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Optimization Design of Architectural Landscape Space Environment Based on Blockchain and Mobile Information Technology

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Abstract: With the continuous acceleration of urbanization, the optimization design of architectural landscape space environment has become an important way to improve the quality of urban life and environmental sustainability. The current traditional design schemes have low efficiency and quality, making it difficult to effectively achieve design data sharing and collaboration. To address the design issues, this article applies blockchain and mobile information technology to the construction of landscape optimization systems. Through the camera modeling method and the texture optimization method, a system for project optimization design and interaction between parties is constructed. The experimental results showed that users use the system studied in this paper to optimize the design work, which improved the experience satisfaction by 12.5% compared with the traditional method. It is conducive to the better development of the architectural landscape space environment optimization design project, so as to provide ideas for the development of mobile informatization in the architectural design industry.

1. Introduction

The research object of architectural landscape space environment optimization design is the physical space. Its focus is on the conception of space and the process of implementing the conception, and the mobile information technology is applied to this process. It has positive practical significance for the construction of architectural landscape space environment optimization design system [1]. Blockchain technology supports the application of smart contracts, which can automatically execute preset rules and conditions when there are changes in the architectural landscape spatial environment data, achieving automated management and regulation. The application of blockchain and mobile information technology in spatial environment optimization design has important practical value and significance for improving the intelligence and coordination of the design process [2].

2. Construction of Project Optimization Design System

Blockchain plays a key role in transparency and security in the optimization design of the architectural landscape space environment. Through Blockchain technology, all data generated during the design and construction process is recorded in a decentralized distributed ledger, including design drawings, construction logs, material lists, etc. Due to the immutability of the blockchain, once this data is recorded, it cannot be modified or deleted, thus ensuring the authenticity and transparency of the information. All project participants can access this data in real time, view the progress of the project, reduce information asymmetry, and improve collaboration efficiency [3].

In addition, Blockchain technology optimizes the project management process through smart contracts. A smart contract is a self-executing contract that automatically performs preset tasks when certain conditions are met.In architectural landscape projects, smart contracts can be used to automate design approval, construction progress inspection, payment processes, etc. When a certain stage of construction is completed and the quality inspection is passed, the smart contract will automatically trigger the payment of the next payment to ensure the timeliness and accuracy of the capital flow. This kind of automated management not only reduces the possibility of human intervention, but also improves the overall efficiency of project management and reduces the risks caused by delays or inconsistent information [4].

2.1. Development Environment

The development environment of the architectural landscape space environment optimization design system studied in this paper is UNITY 3D. Many creators including architectural landscape design, art design, automobile design, film and television design and game development use this platform to turn their ideas into reality.

Advantages of UNITY 3D have the following advantages. It has mature program solutions and a huge resource library. It can support AR and VR. The development language used by it is C# which is simpler than C/C++. It also supports three different platforms of mobile, PC, and host, which has good cross-platform. Combining the above advantages, this paper decided to use UNITY 3D to develop an architectural landscape space environment optimization design system applied to Android and IOS platforms [5].

2.2. System Architecture Construction

The system is based on mobile information technology, and is designed to be inefficient and lead to poor experience satisfaction of stakeholders. The construction of the system architecture should follow the following principles:

2.2.1. Good Business Value

There are mainly three levels of business value, namely collaborative value, business value-added, and design-driven. Collaborative value refers to the coordination of product design and development. Business value-added refers to the outstanding value in the realization of business objectives. Design-driven means that design strategies guide strategy formulation.

Management convenience

The system is developed through a custom template, which facilitates subsequent operations of adding, deleting, modifying and querying the system. In addition, due to the use of a relational database, the serviceability of the system is strong.

2.2.2. Diversity of Output Formats

The system can output a variety of formats. The format list is as follows: DWG, DXF, SKP, FBX, OBJ, 3DS, 3DM, RVT, BIP, PSD, AI, with a total of eleven formats. The system output format can be used in mainstream modeling and drawing software such as AutoCAD, SketchUp, CINEMA 4D, 3DSMAX, Revit, Photoshop, Illustrator, etc.

The system architecture is shown in Figure 1:

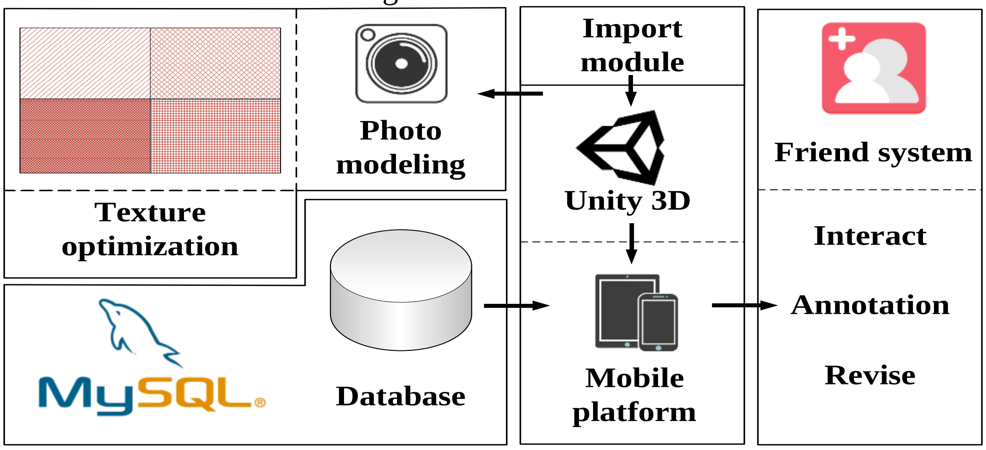

Figure 1: System architecture diagram

At the developer level, the system is developed by UNITY 3D, and the development language is C#. The system can model itself or import models. In addition, it supports exporting the completed architectural landscape space environment optimization design project, matching the various formats mentioned above. After the development, the system is exported to the mobile information terminal through UNITY 3D, which can be used on Android, IOS mobile phones and tablets.

3. Texture Optimization Algorithm

Through the texture optimization algorithm, the texture of the model is optimized, so that the effect of the model and the scene is more realistic under the condition that the amount of system resources occupied is unchanged.

3.1. Grayscale Processing of Images

The grayscale processing of an image is a transformation process from a color image to a grayscale image. The image grayscale processing is as Formula 1:

$$\begin{cases} f1(i,j)=R(i,j) \\ f2(i,j)=G(i,j) \\ f3(i,j)=B(i,j) \end{cases} \tag{1}$$

The value of the grayscale image is the maximum value of R, G, and B in the color image, as shown in Formula 2:

$$f(i,j)=max(R(i,j),G(i,j),B(i,j)) \tag{2}$$

The average value is taken as the gray value of the gray image, as shown in Formula 3:

$$f(i,j)=max(R(i,j)+G(i,j)+B(i,j))/3 \tag{3}$$

Among them, $f(i,j)$ is the value at (i,j) of the converted grayscale image.

The weighted average method refers to assigning different weights to them according to the different sensitivity of the eyes to the three components of R, G, and B, and calculating the average value. A more reasonable grayscale image can be calculated as Formula 4:

$$f(i,j) = 0.3R(i,j) + 0.59G(i,j) + 0.11B(i,j)) \tag{4}$$

3.2. Corrosion Operation

The mathematical expression of the erosion operation can be expressed as Formula 5:

$$\mathrm{E} = \mathrm{X} \oplus \mathrm{B} = \{(\mathrm{x},\mathrm{y}) | \mathrm{B}_{\mathrm{xy}} \subseteq \mathrm{X} \ \} \tag{5}$$

Among them, X is the set of target regions on the x,y plane. B is the structuring element with a given shape and size, and E is the result obtained by etching X with B.

Dilation operation

The mathematical expression of the dilation operation can be expressed as Formula 6:

$$\mathrm{D} = \mathrm{X} \oplus \mathrm{B} = \{(\mathrm{x},\mathrm{y}) \ | \ [\mathrm{B}_{\mathrm{xy}} \cap \mathrm{X}] \neq 0\} \tag{6}$$

3.3. Photo Resampling

There are three commonly used resampling methods in practical applications: nearest neighbor method, bilinear interpolation method, and bicubic convolution method.

Nearest neighbor method

The nearest neighbor method is the simplest. Taking the pixel value of the pixel 1 closest to the point as the sampling value, Formula 7 can be obtained:

$$I(P) = I(N) \tag{7}$$

In Formula 7, I is the pixel value of the pixel.

The image coordinate value of the nearest pixel N is as Formula 8:

$$\begin{cases} \mathrm{x}_{\mathrm{N}} = \mathrm{INT}(\mathrm{x} + 0.5) \\ \mathrm{y}_{\mathrm{N}} = \mathrm{INT}(\mathrm{y} + 0.5) \end{cases} \tag{8}$$

In Formula 8, the pixel value of N point is the pixel value of P point.

Bilinear interpolation method

The main idea of the bilinear interpolation method is to do a linear interpolation in the x and y directions respectively. Mathematically, a triangular function is used to represent the convolution kernel of bilinear interpolation, and its expression is as Formula 9:

$$W(x) = 1 - (x), 0 \leq |x| \leq 1 \tag{9}$$

In practical applications, according to the principle of bilinear interpolation, the resampling calculations in both directions can be combined into one, as shown in Formula 10:

$$I(P) = \sum_{i=1}^{2} \sum_{j=1}^{2} I(i,j) * W(i,j) \tag{10}$$

The resampled pixel value of point P is as Formula 11:

$$I(P)=W_{11}I_{11}+W_{12}I_{12}+W_{21}I_{21}+W_{22}I_{22} \tag{11}$$

In Formula 11, W is a two-dimensional convolution kernel, and I is a lattice.
Bicubic convolution method
The bicubic convolution kernel is a cubic spline function whose expression is as Formula 12:

$$\begin{cases} W_1(x)=1-2x^2+|x| & 0\le|x|\le1 \\ W_2(x)=4-8|x|+5x^2-|x|^3 & 1\le|x|\le2 \\ W_3(x)=0 & 2\le|x| \end{cases} \tag{12}$$

The final resampled value of the P point is as Formula 14:

$$\mathrm{I(P)}=\sum_{i=1}^{4}\sum_{j=1}^{4}\mathrm{I(i,j)} \tag{13}$$

4. System Function Design Based on Mobile Information Technology

4.1. Main Functions of the System

The system has good human-computer interaction, and the interface for interaction is very rich. This article roughly divides user types into two categories. One is the mass user. Such users are relatively unfamiliar with the system and have never received systematic practical training in the past. The other category is professional users. Such users have a wealth of relevant system use and practical experience. This article is based on the perspective of public users, and the development follows the following principles:

4.1.1. Principle of Consistency

When the user uses the system to perform input and output operations, the information presented by the system to the user is related, which is the main embodiment of the principle of consistency in software development.

4.1.2. Principle of Simplicity

In the design process of this paper, the layout of the system window is scientific and standardized, which is divided according to the importance of the information to be displayed. The overall design maintains the atmosphere and simplicity, and optimizes the window design. The main content is shown in the part the eye notices first. Then some auxiliary information is displayed at the bottom of the window, which is not easily noticed by the human eye, in order to simplify the layout of the window. In addition, some related elements are used to embellish some blank areas to emphasize the theme.

4.1.3. Principle of Infectivity

When designing human-computer interaction interface, the use of monotonous text and color matching can easily cause visual fatigue of users. In this paper, a variety of colors are used to increase the attractiveness of the interface to the user, reduce the user's fatigue when viewing the interface for a long time, and increase the user's desire to explore the system. In addition, the design of the system strives for the consistency and integrity of the human-computer interaction interface, but does not ignore the individualization of the interface.

4.1.4. Principles of Clear Expression

In the system icons designed in this paper, each icon can reflect a specific target action according to different commands of the application. At the same time, it has a strong ideology when reflecting the target action, so that the user can roughly understand the specific function of the icon according to the pattern of the icon.

The main functions of the system are shown in Figure 2:

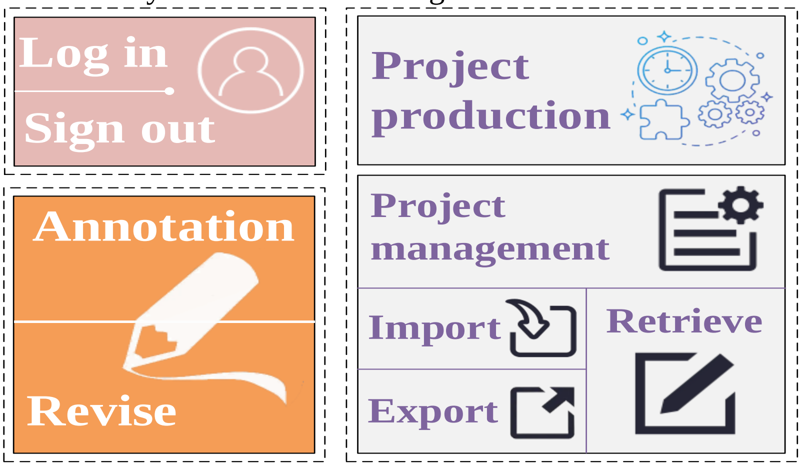

Figure 2: Main functions of the system

The main functions of the system designed in this paper include friend system module, annotation and modification module, project production module and project management module. The friend system module mainly realizes the user login and logout functions. The system does not open the registration function, and the account is built in by the administrator. When the user logs in, they can send items to other friends and users to realize the functions in the annotation and modification module. The project production module mainly realizes the functions of modeling and rendering, which can import external files and internal material libraries in the module. After the project is completed, it can be saved and named, and modified and deleted in the project management module.

4.2. Internal Material Library

The system designed in this paper has a built-in material library, which can be directly called, and can perform operations of zooming in, zooming out, rotating, moving and changing the transparency of the material. The material library contains nearly 1,800 models of buildings, landscape sketches, trees, shrubs, palms, flowers, indoor furniture, people, and animals. The system limits the number of faces to the model and is optimized to ensure the smoothness of the project during operation.

4.3. Friend System

The development of friend system function is an important manifestation of the application of mobile information technology. Under the friend system, bilateral users can interact, realize the functions of annotation and modification, and carry out projects with higher efficiency. Its specific functions are as follows. The user has a unique ID for identification, and can add friends through the ID. After the addition is completed, the name of the friend can be remarked. The friend system has a built-in simple chat system for easy communication. The interaction process between the two friends about the project is as follows:

Assuming that there are user A and user B, user A can send items to user B. When user B receives an item, it represents the establishment of a connection. User A is the producer, and user B is the acceptor. The system will create a common project space for both parties. Projects will exist in this space, and each project will have a unique ID. User B can annotate in the common project space. After the annotation is completed, the system will notify user A to modify it. After user A has completed the modification, he can send a completion request to user B. After viewing the project, user B finds that the completion request still needs to be modified and can reject the completion request, continue to annotate, and repeat the above operations. It should be noted that the other party cannot enter the project to operate during the annotation and modification process.

5. Comparison of Experimental Results

5.1. Sample set setting

This paper invited 50 practitioners of architectural landscape design optimization to participate in the test. They were into two groups, one of which was set as the producer and the other as the acceptor. Both parties used the system developed in this article for the normal process. After the experience, 50 questionnaires were distributed to them, and they scored the previous design optimization system and the optimization design system designed and developed in this paper from four aspects. The design optimization system used in the past was denoted as S1, and the optimization design system designed and developed in this paper was denoted as S2.

5.2. Analysis of results

5.2.1. Project Optimization Speed Score Results

Project optimization is the core competitiveness of the architectural landscape space environment optimization design system. The architectural landscape space modeling and rendering capabilities of the two systems were compared from the perspective of the manufacturer and the acceptance party. The results are shown in Figure 3:

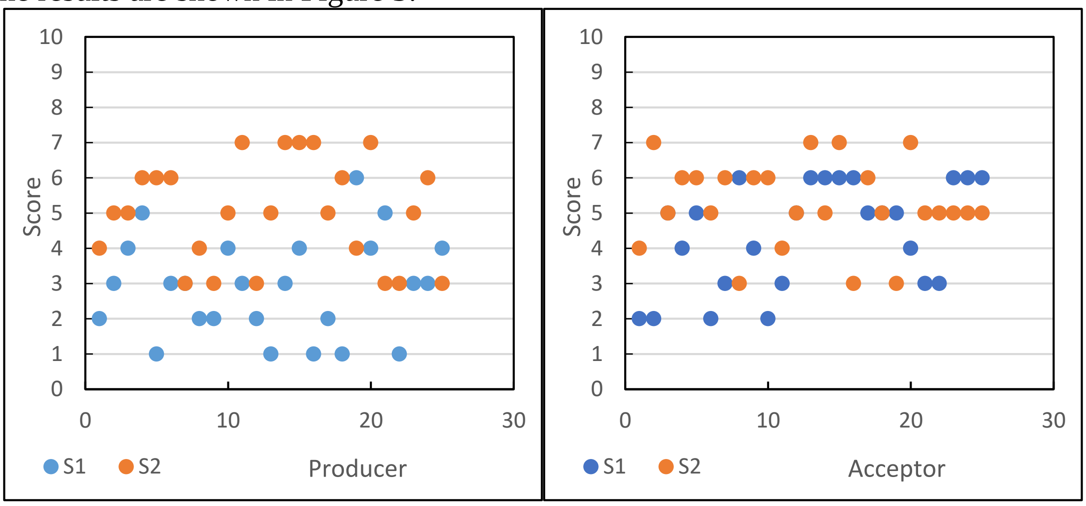

Figure 3: Convergence speed comparison

Figure 3 shows a comparison of the results of the two systems in terms of project optimization speed. From the perspective of the manufacturer, the score of the project optimization speed of the design optimization system used in the past was between 1-6, while the score of the project optimization speed of the optimized design system developed in this paper was between 3-7. It showed that the optimization design system developed in this paper is better than the previous design optimization system in project optimization speed. From the perspective of the acceptor, the score of the project optimization speed of the design optimization system used in the past was between 2-6, while the score of the project optimization speed of the optimized design system developed in this paper was between 3-7. It indicated that the optimization design system developed in this paper is not significantly different from the design optimization system used in the past in terms of project optimization speed.

5.2.2. System Usability Scoring Results

The ease of use of the system is related to the experience of the architectural landscape space environment optimization design system. The ease of use of the two systems was compared from the perspective of the manufacturer and the acceptance party, as shown in Figure 4:

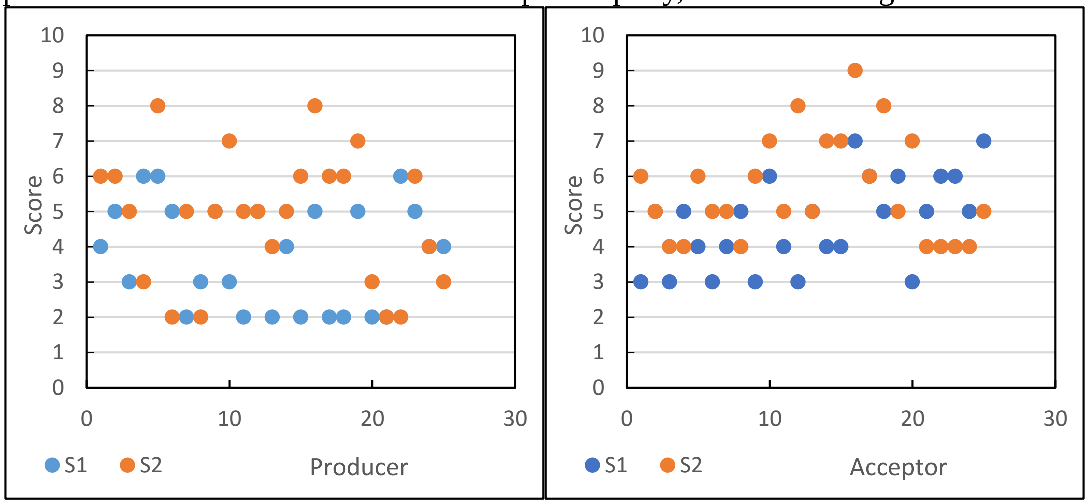

Figure 4: System usability comparison

Figure 4 shows a comparison of the ease-of-use results for the two systems. From the perspective of the producer, the project usability score for the design optimization system used in the past was between 2-6, while the project usability score for the optimization design system developed in this paper was between 2-8. This showed that the optimization design system developed in this paper is slightly better than the previous design optimization systems in terms of ease of use. From the perspective of the acceptance party, the project usability score of the design optimization system used in the past was between 3-7, and the project usability score of the optimization design system developed in this paper was between 3-9. It showed that the optimization design system developed in this paper is quite different from the design optimization system used in the past in terms of project usability, and the system developed in this paper is better in usability.

5.2.3. Interactive Convenience Scoring Results

The convenience of interaction is the innovation of the system developed in this paper. The interactive convenience of the two systems was compared from the perspective of the producer and the acceptor, as shown in Figure 5:

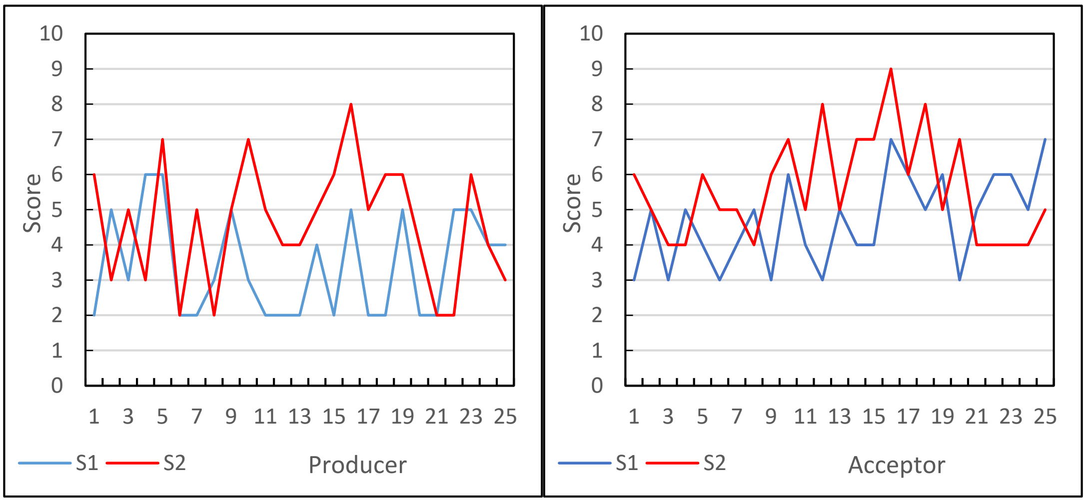

Figure 5: Interaction convenience

Figure 5 shows a comparison of the interaction convenience results between the two systems. From the perspective of the producer, the score of the project interaction convenience of the design optimization system used in the past was between 2-6, and the score of the project interaction convenience of the optimization design system developed in this paper was between 2-8. It showed that the optimization design system developed in this paper is better than the previous design optimization system in the convenience of project interaction. From the perspective of the accepting party, the score of the project interaction convenience of the design optimization system used in the past was between 3-7, and the score of the project interaction convenience of the optimization design system developed in this paper was between 4-9. It showed that the optimization design system developed in this paper is far superior to the design optimization system used in the past in terms of project interaction convenience.

5.2.4. Comparison of Final Scoring Results

The three comparison results obtained in the above experiments are comprehensively weighted, and finally the comprehensive score comparison results of the two systems are obtained, as shown in Figure 6:

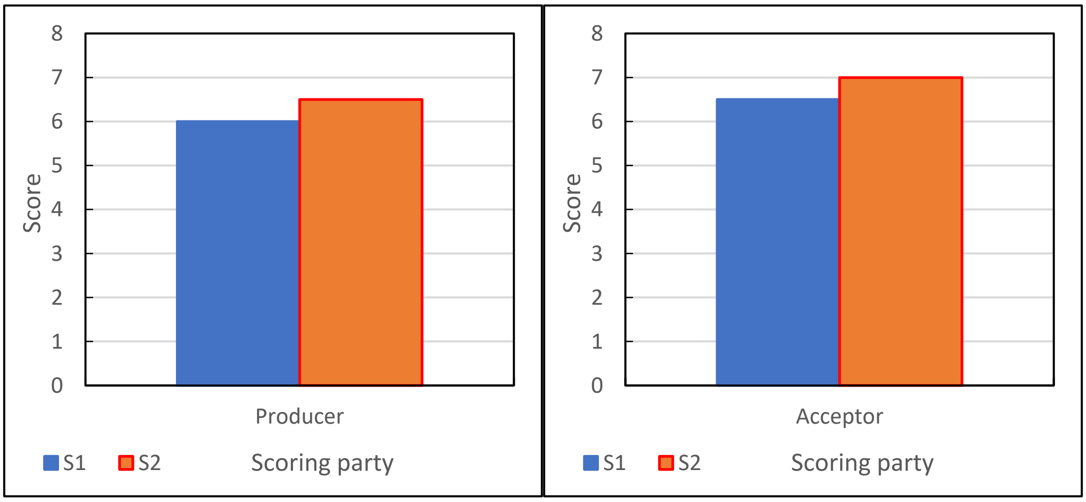

Figure 6: Comprehensive score comparison

Figure 6 reflects the comparison of the final scoring results of the two systems. From the perspective of the manufacturer, the comprehensive score of the design optimization system used in the past was 6 points, and the comprehensive score of the optimization design system developed in this paper was 6.5 points. From the perspective of the acceptance party, the comprehensive score of the design optimization system used in the past was 6 points, and the comprehensive score of the optimization design system developed in this paper was 7 points. The performance of the optimization design system developed in this paper was far better than the previous design optimization system, and the user satisfaction was improved by about 12.5%.

6. Conclusions

This paper integrates mobile information technology into the research of architectural landscape space environment optimization design system, and constructs a system for project optimization design and interaction between parties by means of camera modeling method and texture optimization method. Through the analysis of 50 samples in the experiment, the results showed that using the system studied in this paper to optimize the design work can improve the experience satisfaction by 12.5% compared with the traditional method. It is conducive to the better development of the architectural landscape space environment optimization design project, which has great significance and far-reaching influence on the construction of the architectural landscape design project.

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