

Application and Practice of Digital Rural Construction Driven by Unreal Engine Technology——Taking Qijia Village in Chengde City as an Example

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Abstract: With the rapid development of digital technology, digital rural construction has become a key way to promote the strategy of rural revitalization. The rapid advancement of information technology has brought new opportunities to this field. Unreal Engine (UE), as a powerful real-time 3D creation tool, has shown great potential and broad application prospects in the construction of digital villages. This paper uses the Unreal Engine to create immersive virtual reality (VR) and augmented reality (AR) experiences, allowing villagers and decision-makers to intuitively understand and participate in the planning and preview of rural infrastructure, farmland, and residential areas before the project begins. This research can also help build virtual community platforms and ensure that rural construction work meets the actual needs and expectations of local residents. This paper aims to explore the application and practice of Unreal Engine in digital rural construction, and provide reference and inspiration for research and practice in related fields by analyzing its advantages, application cases, and future development directions.

Keywords: digital countryside, Unreal Engine, interaction design

1. Introduction

In recent years, with the increasing attention of the country to the rural revitalization strategy, the national and local governments have successively issued a series of policy documents on the construction of digital villages, such as the "Outline of the Development Strategy for Digital Villages" and the "Guiding Opinions on Promoting the Development of Digital Villages", providing policy support and direction guidance for the construction of digital villages. The construction of digital countryside has become an important measure to promote the development of rural economy, culture, ecology and other aspects. Traditional rural construction mainly relies on the planning and construction of physical space, while the introduction of modern information technology provides new possibilities for digital rural construction. As an efficient virtual reality technology tool, Unreal Engine provides a new perspective and method for rural digital transformation with its highly realistic rendering ability, powerful interactive functions, and flexible development environment, and can play an important role in the construction of digital villages.

2. Advantages of Unreal Engine in developing digital villages

Digital rural planning and design: This study constructs a virtual model of digital countryside through Unreal Engine, simulates and predicts possible future situations, provides scientific and reasonable solutions for rural planning and design, and improves the feasibility and practicality of rural planning. For example, different building layouts, landscape designs, and other effects can be presented to help planners better evaluate and optimize their plans.

Digital rural management and services: Establish and improve a long-term system for cultivating digital literacy among rural farmers. The cultivation of digital literacy among farmers is not something that can be accomplished overnight, but rather a dynamic and constantly evolving process. The purpose of this study is to provide efficient and intelligent means for rural management and services. For example, digital population management, land management, agricultural insurance, etc. can better meet

the production and living needs of rural residents.

Digital agriculture production and management: In the field of agricultural production, it helps farmers accurately grasp the growth status of crops, predict yield, and pest and disease conditions, thereby optimizing the agricultural production process and improving the efficiency of agricultural production [1]. For example, we are conducting digital population management, land management, agricultural insurance, etc., hoping to better meet the production and living needs of rural residents.

Digital rural ecological protection and governance: This study utilizes the engine to monitor environmental pollution, climate change, and other factors, providing scientific basis for rural ecological environment protection and governance, and promoting the improvement of rural ecological environment.

Digital rural cultural inheritance and development: This study records and displays rural cultural heritage, such as traditional architecture and folk culture, through digital means, promoting the inheritance and development of rural culture. Virtual cultural display scenes can be created to allow people to more intuitively understand and experience the charm of rural culture.

3. Current situation and digital demand of rural construction

3.1 Current situation of rural construction

In the context of the new era, the construction of digital villages needs to explore different development models according to local conditions, orderly promote the development of smart villages, and continue to comprehensively promote rural revitalization [5]. The combination of "digital villages" and "rural e-commerce" is not balanced. In China, the most extensive application and development of the digital economy is in the field of e-commerce [3]. Rural natural resources are abundant, providing a foundation for agricultural production, ecotourism, and other activities. The ecological environment is beautiful, the ecosystem is relatively complete, and it has extremely high ecological value. Rural areas also preserve rich traditional culture, including folk customs, festivals, handicrafts, local operas, etc. These cultural heritages are important carriers of national spirit. In addition, rural areas can produce high-quality agricultural products with regional characteristics, such as green organic vegetables, fruits, and specialty aquaculture products. The social relationships are close, and the interpersonal relationships in rural communities are relatively close. Neighbors help and support each other, and the social cohesion is strong. However, current rural exhibitions face many urgent problems that need to be solved. Firstly, the form often relies on pictures, text introductions, or simple brochures, lacking vividness and attractiveness, making it difficult for the audience to fully and deeply understand the charm of the countryside. Secondly, the scope of dissemination is very limited, and traditional displays are mainly conducted locally, making it difficult to break through geographical limitations and attract a wider audience, which limits the expansion of rural influence. Again, slow information updates make it more difficult to reflect the latest changes and development trends in rural areas in real time, resulting in a gap between the displayed content and the actual situation, which affects the effectiveness of publicity. Finally, the interactivity of rural exhibitions is poor, and the audience can only passively receive information and cannot interact with the displayed content, making it difficult to generate profound experiences and resonance.

3.2 Digital demand for rural construction

There are multiple demands for the construction of digital rural areas. Firstly, infrastructure should have good network coverage and related equipment to provide guarantees for accessing digital services and information. Secondly, in agricultural production, intelligent means such as remote sensing monitoring are needed to improve efficiency and quality. Digital infrastructure has the attribute of public goods and has positive externalities on rural economic and social development [4]. Rural governance also needs to be digitized, including online government services and transparency in village affairs.

The construction of digital villages also requires digitalization in e-commerce and logistics, education and training, healthcare, financial services, and ecological environmental protection. E-commerce websites can provide a broader market for agricultural products, help farmers directly connect with consumers, and enhance product sales and brand influence [2]. E-commerce and logistics need to improve their systems and expand sales channels, education needs to provide online resources,

healthcare needs to establish remote systems, finance needs to promote digital services, and ecological protection needs to rely on digital supervision. At the same time, we should attach importance to data security and privacy protection.

4. Application of Unreal Engine in the construction of digital countryside in Qijia Village

4.1 Project introduction

Qijia Village, Cangzi Township, Chengde County, Shuangluan District, Hebei Province, is located in the central part of De County. It borders Chengde City to the west, Mengjiayuan Township to the south, Gaositai Town to the north, and Sangou and Liugou Towns to the northeast and southeast, respectively. The township government is located in Cangzi Village, 27.4 kilometers south of the county seat and 25 kilometers west of Chengde City.

The advantages of building a digital countryside in Qijia Village, Chengde City are significant: superior geographical location, abundant natural resources, providing a solid foundation for digital transformation; Clear policy guidance, complete infrastructure, and creating favorable conditions for technology application; The agricultural and forestry industries have a solid foundation and are moving towards diversified development. The application of digital technology will greatly improve production efficiency.

This project aims to carry out rural renovation in Qijia Village to enhance landscape quality and introduce sustainable architecture and ecological innovation concepts. This study utilizes Unreal Engine technology (UE5) for digital design in rural areas. Supported by information technology, guided by urban planning, and centered on the needs of the population, we organically integrate the five aspects of elderly care, transportation, vegetation, cultural tourism, and sports to achieve an efficient, intelligent, and humanized rural management model. Through digital browsing management and other forms of expression, the organic combination of physical space and virtual space has created a new intelligent countryside.

4.2 Specific operating steps

(1) Data collection: This study utilizes satellite imagery, aerial photography, field surveys, and other methods to obtain basic information on the geographic location, terrain, and land use of rural areas. We collect detailed field survey data on buildings, roads, vegetation, etc., and then we collect characteristic cultural information of the village through field surveys and organize analysis. As shown in Figure 1.

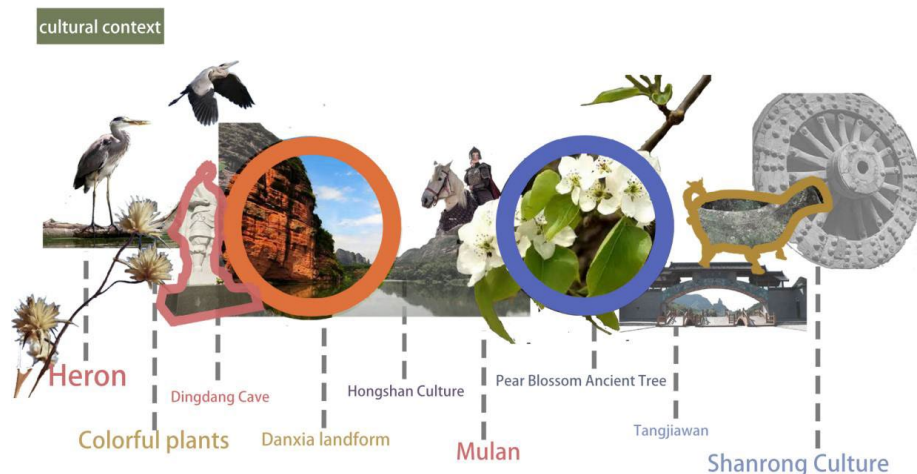


Figure 1: Analysis of the cultural context of Qijia Village

(2) Model processing: We organize, calibrate, and preprocess the collected data, and use modeling software (SketchUp) to finely model and process erroneous data. We will convert the constructed model file into a format supported by Unreal Engine. Vegetation import: This study uses Unreal Engine's vegetation generation tool or imports external vegetation models to simulate vegetation

landscapes such as trees, grasslands, and farmland in rural areas. Terrain construction: This study uses terrain tools in Unreal Engine to create rural terrain models based on terrain mapping data, including mountains, rivers, valleys, etc.

(3) Architectural modeling: For various types of buildings in rural areas, 3D modeling software is used for individual modeling, emphasizing details and authenticity. The design of the homestay and tourist center utilizes existing building walls and selects antique buildings from Qijia Village for wall beautification design, adding greenery and creating a charming avenue. As shown in Figure 2.



Figure 2: Architectural rendering of Qijia Village homestay and tourist center

(4) Road and infrastructure modeling: This study constructs a rural road network, including main roads, auxiliary roads, and alleys. This study also created a procurement and identification system with local characteristics, mainly based on the design theme of "Searching for Egret Tracks in Danxia, Observing the Junling Mountains in Pear Garden", extracting the characteristics of the site as the main design basis, and appropriately embellishing with pear blossom patterns, which not only reflects the residential style of Qijia Village, but also contains elements of the pear tree industry: with wood brown, earth yellow, and bright yellow as the overall tone. Simple yet atmospheric, such as village signs, navigation maps, etc. As shown in Figure 3.



Figure 3: Design diagram of Qijia Village identification system

(5) Material and texture mapping: We assign real materials and textures to the model, and use existing local materials such as soil, bricks, wood, etc. We put the material textures into the Unreal Engine for material compilation to enhance realism.

(6) Lighting and environment settings: This study first creates a high fidelity sky ball model, which is typically done through 3D modeling software such as Blender, Maya, etc., and then imports it into game engines that support visual effects such as Unreal Engine, Unity, etc. We design and implement a powerful weather controller blueprint. Based on the local climate and time, this study sets appropriate lighting effects, including sunlight, shadow, and sky environment, as shown in Figure 4.



Figure 4: Rendering of the lighting environment in the entertainment public space of Qijia Village

(7) Interaction and feature addition: Add some interactive elements. Considering that the elderly population in Qijia Village is the majority and there is a strong demand for elderly care services, a set of elderly information exchange platforms has been established in the virtual engine. The platform has chat rooms where different topics can be set up for online communication among the elderly. At the same time, real-time monitoring can be conducted on the elderly and first-hand data can be obtained to promptly identify problems and provide corresponding assistance, as shown in Figure 5.

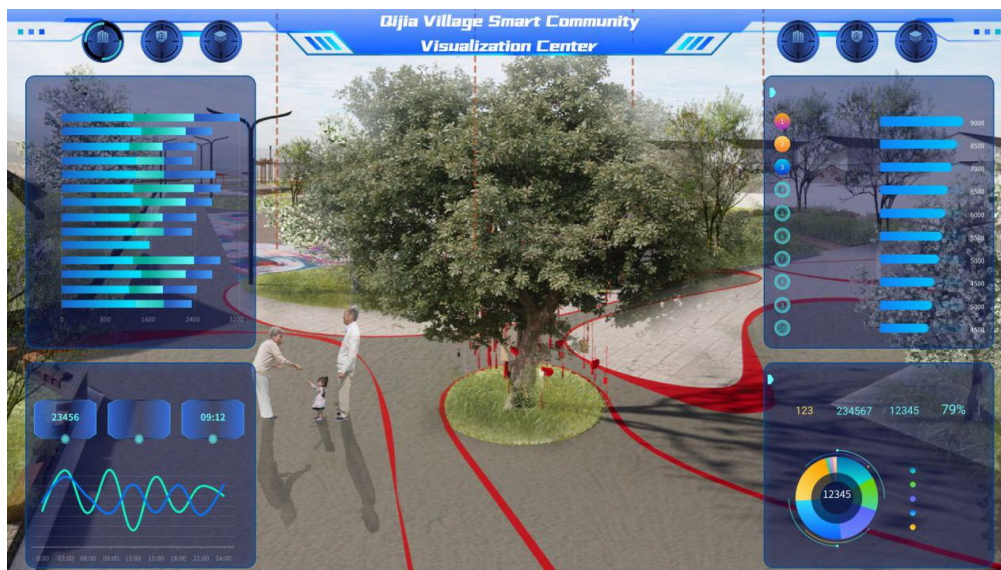


Figure 5: Visualization data display of elderly care in Qijia Village

In the process of building a smart community, Qijia Village adopts an intelligent traffic management system to solve these problems. For example, we are building intelligent parking facilities within the community, which utilizes reservation and intelligent systems to plan parking routes and achieve efficient utilization of parking spaces, as shown in Figure 6.



Figure 6: Digital visualization display of transportation in Qijia Village

In addition, various interactive designs will be carried out through the establishment of an intelligent monitoring system for urban greening and a smart platform for urban sports. For example, The button click pop-up window in this study displays the current dynamics in real time, and by switching camera viewports, villagers can better observe the real-time dynamics of the countryside or achieve dynamic effects such as water flow and wind blowing, as shown in Figure 7.



Figure 7: Interactive UI interface of Qijia Village

Creating high-precision rural geographic information models requires a lot of time and effort, as well as certain technical and artistic abilities, but ultimately can provide strong support for digital rural construction, rural planning, and tourism promotion. Through the practice of Qijia Village, the specific process of digital rural construction has been summarized, as shown in Figure 8.

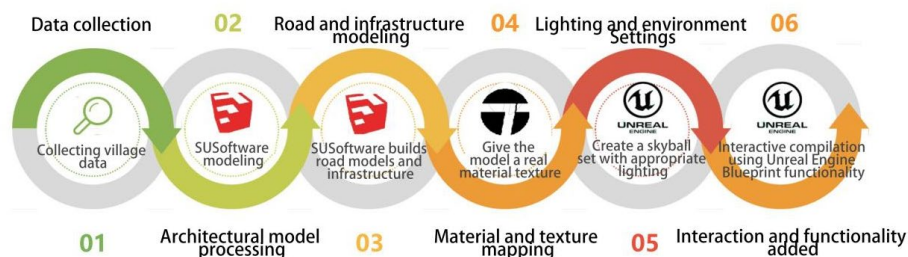


Figure 8: Steps of digital rural construction

5. Conclusion and outlook

Unreal Engine, with its excellent graphic rendering capabilities, is gradually reshaping the appearance of digital villages. It not only creates natural landscapes and architectural details that come from the surrounding environment, but also combines IoT technology to achieve real-time monitoring and display of rural facilities and environment, enhancing the accuracy and timeliness of management decisions. Its cross platform feature makes the digital countryside within reach, allowing people to immerse themselves in it anytime and anywhere, whether through mobile devices or AR/VR devices. In addition, Unreal Engine has also promoted the digital inheritance and innovation of rural culture, providing new display and marketing methods for industries such as rural tourism and agricultural product sales, accelerating industrial integration, and enhancing economic competitiveness.

Looking ahead to the future, Unreal Engine is not only a powerful technological support for digital rural construction, but also an important engine for promoting comprehensive rural revitalization and sustainable development. It not only helps the government improve governance efficiency and transparency through scientific planning and decision-making, but also attracts digital technology talents to participate in rural development, and enhances the digital literacy of rural residents through education and training programs. This integrated and innovative technological application will undoubtedly inject unprecedented vitality and opportunities into multiple villages, leading them towards a more prosperous future. In short, Unreal Engine has enormous potential and development space in the construction of digital rural areas, and is expected to inject strong impetus into the comprehensive revitalization and sustainable development of rural areas.

References

- [1] Wei H Y. *Research on the Strategy of Improving Farmers' Digital Literacy under the Background of Digital Rural Strategy* [J]. *Science and Education*, 2024, (14): 40-43.
- [2] Pan C H. *The Path of Digital Rural Community Construction in Continuing Education Services from the Perspective of Rural Revitalization* [J]. *Continuing Education Research*, 2024, (08): 31-35.
- [3] Li Z Y. *Exploration of the Path of Empowering Rural Revitalization with Digital Economy* [J]. *Cooperative Economy and Technology*, 2024, (17): 20-21.
- [4] Zhang H C, Yang T, Ying Y L. *The Rural Revitalization Effect of Digital Infrastructure Construction* [J]. *Finance and Economics*, 2024, (06): 60-73.
- [5] Gu S R, Wang R Y. *Achievements, Problems, and Improvement Paths of Digital Rural Construction under the Background of Rural Revitalization* [J]. *Journal of Xichang University (Social Sciences Edition)*, 2024, 36 (02): 10-17.