The Preliminary Study of Ubiquitous Infrastructure of Museum Service Applications in National Palace Museum

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Abstract: - Moving along with social evolvement, museums have adopted in their recent development sophisticated information technologies into various museum disciplines including collection management and registration, research, curatorial, exhibition and education. New technologies also facilitate other missions such as public service, ticketing, digital value-added applications and cultural creativity, while advanced digital technologies bring new excitement and visiting experience to the audience. This essay will highlight those projects newly different function and diversification for visitors.

Key-Words: - RFID, NPM, Ubiquitous, U-museum, Wireless, Sensor

1 Introduction
Since the last decade, National Palace Museum (NPM) has achieved the great success in digital heritage development, which include the Digital Archives, Digital Museum and E-learning. Hundreds of thousands of museum objects have been saved in digital forms, which have brought significant benefits to the museum and the society. In the aspect of museum operations, the digital images can enhance curatorial practices, conservation research, learning resources dissemination, cultural marketing, and so on. In the viewpoint of the society, the public has more opportunities to learn the museum collections via a variety of approaches and empowered themselves whatever at work or in life.

During the period of 2008 and 2009, to coordinate with government policy of "U-Taiwan Plan," National Palace Museum mapped out the "U-Museum Project, a NPM New Century Showcase of Using Ubiquitous Technologies in a Museum Context" so as to attain the goal of "endowing collections with new countenance and creating new values of NPM."

Based on abundant artifact collections together with the employment of Radio Frequency Identification (RFID) and wireless networking technologies, NPM has been implementing Ubiquity Project with aims to transform NPM from a traditional museum into a U-Museum and to assist domestic cultural and creative industries in reaching out the world. During the two-year period, many examples of U-tech applications such as Wireless Communication, Location-Based Services, WLAN Roaming, U-Temperature & Relative Humidity Monitoring System, introduction of RFID management trial system, U-educational theme multimedia and wireless audio-guide system have been created.

This essay was compiled to give a thorough description of various accomplishments NPM has achieved in Ubiquity Project. It is assumed that the digital museum could bring more positive impacts to the society, especially in capacities of learning and economic benefits. Therefore, based on the previous achievement, NPM decided to step further to build the U-Museum service [1], which aims to utilize the Ubiquitous technology across the museum. In the very beginning, we identified our objectives based upon the core mission of the museum.

2 Methodology
Originating from Latin, the word "Ubiquitous" means "god being in all places." In the modern digital era of today, being Ubiquitous refers to an ideal condition in which information and services can be accesses through various IT products and Internet.

The goal of establishing an ideal Ubiquity environment could not be reached in a single step yet the first light of which would not have been revealed without long-term support and impetus from the government. The "E-Taiwan Initiative" was introduced in 2000 with emphases on construction of information and communication infrastructure. Five years later, based on preliminary achievements of digitization, the "M-Taiwan Program" was initiated as a support to build a wireless broadband network.
system. In 2008, "U-Taiwan Project" was launched, in which new technologies of Radio Frequency Identification (RFID) combined with digital database, digital home, internet, wireless network and information appliances were employed to address an "anytime, anywhere, secure and convenient" service network covering Tele-Care, security surveillance, digital entertainment, vehicle navigation, UHF container smart seal, medical waste tracking and airport baggage claim, with an aim for bringing digital information to a new level through technology integration.

RFID stands for radio frequency identification. It is an auto-identification technology, which used radio waves to transmit information. RFID systems generally comprise of three main components, namely: tags, readers, and a data processing system [2]. A tag has a unique identification number (ID) and memory that stores additional data such as manufacturer name, product type, and environmental factors including temperature, humidity, and so on. The reader can read and write data to tags through wireless transmission. In a typical RFID application, tags are attached or embedded in objects that must be identified or tracked [3]. For using in the art piece, RFID will not interfere or transform the artist’s result, because they are totally invisible [4]. Like other auto-identification technologies, its underlying purpose is to allow computers to acquire identifying information about physical objects in the real world.

3 The Infrastructure of U-museum Service

NPM has participated in National Digital Archives Program and Museum Digitization Program starting the year of 2000 and accomplished various missions including extensive database building for key collections; launch of websites in ten languages to provide wide knowledge of various subjects; installation of wireless network system; publication of e-journal with a circulation of 190,000; providing e-learning and on-line exhibitions; and application of various electronic media into museum display. During 2007 and 2008, to coordinate with government policy of "U-Taiwan Plan," National Palace Museum mapped out the "U-Museum Project, a NPM New Century Showcase of Using Ubiquitous Technologies in a Museum Context." As listed hereunder, a total of four sub-plans were implemented during the two-year period.

The basic goal of this Project is to provide museum information services in an "effective and timely" manner. With completion of wireless network infrastructure active push service through cell phones over WLAN will be the next initiative. The employment of RFID technologies makes it possible to extend services from the gate of NPM to a nearby MRT station so that NPM will be able to send welcoming messages and exhibition information to visitors upon their arrival at the station.

To secure information security, a "multi-tier" and "centralized" approach was adopted for wireless security management with mobility controllers installed for network authentication and backup to regulate wireless equipment and access in the museum (as shown in Fig. 1). The construction of Wireless Network Infrastructure not only opened the gate to NPM Ubiquity but also laid a sound foundation on which quality information services could be formulated.

The concept of "Intelligent Museums" has been prevailing in the international community, which refers to the employment of interactive digital technologies into all museum services. The ultimate goal of NPM Ubiquity Project was to transform National Palace Museum into a museum with Ubiquitous services. The Infrastructure of service environment is shown in Fig. 1. This is a total solution using RFID to integrate museum’s service. It comprises three parts for functional implementation, which is the hardware layer such as tag, reader, interface; Software layer such as middleware and integration user interface; and integration existing Applications into the system [5].

4 Applications of U-museum Service

4.1 U-Temperature and Relative Humidity Monitoring System

This project was undertaken by the Department of Conservation and Preservation. The objective is to monitor the temperature and relative humidity precisely, as the fluctuation of these factors may
cause damage to collections. Specifically speaking, the inappropriate and fluctuating moisture levels may lead to the mechanisms of mechanical and chemical change or the encouragement of biological infestation. Optimal and stable preservation environment has always been the main concern in antiquity preservation. Although air conditioners are the main equipment for temperature and humidity control, there remain other factors that may induce fluctuations in temperatures and humidity, such as coefficient of performance varying with distance from air outlet, impact from external environment, leaking roofs, layout of exhibition halls, material of showcases and dryness of the material. Fluctuations in temperatures and humidity may cause damage to antiquities, which may even become irreparable when it turns especially bad.

As the result, the damage could be biological activities (moulds, fungi, and insects), metal corrosion, shrinkage of textiles, warping of wood, cocking of paper, and so on. Unfortunately, there are too many source of moisture in the museum, including air-conditioning, rising damp in building, leaks in the roof, material of display cases, and plants close to collections or people’s emission (breathing, wet cloths).

Therefore, in order to monitor the environment of galleries, NPM placed the normal sensors in every display case. However, these sensors can reflect the present temperature and relative humidity, but cannot store these data for statistic reporting. Therefore, it is hard to monitor the statues of objects in every minute. Besides, the conservators must go on an inspection checking in every gallery to collect these environmental data. The daily routine is a time-consuming and laborious task. Therefore, it is imperative to implement the U-Temperature and relative Humidity Monitoring System in galleries and storages.

Hence, automatic temperature and humidity monitoring systems were installed in NPM to maintain an optimal and stable environment for antiquity preservation. With the employment of state-of-the-art technologies, antiquity preservation standard will be improved. Temperature and humidity sensors made to the order of museum were installed in all showcases at all exhibition halls and galleries. Data collected and abnormalities will be sent to relevant staff through wireless transmission via routers and gateway servers. The staff will then be able to learn the information from their computers or portable devices, so that all personnel involved have a clear picture swiftly and conveniently and environment control becomes efficient, timesaving, energy saving and cost effective.

The implementation of the system aims to improve the present conservation environment, to enhance capacities of museum staff for monitoring the conditions of the conserved collections, and to set up the instant warning signs to alarm abnormal conditions. In this system, NPM planned to place the sensor nodes in display cases of galleries and storages. The data of temperature and relative humidity will be transmitted to the main host via the wireless local area network. Also, NPM designed customized software to manage to the database, if abnormal conditions occurred the system would automatically notify to administrators. The function of system flow chart as shown in Fig.2.

![Figure 2 Flow Chart of the system](image)

### 4.2 U-Product and Asset Management System

The huge collections of NPM together with ever-increasing new creations coming up in various forms have made registration of diverse museum collections a difficult task. The deployment of RFID systems for films, multimedia discs and publication stack rooms will facilitate collection management and effectively help to protect intellectual property rights of cultural creativity source material.

The Department of Marketing and Licensing undertakes this project. The objective of this project is to set up an effectively manage digital assets of image archives, publications and products for the aim of cultural marketing and licensing. In the previous project, NPM has digitized enormous amount of museum collections into digital form, and reproduce them into a variety of formats, such as multimedia DVDs, films, web sites, publications, and products. It is estimated the there are approximately 4,000 kinds of commissioned products or replicas produced every year and sold in NPM gift shop.

Therefore, in order to effectively manage these products, NPM decided to use RFID technology in management system. The integrated management system consists of three sub-systems, including

The Image Archive Management System aims to manage the Positive Film Archive and the Digital Images Archive. Prior to the application of digital cameras, the museum had stored a great amount of positive films taken by traditional cameras. In order to integrate two types of image archives, the RFID tags were attached to the outer of positive films. Then each film could be found by RFID readers, which can automatically transmit data to management system. In this way, the administrators can easily find out the required image and process the image loan service or image licensing. The RFID tags were used in publications management system as well as the products management system. That was learned from the successful experience of the giant retailer Wal-Mart in the world, the RFID had been effectively applied in the warehouse management system.

4.3 U-Museum Guide System
The U-Museum Guide System includes two main projects, one is the U-Museum Guided developed for gallery attendants, and the other is the U-Museum Card developed for museum visitors. First of all, NPM identified four major museum services as exhibition, tour guide, learning and visitor service. The features of these services should be integrated, interactive and personalized. NPM build up the infrastructure of Ubiquitous Museum Services. The wireless access points have been set up across the exhibition hall.

For U-Museum Guide, the objective of this project is to support gallery attendants to provide high quality services to museum visitors. The reason for that is gallery attendants are usually the first people that museum visitor come to contact with. Therefore, NPM planned to equip them well with a handheld device, which integrates diverse museum services. And NPM had defined six core functions of the U-Museum Guide, including VoIP (voice over internet protocol), instant messaging, map navigation, instant alarm, translations, and camera.

The VoIP is used for internal contact within the museum. And the function of Instant Messaging is decided to provide information about exhibitions and activities. The Map Navigation can guide visitors the direction of galleries, restrooms or elevators. Particularly, it can show the nearby sightseeing spots for the overseas visitors. Besides that, the Instant Alarm is designed for security monitoring. Once the door of showcase is opened, the system will send out warning sign to the gallery attendants. Also, it can demonstrate the emergency procedure to remind gallery attendants. The Translations function is to response the foreigners enquire. NPM designed the most used 100 sentences in English and Japanese. The last function is the Camera. It is used to record unexpected situations, such as arguments or emergencies.

4.4 U-Museum Card System
Aiming to foster in-depth understanding and appreciation of antiquities for visitors and with the employment of multimedia, information and communication technologies, NPM has established various thematic interactive installations offering brand new and pleasant experiences of learning tours in the museum.

Apart from the application of the U-Museum Guide System designed for gallery attendants, the U-Museum Card is designed for museum visitors. The U-Museum Card aims to provide integrated, personalized, and diverse services to visitors via RFID technology. In this way, the U-Museum can facilitate two-way communication between visitors and museum. Specifically speaking, the U-Museum Card enables the museum to manage the visitor’s flow, to offer self-directed tours, and to provide personalized services.

Museum visitors can use the U-Museum Card as the electronic ticket. Once they enter the gallery, the Kiosk placed in front of the entry can detect visitors’ cards, and display the welcoming message, the suggested visiting routes, or gallery introductions. If the gallery is filled with people, the Kiosk can suggest visitors to come back later. After the visit, visitors can register their personnel information or preferences on-line. Afterward, they can receive information about preferred exhibition themes or activities via e-mails. These personalized services are subject not only to maintain existing visitors but also attract more potential visitors for their re-visit.

For Self-Directed Tour is designed to integrate audio tour guide or handheld devices with the U-Museum Card. When a visitor is detected in front of a device, a server identifies the language the visitor selected at the reception desk, and simultaneously generates a commentary in the appropriate language. Further to this, the handheld device can provide multimedia content or e-learning courses. The vision of U-Museum service as shown in Fig.3.
5 Advantages of Infrastructure of U-museum Service

The trend of using RFID technology on museums is growing fast. It will not only save time of museum’s manpower, but also process full information and extend the services of museums. There are several new ways to apply RFID in museums in this article, from entry management, self-guide introduction, collection management, inventory and asset tracking, and control of publications management. The advantages of RFID application completely fulfill from the attraction of RFID such as to help the self-guide introduction, to improve the study effect, to shorten the inventory tracking, and to access control. Therefore, museums should enhance the technology of RFID and computers to design each needs, to show newly different function and diversification for visitors.

6 Conclusion

Riding on the ever-changing waves of digitization in the 21st century and bringing into execution the NPM U-Museum Project, NPM has successfully created and developed innovative web-based information services in a museum context. After the NPM U-Museum Project came to an end in 2009, a new "NPM Intelligent Cultural Creativity Project" will commence starting 2010 with an aim at merging museum services with creativity, daily lives and technologies and marching toward the vision of "endowing collections with new countenance and creating new values of NPM."

U-Museum service requires a lot of efforts, from initial user need investigation and merchandiser selection through designing and implementing the construction to ongoing maintenance and evaluation. So far, RFID is a successful technology to use in variety of areas. Museum can take advantage of this emerging RFID technology to help routine and daily jobs. Therefore, museum could emphasize more efforts on its educational missions and less on time-consuming tracking issues.

This paper presents the best practice of NPM adopting RFID technology for U-Museum service infrastructure. It will continuously build up for several years. Research on the actual achievement of the promises of RFID and a more detailed understanding of effective implementation strategies also need to be undertaken.

References: