

The Guide Utilization Services System Design of University Digital Archives based on Augmented Reality Technology

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Abstract

Augmented reality technology is a technology that could let physical information (visual information, sound, taste, smell, etc.) which originally difficult to experience in the real world within a certain range of time and space, and then could superimpose these information on the real world to be perceived by human senses through scientific and technological simulation, so as to achieve surreal sensory experience. For archive guide utilization service, this technology is worth popularizing and applying, and it has become more mature. If applied to the field of archives, this technology will play a huge role in the navigation of archival data, tour interpretation, and remote archive query and so on. Based on these realizable functions, this paper will use unreal software to design the guiding service system of university archives, in order to optimize users' experience and serve more alumni in need of help.

Keywords

Guide and Utilization Services, Augmented Reality, University Archives, Digital Archives.

1. The Meaning and Current Situation of Guided Services in University Archives

1.1 The Meaning of Guide Utilization Services

University archives have a wide range of archiving and many types of archiving materials. Among them, teaching archives have the largest amount of archiving and collection, which are the most frequently used and most closely related to users' study, work and life. In recent years, with the continuous development of the special audit work of cadre personnel files, the Ministry of Education's certification of academic degree materials in increasing, the amount of consulting teaching files in university archives is increasing year by year; especially the business of former graduates from other places is high. In 2020, during the COVID-19 epidemic prevention and control period, the urgency of users' demand for document checking became more prominent because they could not go to the archive for document checking service. As a result, most of this business was entrusted to university students and teachers. In the process of handling, the mandatary has a little knowledge of the trustor's personal information, file checking process, available file materials, etc., resulting in the unsmooth use of files.

In order to improve this situation, let users better understand the search scope and ways of utilizing, further quickly and conveniently acquire the service information of archive utilization, and alleviate the dilemma of not being able to access the service in another places, it is very necessary to use relevant digital technology to carry out the online guide utilization service of archives.

1.2 Current Situation of University Archives' Guide Utilization Service

According to the survey, there are mainly following forms of guide utilization service in university archives:

(1) Website guide and utilization service: through the archives website platform and the archives information network, it is the most common form of guide and utilization service of university archives to provide the location of the archives to the public, and also one of the important channels for the public to seek the way of archives inquiry. However, due to the differences in service orientation, service module setting and technical service application of each archive website, the network service environment created and service content presented are also different. This is not only directly related to the service quality and service capacity of archives website platform, but also directly affects the public's service evaluation of archives website.

(2) Exhibition service: exhibition service includes internal exhibition and online exhibition in two forms, generally, the exhibition is mostly in the form of thematic exhibitions, many universities are also open to the public in the homepage or information network link, it indeed very convenient. The thematic exhibition mainly includes the contents of the archives collection, the compilation and research results of the archives, etc., which is an important way of displaying and publicizing the collection resources of the archives of colleges and universities, and also an important channel for the guide and utilization of the archives.

(3) VR navigation system: According to the literature search results, Wen-His Chang, a Taiwanese scholar, believes that the purpose of virtual file system construction is to create a virtual environment and constantly improve the traditional file functions in a virtual way. It is considered that the virtual archive service can be better provided by using computer technology to innovate the archive service mode, which is not restricted and affected by shelving and opening time. The system was opened to the public in 2005. The public can visit the virtual interface developed and designed by VR technology, and also experience the explanation and navigation service of virtual characters, and interact with virtual characters¹.

(4) The WeChat official account appointment checking: the rising WeChat official account of university archives in recent years is another important channel for the public to quickly know the checking process and timely understand the archives information, and also a new way for university archives to continuously expand the archives business services. For example, the WeChat official account of Peking University Archives has opened an appointment checking function, that is, after following the official account, you can use the online appointment checking service function to reduce the waiting time for checking documents. The advantage of this method is to simplify the content of the archive website to the portable mobile phone, which is more conducive to the checker to obtain the archive information anytime and anywhere, and without the limitation of region, time and space. At the same time, it is also a new measure for archival work to constantly adapt to the needs of social development in the new era and strengthen the provision and utilization of archives.

2. A Review of Augmented Reality in Archives

2.1 Theoretical Research and Practical Exploration of Archive Augmented Reality Technology

In AR theory exploration, Du Zhujun believes that augmented reality technology can be used for information expansion and three-dimensional display of collection exhibits, historical scene restoration and mobile guide services². Wei aoxi believes that augmented reality technology will have strong feasibility in mobile navigation services, information expansion of planar exhibitions, and explanation of material archives³. Liu Siqiong believes that augmented reality technology has a good application in archives navigation, information push, explanation of archives exhibition, archives protection and other aspects⁴.

In the practical exploration and application of libraries and museums, the application of augmented reality technology has shown results. For example, Pu Wang discusses the application of mobile AR technology in modern library from five aspects: book shelf and resource fusion, AR multimedia books, AR library navigation, AR optical character recognition and AR personalized service⁵. In 2016, the Palace Museum launched VR exhibition items for the first time in the exhibition. Visitors can follow audio directions in a virtual space to "wander" the Jingdezhen ruins and interact with them. VR videos can also show the process of defective imperial kiln porcelain of the Ming and Qing Dynasties from firing to being discarded by artisan⁶. In 2018, the national Museum of China's "Smart National Exhibition" project made full use of emerging technologies to increase display forms, and adopted virtual reality, augmented reality and other new technological means in the form of presentation, so that visitors can interact with cultural relics. At the same time, diversified and high-tech exhibition methods such as pictures, videos and immersive projection are adopted to shorten the distance with the audience⁷. In addition, with the support of image recognition and augmented reality technology, the "Restoration project of Qin Shihuang Terracotta Warriors and Horses" realizes the restoration of the colour of the terracotta warriors and horses. By opening the camera in the baidu search bar of mobile phone and scanning the light box of the prostration terracotta Warriors and horses under the AR function, the original colourless terracotta warriors and horses can be re-coloured⁸. Furthermore, Badashan Digital Museum APP, mobile exhibition can be carried out through augmented reality technology⁹.

2.2 Application Analysis of Augmented Reality Technology in Archives

Based on the study of the theory of the augmented reality application present situation, its function mainly reflects in the navigation service, resource catalogues and explain, archive protection, the augmented reality technology applied in the archives of the business, its main purpose is to educate the public about collection resources and scope, rich exhibition form and improve exhibition effect, as well as auxiliary file repair and file professional related work. From the augmented reality application cases and application results in the field of libraries and museums, development and design application of augmented reality technology has been increasingly common and mature, it can not only innovate the way of using the service, assist the management of the business and related services work, but also can promote using service capacity, reduce the distance with users, and help users to solve practical query problems.

To sum up, the author believes that university archives should explore the road of design, development and application of augmented reality technology. It is necessary to constantly discover and excavate the collection contents or service business, which suitable for the design and development of augmented reality technology, and to give full play to its technical advantages and further expand its functions in the field of archives, so as to serve other external services in the archives. For example, with the increasing demand for the utilization of remote documents checking requirement, in order to facilitate the distant alumni can easily obtain the required archive information in a more relaxed and pleasant atmosphere, understand the business and process of file checking in Alma mater, and continue to pay attention to the archives external utilization service development process.

This paper tries to design the university digital archives guide service system based on AR technology, constantly broaden the archives service scope, Publicize and popularize the knowledge of archives utilization, help alumni alleviate the dilemma of not being able to visit the archives service, so that users can experience "visiting the archives" service in other places.

3. Architecture of Archive Augmented Reality Navigation Service System Design

The archives augmented reality guide utilization service system is based on AR technology development of archives tour service system, the system will complete "virtual warehouse 3d modelling", "recognition map making and recognition function realization" and "interactive interface

creation and implementation" three functional modules. Through this system, users can understand the collection resources and scope, quickly and accurately find the content and access to the required archival materials, etc.

The advantages of the system are as follows: first, the image recognition model is constructed to guide users to obtain the information of archive utilization and stimulate users' enthusiasm for participation. Second, it simulates the situation that produces the combination of virtual and real environment to realize the data navigation function of collection resources and scope display; The third is to design and develop the real-time interactive interface for users of archives to enhance the special experience of combining reality and virtual for users of the system.

3.1 Tool Selection of Archive Navigation System

This system uses the augmented reality toolkit developed by easy AR, a leading company in the AR industry in China at present, takes Unity3d, a powerful multi-purpose development engine, as the development platform, and uses 3D software Blender as the software of modelling, mapping and animation to output model element materials for the Unity3d platform. In the Unity development platform, C# and python are used as the interactive part of the program development language to write programs to achieve a variety of interaction and function construction.

3.2 Structure Design of Archives Navigation System

The system uses Android platform smartphone as the display device of DAGDL system. The program on the mobile terminal does not need users to add any additional hardware cost, At present, the price of AR glasses such as hololens is about 30000, and the effect has not reached a very practical level. The Structure design of Archives navigation system(AR-DADL system) is shown in Figure 1, Open the mobile phone application, scan the recognition map through the mobile phone camera for image recognition, integrate the generated DAGDL model with the real scene taken by the mobile phone camera, transfer the integrated scene to the eyes of readers through the mobile phone screen, and readers can touch the screen to interact with the virtual dagdl model. The AR-DADL system superimposes the entity information that is difficult to experience in the real world to the real world through AR technology, which is perceived by human senses and interacts with it, so as to experience a new environment with real virtual and real sensory effects, and increase readers' thirst for knowledge and interest.

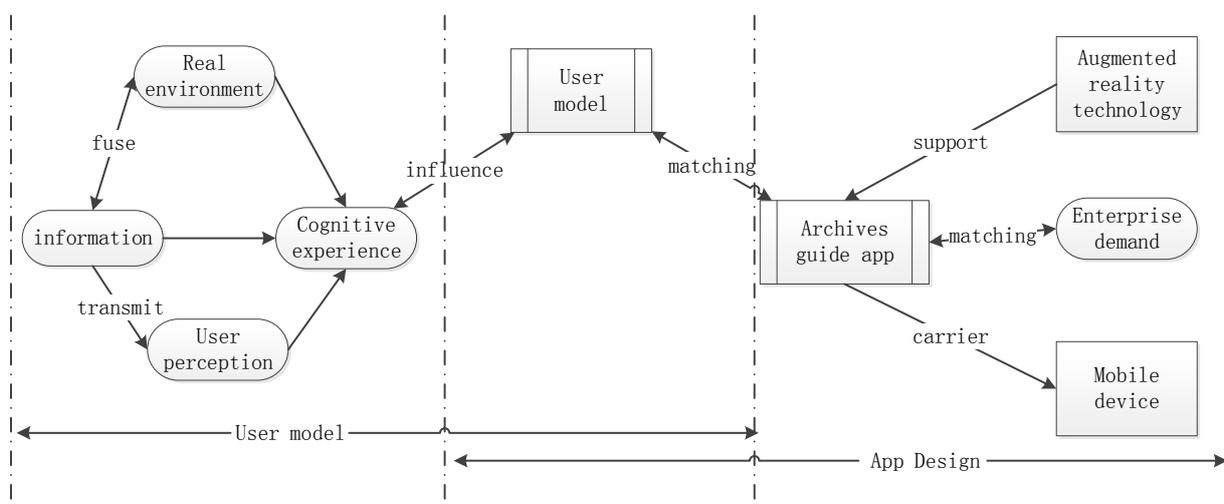


Figure 1. User model and design process of Archives guide APP

The augmented reality system will be divided into three modules to realize the functions of the system. One is the three-dimensional model environment used for interaction. The system will establish a virtual archives model for the archives of Lingnan Normal University, which has the complete

functions of the archives; The second is the production of image recognition. In the process of use, after the user aligns the camera with the recognition map, the corresponding three-dimensional model of the archives will appear. The third is interactive design, that is, the design of user interface, interactive interface and interactive process.

3.2.1 AR-DADL Modeling of Virtual Archives

This design takes the virtual single building of the archives of Lingnan Normal University as the model. In blender software, the poly modeling method of the software is used to divide the model into UV and produce the full-color three-dimensional model of the archives. The archives model interacts with the archives users in the use process of the whole system, which is the core part of the whole ar-dadl system.

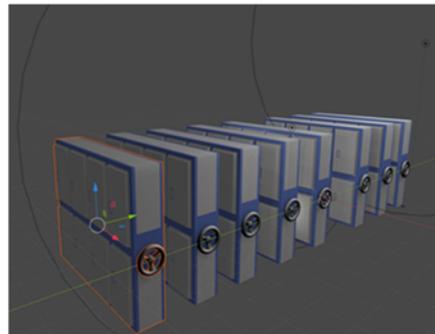


Figure 2. The model of Archives using blendersoftware

3.2.2 AR-DADL Image Recognition Function

Image recognition is realized by easyar. Easyar can provide a more direct image recognition method. Each ar program developed with easyar has a unique license key. First, enter the unique license key in the arcamera component of unity3d, and then use easyar for identification. Then, upload the required identification pictures in the data package provided by easyar, enter the unity3d engine for configuration and debugging, scan the identification pictures with the mobile camera, and finally generate the virtual VR archive model imported into unity in advance in the display device.

Mathematical principle of camera matching for image recognition: In order to establish the imaging model of the camera, as shown in Figure 3, we define the following four coordinate systems: $xwywzw$ represents the world coordinate system (also known as the real space coordinate system); $X'y'z'$ represents the virtual space coordinate system, which is used for the geometric description of the superimposed virtual object; $X_cy_cz_c$ represents the camera coordinate system (also known as the observation space coordinate system); UV is a two-dimensional coordinate system that represents the plane coordinate system of the projected image. The Z axis must coincide with the observer's viewpoint direction.

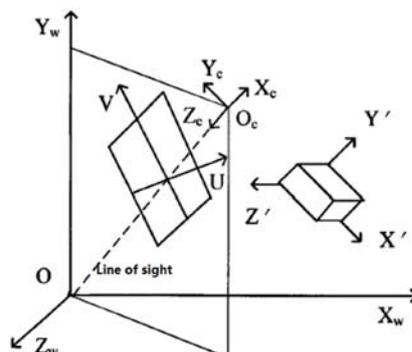


Figure 3. Schematic diagram of three kinds of spatial coordinate system adapt

Augmented reality system should correspond virtual space coordinates with image coordinates, which generally involves the following three coordinate transformations:

- (1) Transformation from virtual space coordinate system to world coordinate system;
- (2) Transformation from world coordinate system to camera coordinate system;
- (3) Transformation from camera coordinate system to image plane coordinate system.

Since the orientation of the virtual object superimposed into the real space is determined by the function to be completed by the augmented reality system, that is, the relationship between the virtual spatial coordinate system and the real spatial coordinate system is known, the first coordinate transformation can be expressed as follows:

$$[x_t \ y_t \ z_t \ 1]^k = S[x' \ y' \ z' \ 1]^k$$

Where s is the transformation matrix from virtual space coordinates to world coordinates. If the view conversion matrix m from world coordinates to camera coordinates is obtained, the second coordinate transformation can be expressed as follows:

$$[x_c \ y_c \ z_c \ 1]^r = M_{ext}[x_t \ y_t \ z_t \ 1]^k$$

M_{ext} is called the external parameter matrix of the camera. This transformation is mainly related to the rotation and translation of the coordinate system. External parameters, that is, the orientation of the viewpoint, including a 3 of the viewpoint \times 3 rotation matrix R and a three-dimensional translation vector t. The third transformation is mainly related to the central projection of the camera and the physical distortion of the internal components of the camera. It is generally expressed as a matrix, called the internal parameter matrix, which is recorded as M_{int} , the third transformation can be expressed as follows:

$$[u \ v \ 1]^T = M_{int}[x_c \ y_c \ z_c \ 1]^T$$

Therefore, the correspondence between the camera image coordinates and the coordinates in the world coordinate system can be expressed as:

$$p = MP = M_{int}M_{ext}P$$

Where p is the image coordinate, R is the world coordinate, and M is the projection matrix of the camera.

$$\begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix} = \begin{bmatrix} R(\theta, \psi, \phi) & T \\ 0^T & 1 \end{bmatrix} \begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix}$$

T is the three-dimensional translation variable, the rotation matrix, is a 3×3 orthogonal identity matrix, which is determined by the Euler angles of three rotation matrices. The positive rotation direction of each angle is defined as the counterclockwise rotation direction when viewed along the positive direction of each axis from the origin of the coordinate system.

$$R = \begin{bmatrix} \cos \psi \cos \phi & \sin \theta \sin \psi \cos \phi - \cos \theta \sin \phi & \cos \theta \sin \psi \cos \phi - \sin \theta \cos \phi \\ \cos \psi \sin \phi & \sin \theta \sin \psi \sin \phi + \cos \theta \sin \phi & \cos \theta \sin \psi \sin \phi - \sin \theta \cos \phi \\ \sin \psi & \sin \theta \cos \psi & \cos \theta \cos \psi \end{bmatrix}$$

$$x = \frac{x_c f}{z_c} \quad y = \frac{y_c f}{z_c}$$

The above formula is expressed by matrix as:

$$z_c \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix}$$

The relationship between (x,y)and (u,v) can be expressed as follows:

$$u = \frac{x}{dx} + u_0 \quad v = \frac{y}{dy} + v_0$$

$$\begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{1}{dx} & 0 & u_0 \\ 0 & \frac{1}{dy} & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

The inverse relationship is:

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} dx & 0 & -u_0 dx \\ 0 & dy & -v_0 dy \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

The following formula is obtained:

$$\begin{aligned} z_c \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} &= \begin{bmatrix} \frac{1}{dx} & 0 & u_0 \\ 0 & \frac{1}{dy} & v_0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} f & 0 & 0 & 0 \\ 0 & f & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix} \\ &= \begin{bmatrix} a_x & 0 & u_0 & 0 \\ 0 & a_y & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix} = M_{int} \begin{bmatrix} x_c \\ y_c \\ z_c \\ 1 \end{bmatrix} \end{aligned}$$

Based on the analysis of the above internal and external parameters, the projection matrix of the camera can be obtained:

$$M = M_{im} M_{ext} = \begin{bmatrix} a_x & 0 & u_0 & 0 \\ 0 & a_y & v_0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} R(\theta, \psi, \phi) & T \\ 0^T & 1 \end{bmatrix}$$

3.1.3 Design of Interactive Function of AR-DADL System

In the first unity run test, the ar-dadl model generated by scanning the identification diagram can make readers more intuitively understand the layout of the archives, but can not specifically present the spatial details of each library. If the interactive function of the ar-dadl model is to be realized, the ar-dadl model needs to be compiled in the unity engine through c# language, Let readers interact with ar-dadl model and really make AR-DADL model "live".

After the development of the augmented reality system of the archives is completed, the software installation package named "running under the system" running under the Android system will be exported and generated. Users can download and install the installation package by using the smart phones of Android and apple system to generate a software installation package named "A mobile application with one name can be generated. After the user clicks and opens the mobile application, the user scans the identification map preset by the system with the mobile camera (the identification map preset by the system can be any picture or QR code, electronic or paper picture, for example, AR-DADL system selects the AR identification map in the figure below as the identification map) , the three-dimensional virtual model of the archives can appear. When you touch the screen with your finger, you can interact with the three-dimensional virtual model to more intuitively understand the archives classification and layout of the archives, which is not limited by time and space, but also

interesting. The three-dimensional model of the archives in the AR-DADL system has been stored in the local mobile phone at the time of installation, so all interactive operations are basically simple. Based on local computing, users can interact with each other with little network traffic.

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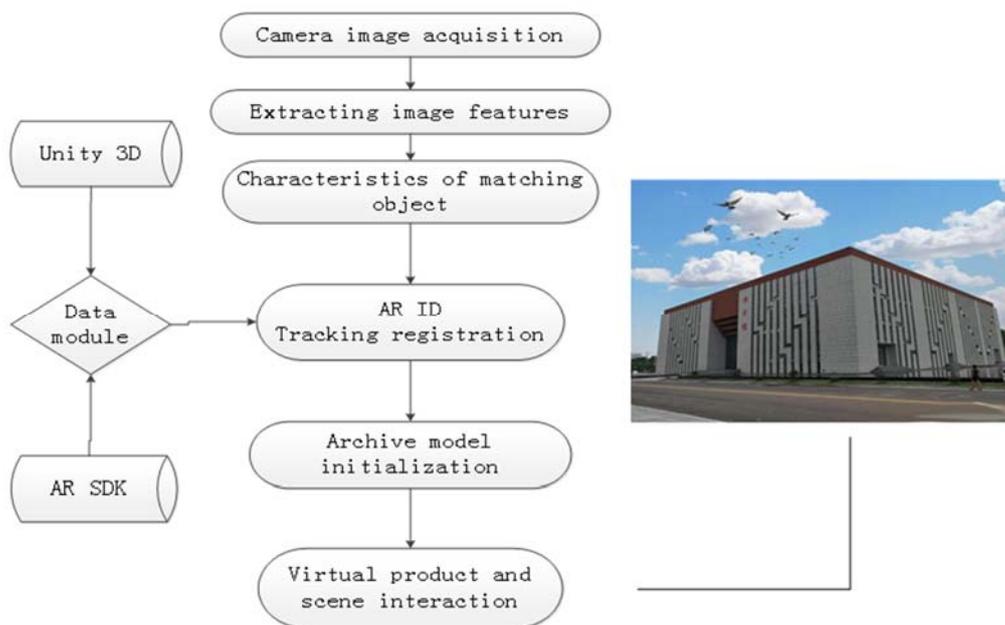


Figure 4. AR-DADL system workflows

4. Prospect of Augmented Reality Application Archive Guide Utilization Service

Developing in the future, augmented reality application in the field of archives will be continuously expanded and extended. On the basis of the experience for reference, augmented reality technology may also play an important role in the publicity and education guidance of teenagers in the future, the public's participation in voluntary archival service, and the design of archival cultural products that inherit archival culture. It is worth paying attention to that the application of augmented reality technology in the field of archives will develop towards the trend of personalized setting for specific target groups, so as to continuously meet the multi-level and multi-directional needs of the social public, and to provide diversified service content, and to achieve better practical application effect. In addition, in the selection of application places and objects of augmented reality technology, augmented reality technology can be used in international Archives Publicity Day, graduation gift

design for graduates, or in general education classes to lead the active participation of the younger generation.

Acknowledgments

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