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AI-Enabled Intelligent Cultural Tourism Guide System: Theoretical Construction and Practical Paths for In-Depth Rural Tourism Experiences

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ABSTRACT

Against the backdrop of the in-depth advancement of the rural revitalization strategy, rural tourism has become a core carrier for activating rural economic vitality and inheriting local culture. However, the pain points of traditional interpretation models—such as outdated information, single interaction, and superficial cultural experiences—stand in sharp contradiction to the new generation of tourists' demands for immersive, personalized, and intelligent experiences. From an interdisciplinary perspective integrating digital humanities and technological applications, this study constructs a theoretical framework and practical scheme of an "AI digital guide" aiming to resolve the structural contradictions in rural tourism interpretation. The research decodes rural cultural genes and realizes scenario-based reconstruction through knowledge graph technology, builds dynamic tourist portraits and intelligent recommendation mechanisms based on multi-dimensional data, establishes a human-machine collaborative service network of "AI assistant + local cultural holders", and forms a low-threshold technical scheme adapted to rural infrastructure. The core innovations are reflected in three dimensions: theoretically, proposing the concept of "cultural digital twin" and the "Scenario-Cognition-Behavior (SCB) Model" to fill the theoretical gap in rural cultural digitization; practically, pioneering a dual-track human-machine collaborative service model to balance technical efficiency and humanistic warmth; methodologically, forming a "technology-culture-economy" three-dimensional integrated research paradigm to provide methodological reference for non-technical disciplines participating in AI cultural tourism research. Without empirical analysis, this study focuses on theoretical construction and practical path design, offering replicable framework solutions for the intelligent transformation of rural tourism and opening up new perspectives for interdisciplinary research in tourism management, artificial intelligence, and cultural communication.

KEYWORDS

Rural tourism; AI intelligent guide; Cultural digitization; Human-machine collaboration; Rural revitalization; SCB model

1 Introduction

The quality upgrading of rural tourism is inseparable from the innovation of interpretation services. Currently, rural tourism interpretation still mainly relies on fixed signs, voice broadcasts, or human guides. The former has slow information updates and rigid interaction, making it difficult to convey tacit culture such as intangible cultural heritage (ICH) and oral history [1]; the latter is limited by labor costs, failing to achieve large-scale and personalized services. Meanwhile, Generation Z has become the core consumer group of rural tourism, and their demand for cultural immersion and intelligent interaction has further intensified this "supply-demand contradiction".

The maturity of artificial intelligence (AI) technology provides a possible solution to this contradiction. The real-time interaction capability of Natural Language Processing (NLP), the scene integration technology of computer vision and Augmented Reality (AR), and the personalized adaptation function of recommendation algorithms have demonstrated strong effectiveness in urban cultural tourism and museum scenarios [2]. However, the application of AI in rural scenarios faces adaptation challenges: cultural digitization models are mostly targeted at standardized scenarios such as museums, making it difficult to adapt to the "liveness and dispersion" of rural culture; technical schemes rely on high-cost VR/AR equipment, which is disconnected from the rural infrastructure of low bandwidth and low configuration; existing research focuses more on technical functions, ignoring the collaboration with local cultural holders and economic sustainability [3].

Based on this, this study takes the "AI-enabled intelligent cultural tourism guide system" as the core carrier, based on the economic perspective of finance and accounting disciplines, and collaborates with computer teams to construct an "AI digital guide" framework. The core objectives are: to fill the theoretical gap in rural cultural digitization; to design a low-threshold technical scheme adapted to rural reality; to establish a human-machine collaborative service model [4-5]; to form an interdisciplinary research paradigm. Without empirical analysis, this study focuses on theory and practical paths, providing guidance for the intelligent transformation of rural tourism.

2 Literature Review

2.1 Traditional Rural Tourism Interpretation Research

Early research focused on improving the professional quality of human guides and standardizing sign systems. In the later stage, it shifted to the application of electronic interpretation tools, but most of them were digital reproductions of traditional models, failing to solve the problem of superficial culture [6]. In recent years, personalized research has attempted to design routes based on tourist portraits, but only relying on basic data, lacking in-depth consideration of

cultural preferences; although the concept of "culture-empowered interpretation" has been proposed, no specific technical paths have been given, leading to difficulties in the implementation of research results..

2.2 Research on AI Application in Cultural Tourism

Research on AI in cultural tourism has gone through three stages: basic function realization, recommendation algorithm application, and in-depth integration. However, the extension to rural scenarios has obvious shortcomings: poor adaptability of technical schemes, as high-cost equipment is incompatible with rural infrastructure; insufficient theoretical depth, as the human-machine collaboration mechanism only involves qualitative descriptions; single disciplinary perspective, ignoring cost-effectiveness and sustainability, making it difficult to promote [7].

2.3 Research on Rural Cultural Digitization and Inheritance

Cultural digitization research has shifted from storage to activation, but rural-related research lags behind: most focus on the digitization of single cultural elements (such as 3D modeling of Hakka Tulou), staying at the "display-oriented" level, disconnected from tourism experiences [8]; lacking rural-specific theoretical models with poor adaptability; ignoring local participation, resulting in digital content divorced from reality.

2.4 Research Review

Existing research has three core academic gaps: the lack of exclusive theoretical models for rural cultural digitization; the lack of rural-adapted schemes and human-machine collaboration mechanisms in AI cultural tourism research; insufficient interdisciplinary participation, making it difficult to balance technical feasibility, economic sustainability, and humanistic warmth. This study carries out innovations targeting these gaps [9-10].

3 Research Framework and Core Content

3.1 Decoding of Rural Cultural Genes and Scenario-Based Reconstruction

The tacit and scattered nature of rural culture requires breaking through static classification for decoding. Through literature review (local chronicles, ICH lists), in-depth interviews (inheritors, senior villagers), and participant observation (festivals, production activities), the study extracts core cultural elements, such as Tulou construction techniques and Hakka folk song rhythms [11].

Neo4j is used to construct a knowledge graph, transforming elements into "entity-relationship-attribute" triples (e.g., "Tulou - contains - construction techniques") to achieve dynamic association [12]. Combined with lightweight AR technology, tourists can trigger interactive experiences by scanning codes: AR restores the construction process in front of Tulou, and AR shows the entire process of handicrafts in ICH workshops; generative AI is introduced to dynamically generate personalized cultural content according to tourists' preferences (cartoon cultural stories for parent-child tourists, in-depth interpretations for cultural enthusiasts), realizing the "dynamic communication" of culture [5].

3.2 Construction of Dynamic Tourist Portraits and Intelligent Recommendation Mechanisms

The diversified demands of rural tourists require the construction of dynamic portraits. Spatiotemporal trajectory data are collected through scenic WiFi probes (to identify points of interest), emotional tendency data are analyzed through NLP (reviews and feedback), and consumption preference data are collected through stratified sampling questionnaires, forming three-dimensional data.

K-means clustering is used to identify four typical groups: "cultural in-depth experience type", "leisure sightseeing type", "parent-child interaction type", and "health and wellness vacation type"[13]. LSTM time-series neural networks predict subsequent points of interest. Based on reinforcement learning (Q-learning), a recommendation algorithm is designed: taking tourists' real-time behavior as the "environment" and feedback as the "reward", dynamically optimizing content. For example, if tourists are interested in ancient bridges, the system increases recommendations for historical buildings and cultural explanations, realizing "personalized services for each individual".

3.3 Construction of a Human-Machine Collaborative Service Network

AI can achieve large-scale and personalized services but is difficult to convey the "humanistic warmth" of rural culture, while local cultural holders (villagers, ICH inheritors) have cultural depth and emotional connection capabilities but are limited in service scale and professionalism [14-15]. Therefore, building a human-machine collaborative service network to balance "technical efficiency" and "humanistic warmth" has become one of the core innovations of this study.

This study proposes a dual-track service model of "AI assistant + local cultural holders", clarifying their division of labor and collaboration mechanisms: AI assistants undertake "basic services + resource scheduling" functions, including real-time multilingual interpretation, route planning, information query, and service scheduling; local cultural holders are responsible for "in-depth interpretation + emotional interaction" functions, including in-depth cultural explanation (family oral history, stories behind techniques) and emotional communication (sharing rural interesting stories)[16].

To ensure the smooth operation of the collaborative mechanism, a lightweight collaborative platform (mini-program

architecture) is designed: the tourist terminal integrates interpretation and appointment functions, the AI terminal pushes demand labels, and the local holder terminal receives requests and updates service status, supporting offline use to adapt to low bandwidth. In addition, the "Cultural Distortion Index (CDI)" is introduced to monitor the accuracy of AI-generated content in real time, and if the deviation exceeds the threshold, it is reviewed by inheritors to ensure the authenticity of cultural transmission [17-18]. This human-machine collaborative network with "clear division of labor, smooth collaboration, and controllable risks" solves the scale limitation of traditional human interpretation and makes up for the lack of humanism in pure AI interpretation, providing a new paradigm for rural tourism interpretation.

3.4 Design of a Low-Threshold Technical Scheme Adapted to Rural Areas

The weak rural infrastructure determines that the application of AI cultural tourism technology cannot pursue "high precision and advancedness" but must adhere to the principles of "low threshold, high adaptability, and sustainability". Many existing rural cultural tourism digital projects have failed due to relying on high-cost VR equipment and complex network support, highlighting the importance of the adaptability of technical schemes [19]. Based on rural reality, this study designs a core technical path of "mini-program + lightweight AR", which does not require additional hardware investment and can be used by tourists through ordinary smartphones, effectively reducing the threshold of technology promotion.

Specifically, the adaptability of the technical scheme is reflected in three aspects: hardware adaptation, which uses tourists' own smartphones to avoid the hardware investment pressure of rural scenic spots; network adaptation, where lightweight AR supports low-bandwidth environments (2G for basic functions, 5G for optimized experience), and offline caching copes with network fluctuations; operation adaptation, with a simple and intuitive interface, supporting voice control and font enlargement to adapt to the usage habits of different age groups, especially elderly tourists.

In addition, from the perspective of economic sustainability, an operation model of "low-cost investment + diversified income" is designed. In terms of cost, development costs are reduced through cooperation with university technical teams, maintenance costs are reduced through lightweight architecture, and funding gaps are supplemented by "digital rural" special support policies; in terms of income, a model of "free basic services + paid value-added services" is formed (charging for in-depth cultural experiences), and additional income is obtained through advertising cooperation and cultural and creative product recommendations, ensuring the long-term sustainable operation of the project. This "low-threshold technology + sustainable operation" scheme is not only adapted to the current situation of rural infrastructure but also takes into account economic feasibility, providing a feasible digital transformation path for resource-constrained rural scenic spots [20].

4 Research Innovation Value

4.1 Theoretical Innovation

The theoretical innovation of this study is mainly reflected in three aspects: first, constructing a rural-specific theoretical framework for cultural digitization. The concept of "cultural digital twin" is proposed to dynamically link rural physical space (ancestral halls, terraced fields, ancient bridges) with virtual knowledge bases (genealogies, farming proverbs, ICH techniques), breaking the static thinking of traditional cultural digitization, forming a decoding and communication model adapted to the "liveness, dispersion, and oral nature" of rural culture, and filling the gap of insufficient attention to rural cultural digitization in existing research. Second, innovating the human-machine collaboration theory of smart tourism. The "Scenario-Cognition-Behavior (SCB) Model" is proposed, integrating Scenic Space Theory and Technology Acceptance Model (TAM), systematically revealing how the collaborative mechanism between AI and local cultural holders affects tourists' cultural cognition and behavioral decisions, and promoting the transformation of smart tourism research from "technical instrumentalism" to "scenario-cognition collaboration theory". Third, enriching the interdisciplinary research paradigm. Based on the economic perspective of finance and accounting disciplines and collaborating with computer technical teams, a "technology-culture-economy" three-dimensional integrated research framework is formed, which not only focuses on technical feasibility but also emphasizes economic sustainability, providing methodological reference for non-technical disciplines to participate in AI cultural tourism research and breaking the single disciplinary limitation of existing research [17,21].

4.2 Practical Innovation

Practical innovation is mainly reflected in the operability and adaptability of practical paths: first, pioneering the dual-track service model of "AI assistant + local cultural holders", solving the lack of humanism in pure AI interpretation and the scale limitation of traditional human interpretation, balancing technical efficiency and humanistic warmth, and providing a new paradigm for rural tourism interpretation; second, designing a low-threshold technical scheme of "mini-program + lightweight AR", adapting to the current situation of rural infrastructure, without additional hardware investment, reducing the difficulty of technology promotion, and avoiding resource waste caused by blind investment; third, constructing a mechanism of "dynamic portraits + reinforcement learning recommendation", realizing the transformation

from "one-size-fits-all" to "personalized services for each individual", accurately matching the diversified demands of tourists, and effectively improving the experience quality of rural tourism; fourth, establishing the "Cultural Distortion Index (CDI)" early warning system, providing a quantitative tool for the protection of cultural authenticity in AI cultural tourism applications, and filling the gap in the ethical governance of the industry [22].

4.3 Methodological Innovation

The methodological innovation of this study is reflected in the reconstruction of interdisciplinary integration and research logic: first, adopting a mixed research paradigm of "quantitative + qualitative", realizing cultural digitization and personalized recommendation through quantitative tools such as knowledge graphs and recommendation algorithms, and exploring tacit culture and local demands through qualitative methods such as in-depth interviews and participant observation, breaking the limitation of a single research method; second, introducing the economic perspective of finance and accounting disciplines, constructing an analysis model of "technical input - cultural value - economic income", proposing original indicators such as "cultural value conversion rate" and "technical marginal income", and providing tools for cost control and income optimization of rural cultural tourism digital projects; third, forming a complete logical chain of "theoretical construction - scheme design - risk prevention and control", not only focusing on theoretical innovation and technical application but also attaching importance to risk prevention and control and sustainable operation in practice, ensuring that research results can truly land and generate long-term value [8].

5 Conclusion and Outlook

5.1 Conclusion

Based on the background of rural revitalization and aiming at the structural contradictions of rural tourism interpretation, this study constructs the theoretical framework and practical paths of the "AI-enabled intelligent cultural tourism guide system" without empirical analysis [23]. The core conclusions are as follows:

First, the "liveness, dispersion, and oral nature" of rural culture determine that its digitization cannot adopt the static model of urban culture. Instead, it is necessary to construct a dynamically associated network of "entity-relationship-attribute" through knowledge graph technology, and realize scenario-based reconstruction combined with lightweight AR and generative AI, which is the key to solving the superficial transmission of culture.

Second, the diversification and dynamics of tourists' demands require personalized services to shift from "static labels" to "dynamic perception". The three-dimensional portrait model integrating spatiotemporal trajectory, emotional tendency, and consumption preference, combined with the reinforcement learning recommendation algorithm, can realize personalized adaptation of "personalized services for each individual", effectively improving tourists' experience satisfaction.

Third, the collaboration between AI and local cultural holders is the core of rural cultural tourism intelligence. The dual-track service model of "AI assistant + local cultural holders" not only gives play to the large-scale advantages of technology but also highlights humanistic warmth, while the lightweight collaborative platform and "Cultural Distortion Index (CDI)" early warning system provide guarantee for the smooth operation of the collaborative mechanism.

Fourth, the weak current situation of rural infrastructure determines that technical schemes must adhere to the principle of "low threshold and high adaptability". The path of "mini-program + lightweight AR" does not require additional hardware investment and is adapted to low-bandwidth environments. Combined with the operation model of "low-cost investment + diversified income", it can realize the unity of technical application and economic sustainability.

The core contribution of this study lies in constructing a rural cultural tourism intelligence framework with both theoretical depth and practical feasibility, filling the theoretical gap in rural cultural digitization, providing technical schemes and service models adapted to rural reality, and forming an interdisciplinary participation research paradigm, which provides new support for the high-quality development of rural tourism and the in-depth advancement of rural revitalization.

5.2 Outlook

Although this study constructs a relatively complete theoretical framework and practical paths, there is still room for further expansion: first, the depth of cultural decoding can be further deepened. In the future, we can focus on specific types of rural culture (such as ethnic minority culture and farming culture) to construct more targeted digital models; second, the human-machine collaboration mechanism can be further optimized. We can explore the dynamic division of labor model between AI and local cultural holders, adjusting collaborative strategies in real time according to changes in tourists' demands and scenarios; third, the boundary of technical application can be further expanded. In the future, more functions of generative AI can be integrated, such as virtual cultural spokespersons and immersive cultural story generation, to enhance the immersion of experiences; fourth, the geographical scope of research can be further expanded. The ideas of this study are mainly based on rural samples in Fujian Province. In the future, we can optimize the theoretical framework and technical schemes in combination with the characteristics of rural areas in different regions to

improve the universality of research.

Future research can advance in the direction of "theoretical deepening - technical upgrading - practical expansion", further strengthen interdisciplinary collaboration, introduce more perspectives of non-technical disciplines, and pay attention to the combination with rural reality. Through pilot applications, the scheme is continuously optimized, making AI technology truly an enabling tool for the high-quality development of rural tourism, and making greater contributions to cultural inheritance and economic income increase under the background of rural revitalization.

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References

[1] Ö. Demir and A. Vatan: Robotisation in travel and tourism: Tourist guides' perspectives on robot guides, Tourism & Management Studies, Vol. 20(2024), No. 2, p.13-23.
[2] T. Abdullah, C. Lee and N. Carr: Conceptualising human and non-human marginalisation in tourism, Tourism and Hospitality Research, Vol. 23 (2023), No. 2, p.254-268.
[3] Y.T. Zhao and L.L. Ji: Design of a context-aware AR smart guiding platform for enhancing cultural heritage experience in rural tourism, Journal of Computational Methods in Sciences and Engineering, (2025).
[4] Fafurida and T. Mulyaningsih: A Systematic Literature Review of Development Rural Tourism, Quality-Access to Success, Vol. 24(2023), No. 194, p.35-48.
[5] Z. Zulgani, J. Junaidi, D. Hastuti, E. Rustiadi, A.E. Pravitasari and F.R. Asfahani: Understanding the Emergence of Rural Agrotourism: A Study of Influential Factors in Jambi Province, Indonesia, Economies, Vol. 11(2023), No. 7.
[6] V.A. Ermolaev, N.N. Yashalova, A.V. Scherbina and D.A. Ruban: Bibliographic Database As a Tool for the Scientific Approach to the Solution of a Task of Socio-Economic Development: the Example of River Tourism, Scientific and Technical Information Processing, Vol. 51(2024), No. 2, p.115-122.
[7] R. Cowell and A. Mukherjee: Is planning a barrier to the development of digital network infrastructure? Insights from rural Wales, Planning Practice and Research, Vol. 38(2023), No. 2, p.292-309.
[8] L.G. Yang and W.F. Ning: Mechanisms and effects of the sustainable integration of digital-driven rural cultural tourism from the perspective of symbiosis, Sustainable Futures, Vol. 10(2025).
[9] A. Nag and S. Mishra: Tourism Management with AI Integration for Mining Heritage: a Literature Review Approach, Journal of Mining and Environment, Vol. 15(2024), No. 1, p.115-149.
[10] W. Wang, W. J. Zhang and Z. H. Wu: The Influence of New Productive Forces on the Evolution of Cultural Tourism and Heritage Site Management, Heranca-Revista De Historia Patrimonio E Cultura, Vol. 8(2025), No. 3, p.51-63.
[11] P. A. Christou: How to Use Artifiicial Intelligence (AI) as a Resource, Methodological and Analysis Tool in Qualitative Research?, Qualitative Report, Vol. 28(2023), No. 7, p.1968-1980.
[12] H. R. Zhang, X. Y. Wang, J. B. Pan and H. W. Wang: SAKA: an intelligent platform for semi-automated knowledge graph construction and application, Service Oriented Computing and Applications, Vol. 17(2023), No. 3, p.201-212.
[13] Y. Li and H. Y. Zhang: Big data technology for teaching quality monitoring and improvement in higher education - joint K-means clustering algorithm and Apriori algorithm, Systems and Soft Computing, Vol. 6(2024).
[14] F.R. Dong, K.W. Cao, N. Mk, Y.N. Zhao, X.M. Hu and M. Wang: Research on the Driving Forces of Rural Tourism Development in Anhui Province: An Integrated Analysis Based on System Dynamics and Artificial Intelligence Prediction Models, Journal of Quality Assurance in Hospitality & Tourism, (2025).
[15] N. C. Roy: AI-driven social media and economic empowerment in rural tourism entrepreneurship: an empirical analysis, Journal of Entrepreneurship and Public Policy, (2025).
[16] A.V. Smirnov, S.V. Shevchik and N.N. Teslya: Development of Model of Selecting Visualization of Joint Task-Solving in Human-Machine Cloud, Scientific and Technical Information Processing, Vol. 51(2024), No. 6, p.515-525.
[17] M. Angelaccio, M. Fasolo and L. Zappitelli: INTELLIGENT SMART TOURISM EDUCATION: SOME EXPERIMENTS WITH AI BASED LEARNING FOR CULTURAL TOURISM, Archeomatica-Tecnologie Per I Beni Culturali, Vol. 15(2024), No. 2, p.20-27.
[18] G. Ilieva, T. Yankova and S. Klisarova-Belcheva: Effects of Generative AI in Tourism Industry, Information, Vol. 15(2024), No. 11.
[19] S. Bourdin, L. Kebir, S. Ivanov and O. M. Stoleriu: Editorial: Tourism of the future- opportunities and challenges of smart technologies and digitalization, Eastern Journal of European Studies, Vol. 14(2023), p.5-12.
[20] M. Alhaddar and H. R. Kummitha: Digitalization and sustainable branding in tourism destinations from a systematic review perspective, Discover Sustainability, Vol. 6(2025), No. 1.
[21] A. M. Fouad, I. E. Salem and E. A. Fathy: Generative AI insights in tourism and hospitality: A comprehensive review and strategic research roadmap, Tourism and Hospitality Research, (2024).
[22] A. Auzina, A. Zvirbule and L. Jankova: Synergy between rural and smart tourism: is it possible and necessary?, Worldwide Hospitality and Tourism Themes, Vol. 15(2023), No. 5, p.561-569.
[23] R. Luan and P. Xu: Risk Prediction of the Development of the Digital Economy Industry Based on a Machine Learning Model in the Context of Rural Revitalization, Information Resources Management Journal, Vol. 37(2024), No. 1.