standard for a low-level 3D graphics API based on OpenGL ES 2.0, exposed through the HTML5 Canvas element as Document Object Model interfaces. Developers familiar with OpenGL ES 2.0 will recognize WebGL as a Shader-based API using GLSL, with constructs that are semantically similar to those of the underlying OpenGL ES 2.0 API. It stays very close to the OpenGL ES 2.0 specification, with some concessions made for what developers expect out of memory-managed languages such as JavaScript [8].

### H. WebGL Mid-Level API

A WebGL JavaScript application is defined entirely within an HTML document that is loaded into a web browser. In principle, all that a web designer needs is a text editor to write WebGL statements. The WebGL interface takes care of the communication with the client's graphics hardware through OpenGL libraries. The full power of the underlying graphics hardware is thus, harnessed by WebGL for a quality user experience [9]. At the time of writing, fourteen other WebGL mid-level API had been developed including C3DL, Curve3D, CubicVR 3D, Copperlicht, GLGE, KUDA, O3D, OSG.JS, PhiloGL, SceneJS, SpiderGL, TDL, Three.js, X3DOM. Table I shows the comparision of available APIs. They were compared to study their function and to identify a research gap.

TABLE I: THE ARRANGEMENT COMPARISON OF WEBGL MID-LEVEL API

| API | App. Type | AUX. Tool |
|---|---|---|
| C3DL | WebGL | API Library |
| Three.js | WebGL | API Library |
| X3DOM | WebGL | API Library |
| SpiderGL | WebGL | Materia Editor, API Library |
| NetGL | O3D/WebGL | Scene Editor, Shader Editor, Profiler, API Library |
| ***CA3DGL** | **WebGL/Aritfact** | **Materia Editor, Scene Editor, Shader Editor, Profiler, Cultural Artiface API Library** |

## III. PLATFORM DESIGN

### A. Framework Overview

In this paper, researcher presents a complete framework that covers the whole chain from the 3D digitization of real cultural artifact up to the Web publishing. The resulting of digital 3D copies will be archiving, browsing and viewing through Internet.

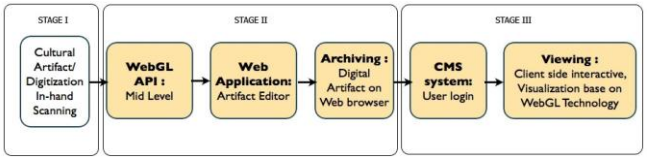


Fig. 1. The framework from 3D digitization to Web publishing

In Fig. 1, the diagram shows the framework of distributed 3D cultural artifact on the web. There are three stages and the detail will start from the second stage.

1) Cultural artifacts are digitized with an in-hand digitization device (high speed 3D scanner in real-time that recovers the object's geometry).
2) The mid level WebGL API will be provided for web developers. Also an Artifact editor and a digital warehouse will be provided for those who may not have their own web data storage. 3D warehouse is the collection of 3D artifacts that provides for users and web developers to store and share 3D artifacts to other users.
3) CMS and viewing include the CMS and WebGL Earth navigator.

### B. System Overview

Several key features should be concerned during the platform designed stage because the 3D objects display on the web are highly complex.

- *High speed resource access*: Web applications usually need several kinds of resources during rendering 3D content in the browser, so it is necessary for the applications to efficiently access resources in time for real-time rendering. The ability of rapidly resource access can help the users more interactive with the browser.
- *GPU (Graphic Processing Unit)*: Graphics hardware has been improved continuously in efficiency and speed. The ability of GPU includes two aspects: the ability to increase speed and to program access directly to the hardware.
- *New Features of next generation web:* Collaborating with the next generation web will be featured as faster and richer in content presentation. Many new features are

introduced to improve the users' experience of web browsing and the most exciting feature is to support the 3D objects.

- *Compatibility with mainstream browsers:* the popular browsers (i.e. Chrome, Firefox, Safari, etc.) should be concerned during the 3D platform development.

CA3DGL is designed for a flexible platform to facilitate the developers to avoid the low level work and focus on the development of high level application logic. Developers are not required to consider the difference of carrying out among the browsers and their complication. However, it is necessary to consider the elements of a 3D application. For more details about the components and its structure of the CA3DGL, please see the Fig. 2 below.

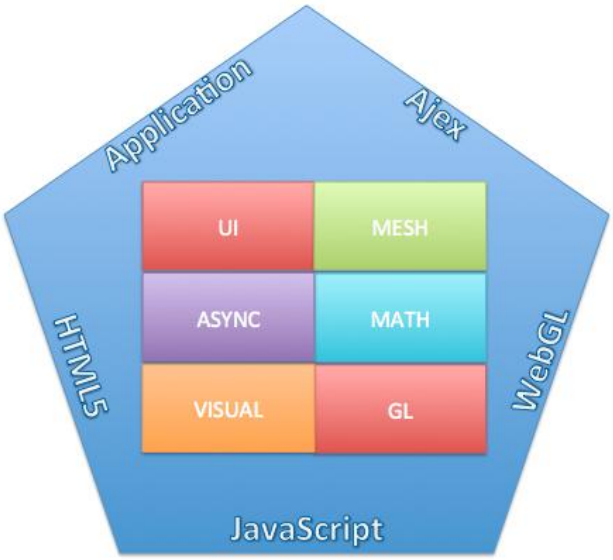


Fig. 2. Architecture of cultural artifacts API platform

According to the architecture of cultural artifacts API platform, there are six significant parts as followings.

- UI: user interface works as a framework and a series of typical 3D operators that allows speedy and easy setup of the web page with 3D viewports. Besides that, it provides an effective management for 3D objects entering and provides ease of use for users to setup the webpage for 3D cultural heritage objects.
- ASYNC: asynchronous content loading requests objects for priority queues and transfer notice to enhance the programmers to implement the asynchronous loading of data and 3D model.
- MESH: 3D model definition and rendering, this module provides the implementation of a polygonal mesh to allow the users to build and edit 3D models on the GPU side.
- MATH: linear algebra objects and functions work as a base tool to reduce a complexity of the mathematic part for a computer graphic programmer.
- GL: graphic library provides the cultural artifact library for the web developers to access WebGL (low level functions).
- VISUAL: system supports special effects such as color, camera, texture, lighting, mouse moment, etc.

CA3DGL focuses on the cultural artifact objects. In this research, the researcher integrates the outstanding features of SpiderGL and NetGL API platform together. The other concern of the system is speed of the display on the browser. Because of bandwidth limitation plays a significant role in application performance for resources are generally deployed at remote servers. Computer graphics applications on desktop usually require the ability of background threads for resource loading to parallelize programs. JavaScript does not support multithreading, so asynchronous loading of remote resource of this platform is designed by using XMLHttpRequest. CA3DGL will use the Ajex mechanism to load resource asynchronous according to need.

## IV. Content Management System

In this section, the platform will be distributed based on WebGL Earth in order to link museums around the world. Fig. 3 shows the navigation of the sources of cultural artifact by WebGL Earth.


Fig. 3. Navigation of cultural artifact museums by WebGL Earth

According to Fig. 4 below, the webpage shows pop-up of 3D cultural artifacts when the user wants to view the 3D objects.


Fig. 4. Viewing the cultural artifacts on CMS

## V. Conclusion

CA3DGL is a new platform, expected that the system will easy uses for web developers to present espesilly 3D cultural artifact on the web pages. The developers not have to face with coding of complex computer graphics. The applications provide the necessary tools such as mathematical entities, 3D models management, data retrieval efficient, and rendering mechanisms for developers. Exploiting these new web technologies in the field of cultural heritage will allow, in the near future, the CMS to provide facility and detailed exploration applications not confined to small objects but including very detailed artifact and even large environments like virtual world. As a result, researcher expects this paper will be friendly and compatible with nowadays web developer who works for cultural artifact area.

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