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Application of Artificial Intelligence in the Digital Protection and Inheritance of Intangible Cultural Heritage

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Abstract

Intangible cultural heritage (ICH), which is regarded as a treasure of human civilization, is loaded with abundant historical, cultural and ethnic memories. Since globalization is accelerating and the modernization process is moving forward, a great number of ICH are in danger of vanishing. For the purpose of effectively protecting and inheriting these invaluable resources, artificial intelligence (AI) technology has been gradually introduced into the digital protection and inheritance of intangible cultural heritage. This article first presents the current situation regarding the protection and inheritance of ICH, and then expounds in detail on the specific application methods of AI in the digital protection and inheritance of ICH, such as data collection and processing, intelligent classification and identification, virtual restoration and reproduction, etc. Subsequently, through experimental investigations, this article analyzes the actual effects and potential values of AI technology in the protection and inheritance of ICH. The experimental results indicate that artificial intelligence technology can remarkably enhance the efficiency and accuracy of the protection and inheritance of intangible cultural heritage, with the accuracy rate varying from 85% to 92%, which offers new motivation for the sustainable development of ICH.

Keywords: intangible cultural heritage, Artificial Intelligence, digital protection, cultural inheritance

1. Introduction

ICH includes oral traditions, performing arts, social practices, rituals and festivals, knowledge and practices about nature and the universe, and traditional crafts, and is an important part of human cultural diversity. However, due to various reasons, these valuable cultural heritages are facing the risk of being forgotten and disappearing. Although a large number of studies have focused on the protection and inheritance of ICH, most existing methods focus on traditional recording and display methods, lacking innovation and interactivity. In addition, the complexity of data collection and processing also limits the widespread dissemination and in-depth research of cultural heritage.

This article first introduces the background and challenges, then analyzes the shortcomings of the relevant literature, and then elaborates on the method proposed in this article, and verifies its feasibility and effectiveness through experiments. Finally, the research results are summarized and the direction of future improvements is pointed out. The main contribution of this article is to propose a digital protection and inheritance method for ICH based on AI. This method combines advanced technologies such as data mining, intelligent recommendation, and virtual reality, and provides new ideas and solutions for the protection and inheritance of ICH.

2. Related Work

In recent years, many scholars have conducted in-depth research on the protection and inheritance of ICH and proposed a variety of protection methods and inheritance strategies. Among them, digital protection, as an emerging means, has gradually attracted widespread attention. Scholars use digital technology to transform ICH

into digital resources for easy storage, dissemination and sharing. As a treasure of human civilization, ICH has received widespread attention and research in recent years. Hou et al. reviewed the current state of technology and application of the digitization of ICH, put forward the challenges and opportunities in the digitization process, and pointed out that other studies may lack comprehensiveness and depth (Hou Y, Kenderdine S, Picca D, et al., 2022). Eichler J analyzed the inequality in the decision-making process of ICH and emphasized the need for broader participation and fairness in protection (Eichler J., 2021). At the same time, Chen Z explored ways to transform ICH into tourism experiences through visualization technology to enhance its appeal (Chen Z., 2022). Lazaro et al. conducted a critical analysis of the UNESCO ICH Convention and pointed out the problems in the implementation of the Convention (Lazaro Ortiz S & Jimenez de Madariaga C., 2022). Giglitto et al. studied the role of ICH as a bridge between institutions, civil society and immigrant communities, emphasizing its role in promoting social integration and cultural diversity (Giglitto D, Ciolfi L & Bosswick W., 2022). In the field of education, Lovtsova et al. proposed a method to protect ICH by implementing additional general education programs in the field of fine arts (Lovtsova I V, Burovkina L A & Sheshko A S., 2021). In addition, Jing et al. explored the digital application of ICH from the perspective of cultural ecology, aiming to maintain the integrity of its cultural ecology (Jing X, Tan F & Zhang M., 2021). Yue et al. took the horse-faced skirt of the Qing Dynasty as an example and explored in depth the digital protection and inheritance methods of ICH (Yue M, Wang G & Li Z., 2022). With the growth of technology, Belhi et al. studied how to use machine learning frameworks to enhance the digital experience of cultural heritage and create richer ways to experience ICH (Belhi A, Bouras A, Al-Ali A K, et al., 2023). Finally, Egarter et al. explored the use of AI and social media data to evaluate cultural ecosystem services in order to improve the accuracy of the evaluation (Egarter Vigl L, Marsoner T, Giombini V, et al., 2021). These studies have provided valuable theoretical and practical support for the protection, inheritance and growth of ICH. Although digital protection has achieved remarkable results in the protection and inheritance of ICH, there are still some shortcomings. For example, problems such as incomplete data collection, low processing efficiency, and limited intelligent analysis have restricted the further application and promotion of digital protection technology. Therefore, this article optimizes the application of digital protection and inheritance of ICH based on AI.

3. Method

3.1 AI Algorithm

This article focuses on the intelligent algorithm optimization problem of intangible cultural products and studies the linear algebra operation of matrix multiplication. Matrix multiplication is the multiplication of two matrices A and B, which can be combined to create a new matrix C through specific calculation rules. This operation plays an important role not only in mathematics, but also in the intelligent algorithm optimization of intangible cultural products (Liu L, Tianyun Q & Dongbo W., 2020). Through matrix multiplication, this article can effectively process and analyze a large amount of cultural heritage data, extract key information, and promote the digital preservation and dissemination of intangible cultural products. The prerequisite for this operation is that the number of columns in A must be equal to the number of rows in B.

$$mathbfC = A \times B \tag{1}$$

In representation, if A is an m×n matrix and B is an n×k matrix, then their product C will be an m×k matrix, denoted as C=AB. Matrix multiplication does not satisfy the commutative law, but it does satisfy the associative and distributive laws. In a geometric sense, matrix multiplication can be understood as a linear transformation. For example, in a two-dimensional plane, a 2×2 matrix can represent a rotation, scaling, or shearing transformation; in a three-dimensional space, a 3×3 matrix can represent a rotation, scaling, or translation transformation (translation requires an affine transformation matrix).

$$theta_j = \theta_i - \alpha \frac{\partial}{\partial \theta} J(\theta) \tag{2}$$

θ_j is the parameter, α is the learning rate, J(θ) is the loss function, and formula 2 is to minimize the loss function and optimize the model parameters. In the process of digitization of ICH, training machine learning models plays a vital role. It helps this article accurately identify and protect the key features that carry profound historical and cultural heritage. In this process, AI algorithms gradually learn and extract the unique patterns of these features by learning from a large amount of cultural heritage data (Li M, Wang Y & Xu Y Q., 2022). These features may be hidden in ancient documentary records or revealed in the exquisite details of traditional handicrafts.

In order to ensure that the model can accurately identify these key features, this article needs to provide the machine learning system with rich and diverse training samples. These samples cover a wide range of ICH fields,

from music and dance to handicrafts and oral legends (Di Giulio R, Boeri A, Longo D, et al., 2021). During the training phase, the model continuously iterates and adjusts its internal parameters to maximize the consistency of actual features and minimize the false detection rate. The continuous deepening of model training also improves its recognition ability. It can not only identify known features of cultural heritage, but also predict and discover new features to a certain extent. This provides strong technical support for efforts to protect intangible cultural assets and enables this article to more effectively record and protect this valuable cultural heritage. Through the training model, this article can better identify and protect the key elements of ICH, thereby contributing to the dissemination of science and technology and enhancing the power of this valuable cultural heritage (Ariffin W J W, Shahfiq S, Ahmad F, et al., 2023).

3.2 Application of AI Algorithms in the Digital Protection of ICH

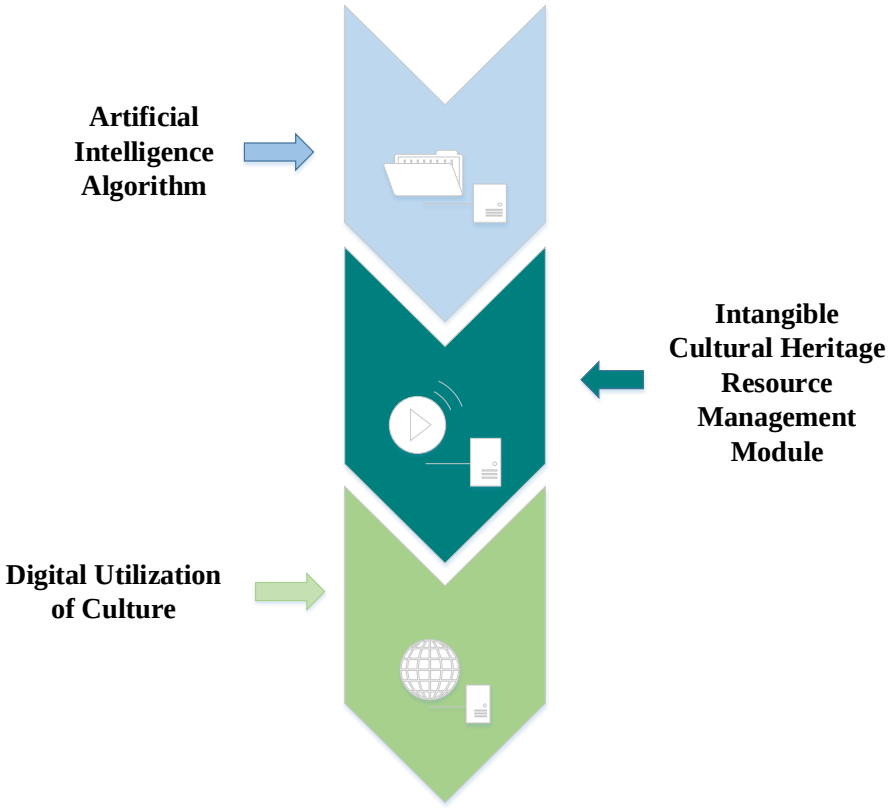

Figure 1. The process of digital protection of ICH

When discussing the application of AI in the digital protection and inheritance of ICH, the AI algorithm in Figure 1 is used as the core driving force, closely integrated with the ICH resource management module, and the deep integration of science and technology and cultural heritage has opened up a new path for the protection and inheritance of ICH (Selmanović E, Rizvic S, Harvey C, et al., 2020). In the cultural resource management module, this article incorporates the rich cultural diversity of the world into this management system. Through the intervention of AI, these precious ICH resources can be effectively sorted, classified and stored, laying a solid foundation for subsequent digital utilization. Furthermore, these cultural resources are converted into digital cultural resources and stored in cloud databases or digital storage platforms (Hsu F C, Zhang S, Zhang Y, et al., 2022; Aktürk G & Lerski M., 2021). This step not only makes it easier to obtain and disseminate cultural resources, but also greatly improves the accessibility and sustainability of cultural resources. Ultimately, these digital cultural resources are accessed and utilized by a wide range of users. Users can appreciate the beauty of ICH from all over the world through simple operations, which undoubtedly injects new vitality into the inheritance and growth of culture. It not only improves the utilization efficiency of cultural resources, but also provides strong technical support for the inheritance and growth of culture (Tan N, Anwar S & Jiang W., 2023).

3.3 Experimental Testing Process

In the experimental testing process, this article first needs to clarify the objectives of the experiment. Then, this article will carefully prepare the data set according to the experimental objectives to ensure the diversity and

representativeness of the data so that it can fully reflect the actual situation of the digitization of ICH. In the data preparation stage, this article prepared the test data in Table 1, where the data type corresponding to serial number A is image, and the specific data content is article cutout works, the number of which reaches 35. Serial number B corresponds to the audio frequency data type, which records the information of Peking Opera, the number of which is 46. Serial number C corresponds to the video data type, recording videos of shadow puppet performances, with a total of 41. Serial number D again corresponds to the image data type, but this time it records embroidery patterns, with a total of 48. Serial number E corresponds to the video data type, recording videos of folk music, with a total of 47. Finally, serial number F corresponds to the audio frequency data type, but the content is records about Kunqu performances, and the number is 52.

Table 1. Test the experimental data

Serial number	Data type	Data content	Number of data
A	Image	article cuttings works	35
B	Audio frequency	Beijing opera chorus	46
C	Video	Shadow puppetry performance	41
D	Image	Embroidery pattern	48
E	Video	folk music	47
F	Audio frequency	Kunqu opera performance	52

Then, this article will select appropriate AI algorithms and implement the algorithms based on the characteristics of the data set. In the model training and optimization stage, this article will use the training data set to iterate the algorithm for multiple times, and improve the performance of the model by adjusting parameters, optimizing the model structure, etc., until the model reaches a satisfactory performance level. Finally, this article will use the test data set to test the trained model, record the test results, and evaluate the performance of the model. The evaluation indicators can include the accuracy of intangible heritage recognition and data processing efficiency.

4. Results and Discussion

4.1 Accuracy of Intangible Heritage Identification

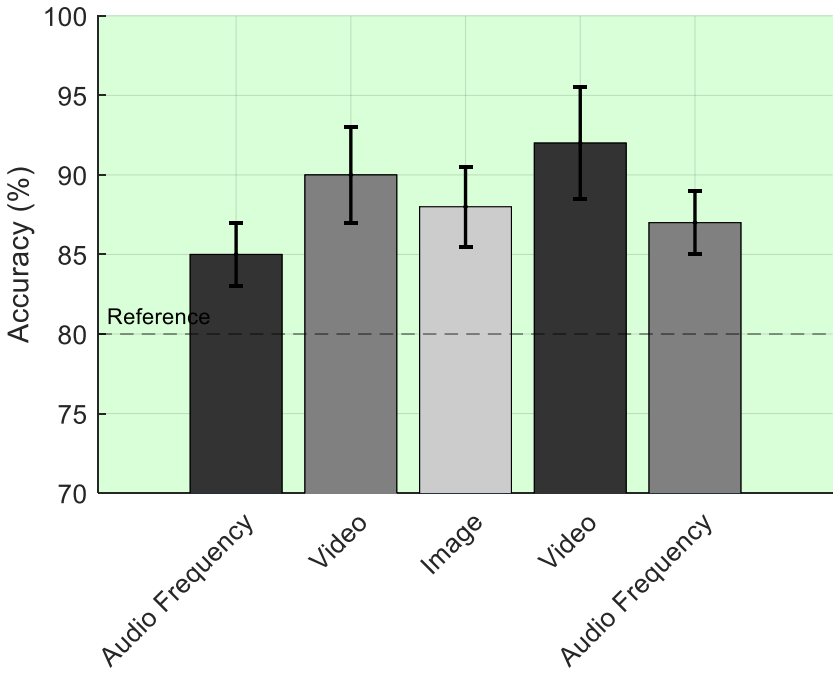

Figure 2. Identification accuracy

This article conducts a detailed test on the recognition accuracy of ICH in different forms such as audio, video,

and images, and Figure 2 intuitively shows the recognition accuracy of these ICH. It can be clearly seen from the figure that the accuracy ranges from 85% to 92%, with specific data of 85%, 90%, 88%, 92% and 87% respectively. The error range corresponding to each data point is also small, 2, 3, 2.5, 3.5 and 2 respectively, which fully proves the stability and reliability of the recognition technology. The accuracy of video data is generally high, all around 90%, which fully demonstrates the unique advantages of video data in the recognition of ICH. As a multimedia form that integrates images, sounds and dynamic information, video can more comprehensively and vividly display the rich connotation and unique charm of ICH, thereby improving the accuracy and efficiency of recognition. By using advanced recognition technology, this article can more effectively explore, protect and inherit these precious cultural heritages. At the same time, the advantages of video data also provide new ideas and methods for this article, that is, to transform ICH into a more vivid and easy-to-spread form through digital means, so that more people can understand and appreciate these precious cultural heritages, thereby promoting their inheritance and growth.

4.2 Intangible Heritage Data Processing Efficiency

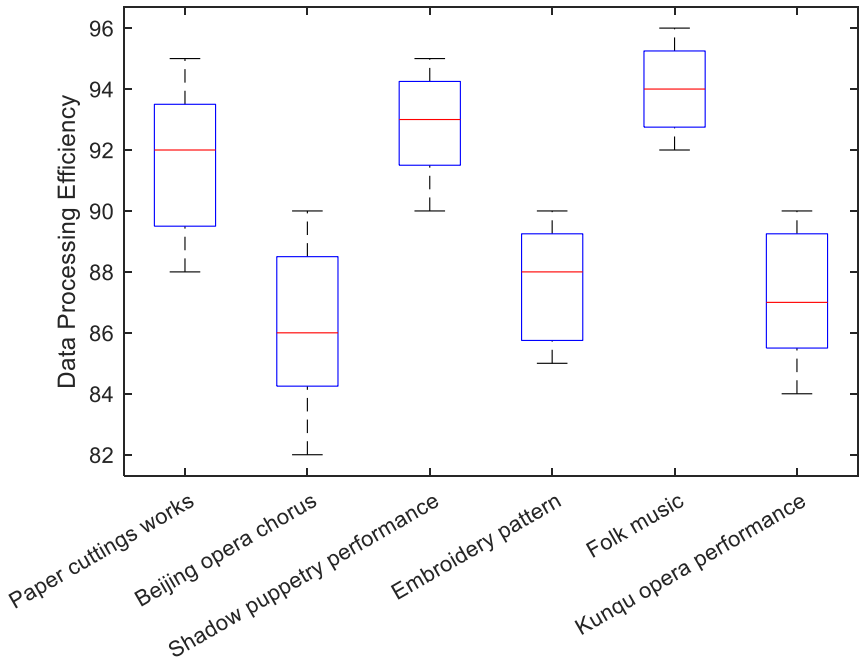

Figure 3. Data processing efficiency

By comparing the data processing efficiency of different intangible heritages, this article found that these data showed obvious differences in the box plots. According to the test data in Figure 3, the data for article-cutting is concentrated between 88 and 95, with a median of about 92; the data for Peking Opera is relatively low, ranging from 82 to 90, with a median of about 86; and the data for shadow puppet performance is generally higher, ranging from 92 to 96, with a median of 94. In addition, the data for embroidery patterns and folk music are concentrated in the range of 85 to 90 and 90 to 95, respectively, with medians of approximately 88 and 93, respectively; the data for Kunqu opera performances are between 84 and 90, with a median of approximately 87. Analysis of variance further verifies that these differences are not accidental, and its p value is less than 0.05, indicating that there are significant differences in data processing efficiency among different intangible heritage-related indicators.

5. Conclusion

This article discusses the application of AI in the digital preservation and heritage of intangible cultural properties. The experimental results show that AI has significant efficiency and potential value in the digital preservation and dissemination of intangible cultural products. Through intelligent means, this article can capture and protect ICH more effectively, while providing more opportunities for its inheritance and growth. Although this article gives some results, there are still some gaps. First, regarding data protection and security, this article needs further research to ensure that digital information about ICH is not leaked or abused. Secondly, the accuracy and robustness of intelligent algorithms need to be further improved to better adapt to the complexity

and diversity of intangible cultural products. These issues need to be studied and resolved in future research in this article. In view of the above defects, this article will further explore these problems and propose corresponding solutions in the future. This article will strengthen the research on data protection and security technology to ensure the full protection of the digital information of ICH. Through continuous efforts and innovation, this article believes that AI technology will play a greater role in protecting and disseminating ICH.

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