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Research on Digital Protection and Inheritance Strategy of Non-Heritage Culture Based on Artificial Intelligence

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Abstract. In order to solve the current problems of single form and poor interactivity of intangible cultural heritage protection, research on digital protection and inheritance strategies of intangible cultural heritage based on artificial intelligence is proposed. Taking the protection of clay sculpture intangible cultural heritage as an example, this paper designs the main functional modules of the system cloud and mobile terminals, proposes a rapid modeling method based on a combination of three-dimensional scanning and grid iterative simplification, and uses ORB-FV and optical flow tracking algorithms to achieve online recognition of images. and tracking registration, complete system development based on Unity3D, and conduct experimental verification. The experimental results show that the total time taken by the system to complete image recognition, tracking registration and three-dimensional rendering is 36.5ms, which can meet the real-time system requirements of mobile augmented reality. Conclusion: This system not only meets the requirements of realism and fluency for the enhanced display of intangible cultural heritage products on the mobile terminal, but also realizes the real-time interactive coloring display function after the enhanced display of the model, which enhances the fun and interactivity of the protection and dissemination of intangible cultural heritage.

Keywords. intangible cultural heritage; mobile augmented reality; ORB-FV; Unity3D

1. Introduction

Intangible cultural heritage (hereinafter referred to as "intangible cultural heritage") carries the great development process of human social civilization and the nation's "genes and blood". It is the spiritual wealth belonging to the country and all people [1]. Thanks to the continuous development of intelligent media and the continuous advancement of cultural digitization, traditional cultural communication channels have been further activated and embedded in a new digital communication context with highly intelligent characteristics [2]. Based on the continuous improvement and improvement of the

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intangible cultural heritage protection and inheritance system and the significant increase in dissemination and popularization efforts, intangible cultural heritage, as a basic component of the national cultural content system, has gained new opportunities to achieve structural innovation and enhance communication vitality, and has entered a new era. The "digital intelligence" empowerment development stage [3]. Relying on digital intelligent technology, intangible cultural heritage will be more effectively protected, disseminated, inherited and innovated.

The exploration of the digital education model of non-heritage is based on the demand for the protection and inheritance of traditional non-heritage culture, and the use of advanced digital technology means to integrate non-heritage culture into education, in order to improve the public's knowledge and understanding of non-heritage culture. The promotion and implementation of this model has important social value [4]. The digital education model of NHM can help traditional NHM culture to be better inherited and promoted. Through the digital platform, NHs can record, display and disseminate their skills, techniques and other elements of NHs, so that more people can come into contact with and learn from NHs, and promote the inheritance and development of NHs [5]. Secondly, the digital education mode of non-heritage can increase the public's knowledge and interest in non-heritage culture.

Traditional non-heritage culture is often difficult to be understood by the public because of information asymmetry and limited inheritance channels. Through the digital education model, it can break through the geographical limitations and allow more people to come into contact with the non-heritage culture and understand the history, skills and values behind it, thus increasing the knowledge and interest in the non-heritage culture [6]. In addition, the digital education model of NRH can also promote the development of NRH industry. Through the digital education platform, traditional non-heritage culture can be effectively combined with modern science and technology to promote the innovation and upgrading of non-heritage products, and improve the added value and market competitiveness of non-heritage products [7]. At the same time, digital education can also cultivate more non-heritage practitioners and enthusiasts, and inject new vitality and vigor into the non-heritage industry [8].

This article digitally protects cultural heritage through AR, which brings the distance between users and ancient culture closer. Therefore, this article uses mobile terminals as the development platform and applies MAR technology to the digital protection of intangible cultural heritage. This method is not only low-cost and easy to promote, but also attaches great importance to the combination of intangible cultural heritage and new technologies that are in line with the times, allowing users to enjoy entertainment The charm of intangible cultural heritage can be felt through the experience, which has certain theoretical and practical significance for the protection and dissemination of intangible cultural heritage.

2. Methodology

2.1 System development framework and functional design

MAR technology applies AR technology to mobile terminal devices, which has high mobility, freedom and flexibility. The MAR-based intangible cultural heritage online display system provides a comprehensive explanation of the handicrafts, and at the same time increases the interactivity and interest of users in learning the production process [9].

This system consists of two parts: the mobile terminal and the cloud. The cloud consists of a Web server and a database, and the mobile terminal is completed using a smartphone [11]. The job of the mobile terminal is to upload the captured images to the cloud through preprocessing. The preprocessing mainly includes two aspects: binarization and denoising, which not only speeds up image transmission, but also reduces image retrieval time. The job of the cloud is to perform image retrieval of the received images in the image resource library. If the retrieval is successful, the corresponding enhanced information will be obtained through the lookup table, and then packaged and sent back to the mobile terminal. Finally, the fusion of virtual and real information will be implemented on the mobile terminal. Visual display [12].

The system function modules are mainly divided into cloud module and mobile module.

The cloud module includes: (1) image retrieval module, the module needs to retrieve the target image of the video frame and the cloud image library for feature point matching, feature point matching is successful, then the retrieved target image for information enhancement [13]. (2) Resource management module, the module will manage the multimedia material resources required by the system. Users upload files in the mobile terminal, the cloud for resource storage, it will be stored in the resource classification and create the corresponding data table, improve the efficiency of the user information retrieval.

The mobile module includes: (1) virtual reality fusion module, which uses augmented reality technology in computer vision images to realize the ultimate effect of fused reality. Firstly, the target image is scanned by the cell phone camera, then the feature points in the image are extracted and matched with the image in the cloud and the information is fused, and finally the enhanced model is displayed on the cell phone. (2) Human-computer interaction module, this module is the exchange of information between human and computer, there are three kinds of interaction: ① by triggering the button event to interact; ② gesture operation, through the touch screen to realize the model of zoom, pan and rotate the 360-degree observation; ③ the user in the identification of the card in a specific area of real-time creative coloring. Figure 1 introduces the main functions of each module.

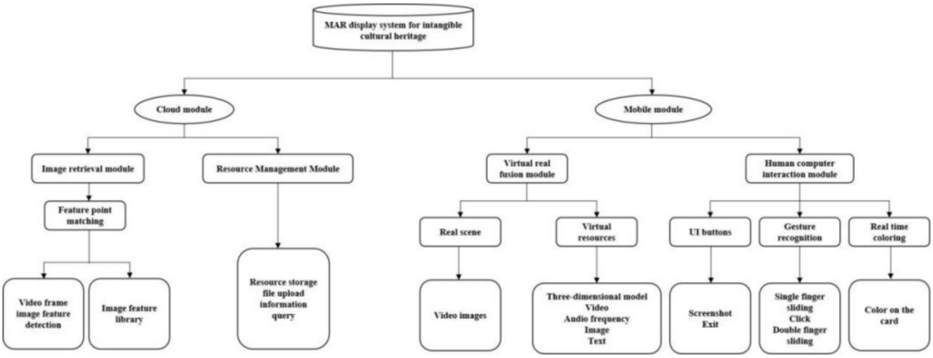

Figure. 1 The main functional modules of the system

2.2 3D modeling and optimization of the clay modeling class

The clay sculpture online recognition system is developed based on MAR technology, mainly using three-dimensional modeling and optimization technology, image online recognition technology, tracking registration and display interaction technology.

The clay sculpture is small in size and has a simple single-sided coloring structure. Therefore, the HANDYSCAN 300 3D handheld self-positioning scanner is used to model the clay sculpture. This method is convenient, fast, and not prone to distortion. First, the 3D scanner projects the encoded raster onto the surface of the target object and captures the modulated raster image. Then, the point cloud data and x, y, z coordinates are obtained through the algorithm embedded in the scanner, and then the obtained 3D point cloud data is created in real time. 3D mesh model, and perform image splicing and registration, smooth synthesis, mesh simplification, etc. on the obtained real-time data. Finally, the obtained triangular mesh is textured to reconstruct a 3D clay model with a strong sense of reality. This article uses the vtk Quadric Decimation grid iterative simplification algorithm to optimize the grid of the .obj three-dimensional model data output after scanning. The algorithm process is as follows:

(1) Compute the matrix for all initial vertices; the

(2) Select all valid edges.

(3) For each valid edge, calculate the optimal extraction target, and the error is the cost of the extracted edge;

(4) Put all edges into a heap according to the weight of (cost);

(5) Remove the smallest edge (cost) each time, and then update the cost of all valid edges containing V_1.

Calculate the initial error matrix Q for each vertex. In the original mesh model, each vertex is the intersection of its surrounding triangle patches, and the error of the vertex is defined as the sum of the squares of the distance from the vertex to the plane:

$$\Delta(v) = \Delta([v_x \quad v_y \quad v_z \quad 1]^{\mathrm{T}}) = \sum_{p\in \mathrm{plans}(v)} (\boldsymbol{p}^{\mathrm{T}}\boldsymbol{v})^2 = \sum_{p\in \mathrm{plans}(v)} (\boldsymbol{v}^{\mathrm{T}}\boldsymbol{p})(\boldsymbol{p}^{\mathrm{T}}\boldsymbol{v}) = \sum_{p\in \mathrm{plans}(v)} \boldsymbol{v}^{\mathrm{T}}(\boldsymbol{p}^{\mathrm{T}})\boldsymbol{v} = \boldsymbol{v}^{\mathrm{T}}\left(\sum_{p\in \mathrm{plans}(v)} \boldsymbol{K}_p\right)\boldsymbol{v} \tag{1}$$

where P=[a b c d] $^{\mathrm{T}}$ represents the plane equation $ax + by + cz + d = 0, a^2 + b^2 + c^2 = 1$ The coefficient of k_p is the quadratic basic error matrix:

$$\boldsymbol{K}_p = \boldsymbol{p}\boldsymbol{p}^{\mathrm{T}} \begin{bmatrix} a^2 & ab & ac & ad \\ ab & b^2 & bc & bd \\ ac & bc & c^2 & cd \\ ad & bd & cd & d^2 \end{bmatrix} \tag{2}$$

Therefore, the initial error of vertex v in the original grid is 0. When the edge shrinks, the edge that minimizes the error of the new vertex after shrinkage is selected in turn, and iterative shrinkage is performed until the conditions are met.

Taking the scanning optimization of the monkey clay model as an example, the number of patches after optimization is significantly reduced. The model.obj format size before optimization is 1.6G, and after optimization it is 496KB. The test results show that the method of combining three-dimensional scanning and mesh iterative simplification can not only achieve rapid modeling of clay sculpture-like intangible cultural heritage, but also can well meet the requirements of mobile screen model display realism and smoothness.

2.3 Image on-line recognition

This paper utilizes the server and adopts the image online recognition technology to realize the real-time search of images. The online recognition system firstly uses the mobile smartphone camera to capture the target image and collect the image features, then describes the features with descriptors, matches the feature characters with the information feature template library in the server, and finally realizes the online recognition of the image. The online recognition system reduces the hardware requirements of the system, and makes the system scalable and portable at the same time.

This paper uses the ORB descriptor Fisher vector conversion algorithm (ORB-FV algorithm for short) proposed by Y Uchida to realize system online identification. Figure 2 is the algorithm flow. The specific algorithm is implemented as follows:

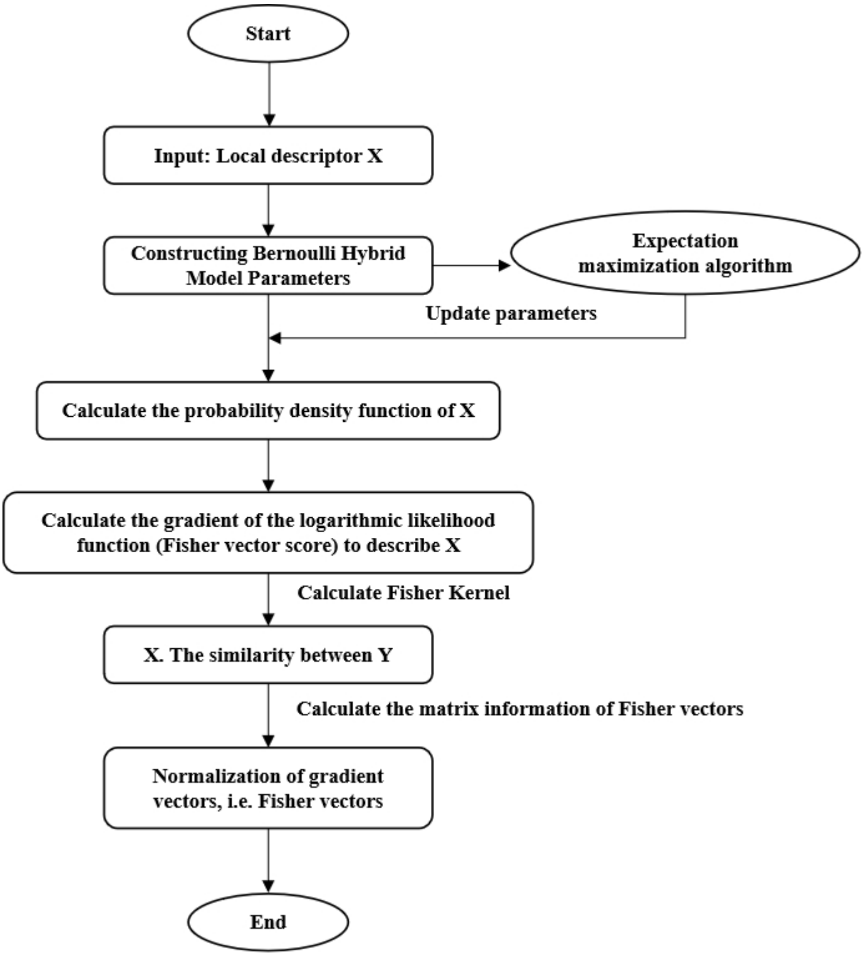

Figure 2. ORB-FV algorithm flow chart

First, let xt represent the D-dimensional features among T ORB features extracted from the image. hypothesis $\lambda = \{\omega_i, \mu_{id}, i = 1,2,\cdots,N, d = 1,2,\cdots,D\}$ represents a set of parameters of a multivariate Bernoulli mixture model with N components, and xtd represents the dth xt. Given a parameter set, the probability density function of T features X is described as

$$p(X \mid \lambda) = \prod_{t=1}^{T} p(x_t \mid \lambda) \\ p(x_t \mid \lambda) = \sum_{i=1}^{N} \omega_i p_i(x_t \mid \lambda) \\ p_i(x_t \mid \lambda) = \prod_{d=1}^{D} \mu_{id}^{x_{dd}} (1-\mu_{id})^{1-x_{td}} \tag{3}$$

To estimate the value of the parameter set, given a set of training features, apply the expectation maximization algorithm. In the expected step, the probability of xs generated by the ith component of the Bernoulli mixture model is

$$\gamma_s(i) = p(i \mid x_s, \lambda) = \frac{\omega_i p_i(x_s|\lambda)}{\sum_{j=1}^{N} \omega_j p_j(x_s|\lambda)} \tag{4}$$

In the maximization step, update the parameters.

$$S_i = \sum_{s=1}^{S} \gamma_s(i);\ \omega_i = S_i/S; \\ \mu_{id} = \frac{1}{S_i} \sum_{s=1}^{S} \gamma_s(i) x_{sd} \tag{5}$$

2.4 Tracking registration

Tracking and registration technology is a key module in AR technology, and the accuracy of tracking and registration determines the performance of the system. Tracking registration technology is an alignment process that displays virtual information in the correct position of the real scene in real time, achieving seamless integration of virtual information and real scenes. Through image recognition technology, the system converts the position coordinates of the target image and the real scene position coordinates through a transformation matrix, and obtains the exact position through image analysis of the landmarks in the real scene, achieving the purpose of real-time registration. Optical flow tracking (Kamade-Lucas-Tomasi Feature Tracker, KLT for short) algorithm is an image feature optical flow tracking algorithm based on optimal estimation. It uses the feature points of the known image frame to predict the rough position of the feature points of the next frame. The experiment uses the KLT algorithm to complete target tracking and registration, improve the efficiency of the system's three-dimensional tracking and registration, and meet the real-time and robustness requirements of the augmented reality system.

2.5 Display and Interaction

This article uses the Unity3D development platform, and the model rendered by Unity3D is always superimposed on the view of the mobile IDE, and has effects such as occlusion on the real scene. In addition, the 3D solution provided by the OpenGL ES 3D engine packaged within Unity3D can be visualized. After completing the modeling, import the clay FBX model into Unity3D and adjust the interactive scene by controlling the intensity of the ambient light source. In addition, the logic of the system needs to be constructed so that the screen displays the effect of coupling the virtual model and the real scene, and the model and target image are accurately registered. When the camera angle changes, the model also changes to achieve a real augmented reality effect.

3. Results and discussion

During the experiment, 100 times were recorded and averaged, and the average time consumption data of each stage was obtained, as shown in Table 1. The total time taken by the system to complete image recognition, tracking registration and 3D rendering is 36.5ms, which can meet the real-time system requirements of mobile augmented reality.

Table 1. Average time taken for the experimental procedure

experimental steps	Average time spent /ms
ORB-FV image online recognition	19.4
KLT optical flow tracking registration	10.2
Model rendering	6.9

4. Conclusion

This article proposes a study on the digital protection and inheritance strategy of intangible cultural heritage based on artificial intelligence. The most important thing about the inheritance and protection of intangible cultural heritage is the cultural connotation and spiritual inheritance. This article applies mobile augmented reality technology to the online display of intangible cultural heritage, proposes a rapid modeling and optimization method suitable for clay sculpture intangible cultural heritage, realizes image recognition and tracking registration based on ORB-FV and KLT algorithms, and develops a multi-functional An interactive form of digital online display of intangible cultural heritage AR system allows users to feel the charm of intangible cultural heritage in an entertaining experience. The development of this system not only contributes to the digital protection of intangible cultural heritage, but is also of great significance to the dissemination of the cultural value of intangible cultural heritage.

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