

Mobile Edutainment System – National Palace Museum as An Example

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Abstract

In order to achieve highest level of knowledge dissemination, many museums have been digitalizing their collections and disseminated them to the world through the Internet. On the other hand, cloud computing and mobile communication technologies will further enhance the penetration capability of digital information, enabling mobile users surfing the wave of information world at anytime and anywhere through mobile devices such as smart phones or tablet PC. Nevertheless, both technologies have their own limitations that may hinder their applicability to the digital museums.

We use the National Palace Museum (NPM) as a reference museum for the application of cloud computing and mobile communication technologies to mobilize digital museums. A set of design guidelines specific to the NPM's services is formulated and a few edutainment systems are implemented based on these guidelines: (1) Qingming Painting and (2) Mao Gong Ding Inscription graphical exhibition systems. By mobilizing, the NPM and other museums will be able to lift their world-class services to another level for the benefit of all.¹

Keywords: mobile computing, digital archive, edutainment

1. Introduction

An important trend among museums worldwide is the digitization and archiving of national cultural heritage in electronic databases for public retrieval through the Internet [6,7]. Due to its long history, the Chinese civilization has a very rich cultural heritage. The National Palace Museum in Taipei is known

internationally as an archive for the treasures of Chinese civilization. Since 2001, the NPM has been digitizing and archiving its precious collections. Through the Internet, most of its digital archive is available for public retrieval to fulfill the museum's mission of dissemination and exchange of museum collections for educational, research, and commercial purposes [6].

After digitization, the next important issue is how best to present its material to the world to achieve the highest level of dissemination of knowledge. Currently, the most popular presentation format for most digital museums is statically structured, HTML-based Web presentation that mimics the presentation of the physical museums. One of the biggest advantages of a digital archive over a physical archive is the flexibility of document retrieval. For example, collections can be arbitrarily classified according to attributes such as time, location, event, etc. Users are able to choose their viewing points for exploring the digital archives to achieve their goals, for either educational or research purpose. For instance, a person researching Chinese porcelain might want to classify porcelain collections by time to study the evolution of porcelain techniques, or by production kilns to compare kiln styles. The rigid format of a physical museum exhibition cannot provide this type of service, whereas a digital museum can easily do so.

It is our long-term mission to develop the necessary technology for enhancing digital museum features to achieve the goal presented above using the available information and communication technologies. This study focuses on the mobilization of the NPM's digital archive using mobile computing and cloud computing technology [3] for the benefit of mobile users.

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2. Analysis of the Mobile Environment

In recent years, advances in mobile communications and cloud computing, plus the emergence of tablet PCs have led to the daily emergence of many new types of applications. Users of the new equipment, have sparked a new social style. In many developed countries, a large proportion of the population has become heavy users of smartphones or tablet PCs. The population of mobile users has far exceeded that of desktop PC users. The characteristics of the mobile computing environment in terms of hardware, software, and use model has been analyzed in our previous study [4].

Characteristics of the Mobile Devices

- **Powerful Human-Machine Interaction Capability**

Most mobile devices are equipped with powerful human—computer interaction capabilities, in particular a capacitive multi-touch screen allowing users to use their fingers to manipulate mobile devices. Unfortunately, many devices have neither a mouse nor a keyboard, so their use model is quite different from that of a conventional computer. However, Web pages currently are designed to operate with mouse and keyboard, to the detriment of touch-screen operation. Web page design for mobile users must thus minimize the need for keyboard typing.

- **Small Screen Size**

The screen size of tablet PCs or smartphones is generally smaller than that of regular PCs. These sizes are generally smaller than typical Web pages necessitating constant scrolling up-and-down or left-and-right to browse a full Web page. Furthermore, the font sizes of many Web pages are usually too small for mobile users to view, in particular for far-sighted seniors.

- **Limited Software and Hardware Capacities**

Most mobile computing devices have fewer hardware and software resources, lower processor speeds, less memory, and narrower network bandwidths. In addition, some popular

PC software is not available on mobile devices; for instance, Apple Inc.'s iPad does not contain a built-in Flash Player. Worse, due to constant innovation in Web authoring tools, Web designers often endow their designs with unnecessary fancy features that inevitably consume more computing resources and create trouble for mobile users.

- **Communication Bandwidth**

The wireless network bandwidth on a mobile device, delivered via either a cellular network or WiFi, is usually much lower than that of home or office PCs. Additionally, many Web pages may embed unnecessary audio and video streams that consume excessive bandwidth, affecting the performance of mobile devices. Many fancy Web designs may no longer be suitable for mobile users.

Behavior Characteristics of Mobile Computing

The use model and environmental constraints of mobile computing are quite different from those of desktop computing, as outlined below.

- **Very short visual attention**

When gazing at the screen, a mobile user may have to pay attention to the surrounding environment simultaneously, resulting in the period of visual attention to the mobile devices being very short. The information on the mobile device must therefore be presented in a manner that allows the user to grasp the required information instantly and clearly. The design of mobile information presentation faces great challenges in all aspects.

- **Information pages will be frequently zoomed or scrolled**

Because the screen size of a mobile device is usually very small, and therefore often unable to present a page of information in its entirety, users must frequently zoom in/out and scroll up/down the page of information.

- **Easy to slide and hard to click or tap**

To manipulate a capacitive multi-touch-screen using finger gestures, it is much easier to slide than to tap the screen because tapping on a specific area of the screen requires a precise gaze and a precise tap. Most Web pages are designed to be easier to click on than to tap. For example, many checkboxes are usually too small to tap.

Capacity Requirements for Cloud Computing and P2P Communication Protocols

When traffic in the NPM's web-site services increases, the NPM's server capacity and network bandwidth cannot be scaled up accordingly due to its funding constraint, leading to a decline in service quality. Cloud computing based services will solve part of this problem.

3. Design Guidelines for Information Presentation on Mobile Devices

The analysis described above shows clearly that the design philosophy of current popular Web sites is not suitable for mobile devices. Through a variety of experiments carried out in this study, we have identified a set of design guidelines for mobile applications, specifically for the digital NPM. The design of a mobile Web page should [4]:

- make use of the multi-touch screen to compensate for the inconvenience caused by the lack of a mouse and keyboard;
- support the traditional Chinese-style layout (up-down style) including operations such as automatic-word-splitting (hyphenation);
- support various types of text input;
- size up graphic user interface (GUI) objects to facilitate precise finger tapping;
- allow users to take advantage of multi-touch features to quickly and easily zoom in/out of a Web page;
- allow automatic-adjustment of line width to avoid line overflow with a change in font size or zooming;
- provide a context-sensitive automatic-word-completion feature to minimize the need for typing;
- provide pull-down menus (or similar mechanisms) as much as possible to reduce the demand for text input;

- provide automatic page scrolling with adjustable scrolling speeds;
- keep information presentation as simple as possible (be user-friendly);
- save bandwidth by avoiding unnecessarily complicated screen pages and using standard script languages such as HTML, CSS, and JavaScript to make pages attractive.

The current popular Web designs use many images or non-HTML tools such as Flash and ActiveX to make Web pages more vivid and attractive. Large images on Web pages may consume considerable bandwidth. Non-standard tools may hinder the viewing of these pages on mobile devices that do not support the required software. On the other hand, the browsers on both the iOS and the Android system support standard HTML, CSS, and JavaScript, which are sufficiently sophisticated to support many artistic designs. Designing Web pages using the standard HTML language suite has many advantages and should be encouraged.

Creating attractive Web pages by using artistic drawings is also very popular. However, artistic drawings are not only time-consuming but also very expensive. Moreover they require intensive communication and coordination between Web designers and artists, which is even more of a burden. The use of the standard HTML language suite will reduce or eliminate the participation of artists. Web designers working alone can create and modify Web pages. Not only will productivity be increased dramatically, but design costs will also be significantly reduced.

4. Prototype systems

We have designed and developed several prototype edutainment systems based on NPM, as described below. We used two famous collections of the NPM to develop two prototype graphical exhibition systems. The first is the famous painting "*Along the River During the Qingming Festival*" (Qingming Painting in short), created by Zhang Zeduan during the Northern Song Dynasty. The second prototype used the Mao Gong Ding Inscription exhibition.

Qingming Painting Inscription Graphical Exhibition Systems

The Qingming Painting documents the real life of the general public in its capital city, Bianjing, which was the most populated city in the world at the time. The preciousness of this painting lies not in the skill with which it was painted or its artistic value, but in its realistic recording of the life-styles of the Northern Song Dynasty. It is a valuable historical record. A small electronic screen cannot display the entire painting, which is painted on a long roll of canvas; users must constantly scroll left/right/up/down and zoom in/out of the screen to view the painting. This may be readily accomplished with a multi-touch screen tablet. However, the process is still very cumbersome because of the length of the Qingming Painting. In our prototype, we used hyperlinks to connect each digital object; these hyperlinks act as an index of knowledge exploration served by a back-end knowledge (meta-data) database. If a researcher wanted to study wagon or boat styles in the Northern Song Dynasty, he or she could easily explore the digitized painting to locate each desired object and tap it to retrieve the meta-data from the back-end database. The design of this system follows the guidelines presented in Section 3. A joint project between our research team and the NPM was established to populate the system with real meta-data and to evaluate the system in a real-use environment. The Qingming Painting exhibition thus offers not only visual appreciation, but also an educational and research function.

Mao Gong Ding Inscription Graphical Exhibition Systems

The second prototype used the Mao Gong Ding Inscription exhibition. The Ding, a bowl with three sturdy legs made of copper, was widely used in ancient Chinese dynasties as a ritual vessel and became a symbol of political hierarchy distinguishing the political status of the superiors from subordinates. In addition to its use in worship and ritual ceremonies, the ding was also used to record the meritorious quality of its owner. Such records were often closely related to important events and historical legends, and therefore are of great historical value. The Mao Gong Ding, cast by Mao Gong who was a relative of the emperor of the Zhou Dynasty, features 497 characters

in a special calligraphy, called Zhongding-Wen, engraved on its surface to record a special event. As the government of the time was weak and incompetent, the emperor delegated to Mao Gong a special and powerful political position, similar to that of today's British Prime Minister. To encourage Mao Gong to work hard and love his people, the emperor also gave him various ceremonial gifts. Mao Gong cast the ding to record the event and express his gratitude. We developed a Mao Gong Ding Inscription exhibition system using images of the inscription. Each character in the inscription has an embedded hyperlink linked to its meta-data, which includes not only the relevant explanation, but also the information about the evolution of the character in calligraphy history. A user can study Zhongding-Wen by clicking on any character to gain access to this information. The system is available as a conventional Web site and as an iPad App, as shown in Figure 1. To further stimulate users and extend the learning efficiency, we also designed and implemented an edutainment system for each platform, as explained below.

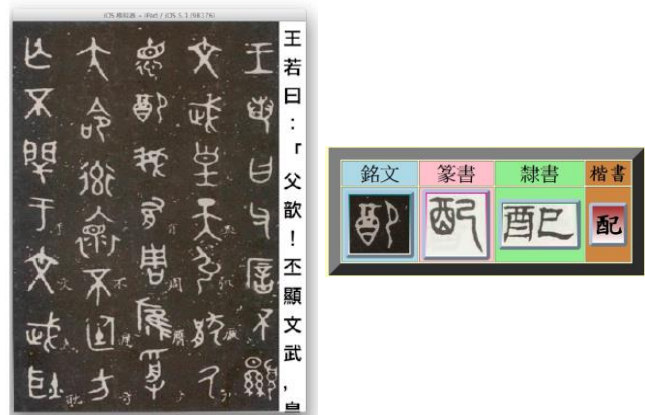


Figure 1: Mao Gong Ding Inscription exhibition system.

Game Based Edutainment Systems

Edutainment, a buzzword for “learning by entertainment”, has long been recognized as an outstanding method of achieving highly efficient learning. However, the creation of such a system has many challenges, requiring many hardware and software resources for its implementation. With their

and inexpensive human-machine-interaction, multi-media presentations, and mobile computing capabilities, smartphones and tablet PCs are good platforms on which to implement edutainment systems for lively, vivid and joyful presentation of museum artifacts. We designed a “guessing game” for each of Mao Gong Ding inscriptions and Qingming Painting to stimulate users and enhance their learning efficiency. Through playing these games, users can learn the Zhongding-Wen more efficiently and gain a deeper knowledge of the Qingming Painting. In Mao Gong Ding guessing game, as shown in Figure 2, the system iteratively shows an inscription (a character in Zhongding-Wen) on the screen, and provides the user with a number of choices of modern characters. (Note: the inscription shown in Figure 2 is composed of two sub-inscriptions: a jar and a spoon. The correct answer is the fourth choice: distribution.)



Figure 2: Mao Gong Ding Inscription Guessing Game system

Figure 3 and 4 shows two guesses in Qingming Painting Guessing Game system. In Figure 3, a clipped image showing a child riding on a cow is shown to the user and the users is to make a choice to answer the question: “What the child is doing?” To answer this question, user must study the painting thoroughly to understand the story told by the painting.



Figure 3: A guess in Qingming Painting Guessing Game system

Figure 4 shows a man who is pulling a monkey with a leash. The question is “Where is the man in the painting?”



Figure 4: Another guess in Qingming Painting Guessing Game system

The implementation of these games shows that smartphones and tablet PCs are ideal platforms for edutainment system, and that such systems can stimulate users’ interest. If greater development resources were available, more sophisticated games for edutainment could be developed.

Nevertheless, there are some problems associated with current implementation of web browsers. Many UI gadgets are not designed for touch screen, but rather for mouse. It is yet to be corrected by browser vendors.

5. Concluding Remarks

In this paper, we analyzed the characteristics of the mobile computing environment in terms of hardware, software, and use model with the aim of supporting the mobilization of digital museums and of developing a set of design guidelines using the NPM as a reference. Based on this analysis and the design guidelines, we designed several application prototypes on Web and the Android platforms. We expect that these technologies will be adopted by the museums around the world.

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