

Digital display of intangible cultural heritage in mining area city and ecological restoration in mining area

Through the case study of 8 mining cities in the world heritage, we find the concept of mining heritage city and its evolution in landscape form. It shows the law of "replacement and return", that is, with the development of the mining industry and the city, a higher stage of the urban living landscape is constantly changing to the early productive landscape. Twenty-first Century is an era of ecological civilization; the guiding ideology, objectives and methods for the construction of the ecological garden type petrochemical city are discussed, and a new model of the ecological garden construction in the petrochemical city is created. The urban ecological landscape system of "ecological nature, plant diversity and people-oriented" should be constructed. The ecological garden of petro chemical industry has improved the urban human settlement environment and promoted the sustainable development of the city. The development of human civilization cannot be separated from the mining of mineral resources such as coal, metal and stone, but it inevitably causes various interference to the natural environment and social life. This process will freeze due to the depletion of mineral resources and eventually return to the original landscape of mining production. The 4 driving forces in the process include mining production, social differentiation, urban development and the trend of the times, among which mining production is the basis for the formation of the urban landscape of the mining heritage. The complex interaction between various elements leads to the occurrence of the process of replacement and regression, mainly in 4 aspects: location environment, public space, zoning layout and form style. This paper discusses the way to establish the 3D digital image model and the interactive display platform of traditional Rockery-Pile techniques, the realization way to intangible cultural heritage (ICH) protection and spread and the application value. The status-quo of the protection and propagation of Rockery-Pile techniques are also analyzed and the solution of 3D digital means for its characteristics and puts forward. This paper presents the methods to build 3D model of intelligent exhibition platform of Rockery-Pile scene. Explain with the help of examples of Rockery-Pile techniques, the 3D model is made and rendered by using

CINEMA 4D software, and interactive design is made by using Unity3D platform, so as to explain, inherit and protect intangible cultural heritage.

Keywords: Mining area; ecological restoration; intangible cultural heritage, 3D digital protection, spread, rockery-pile techniques

1. Introduction

Mining is one of the origins of cities. Mining heritage cities are an important type of historic towns. In the mining heritage city, there are various concepts and methods of mining, mining, industrial heritage, mining city and so on^[1]. There are subtleties in the meaning of the city, which need to be carefully identified according to the specific situation^[2]. Today, the world's environmental problems are increasingly prominent, global warming and glacier melting, sandstorm in northern China and drought in the south for 100 years^[3,5]. The destruction of urban ecological environment has become a potential constraint factor for the further development of cities and the further improvement of people's living standards^[6]. In the general impression, mining areas are dilapidated, chaotic and dangerous places^[7]. However, when many people have witnessed the craggy crater, towering tailings heaps, and the mechanical structures of the vicissitudes, the heart often forms a special ground texture to the damaged land^[8]. The human desire for nature, the city calls for green, and the green space as the core to establish an ecological system that plays a leading role in urban land use and spatial distribution is the urgent need for the implementation of sustainable development under the current urban background conditions^[9]. Mining remains refers to the space traces left by the facilities left by the mining failure and its production process, and the value of protection and education can be called the mining heritage^[10,12].

Since the Convention for the Safeguarding of Intangible Cultural Heritage was released in 2003, the digital conservation of intangible cultural heritage has attracted worldwide attention^[13].

The traditional technique is a large part of the intangible cultural heritage, among which the traditional Rockery-Pile technique occupies a very prominent position in the

Messrs. Ke Qin* and Wanyu Chen, North China University of Technology, Beijing 100144, China

*Email of the corresponding author: zhongljin@126.com

traditional garden^[14]. It is said that it is not landscape without stone^[15]. In 2006, “Xiang Shan Bang Traditional carpenter techniques”, Rockery-Pile skill included, was listed in the first batch of the list of representative items of national intangible cultural heritage. In 2014, as a “traditional gardening art”, Yangzhou Rockery-Pile skill and architectural arts were listed in the fourth batch of the list of representative items of national intangible cultural heritage^[16,18]. In 2015, “Shanshi Han’s Rockery-Pile skill” was listed in the fourth batch of the list of representative items of Beijing intangible cultural heritage. Fig. 1 shows the image taken by the author of the Suzhou Huan Xiu Villa



Fig.1: Picturing by author in Huan Xiu Villa in Suzhou

Since 2004, the number of related literatures on digital conservation of intangible cultural heritage has been growing continuously, which reached a peak in 2016. Now the digital conservation has become a necessary means of protection of intangible heritage^[19]. At present, there are many explorations in the use of digital technology to display intangible cultural heritage at home and abroad^[20]. For instance, Zhangli from Jiangnan University digital media institute has exploited a web on Huishan clay figurine with 3D laser scanning technology and interaction approach. Besides, Nawen from Tsinghua University takes advantage of interaction approach has exploited a web on Daur ethnic minority group. Intangible cultural heritage forms in digital display system from above are relatively clear. In comparison with other traditional arts and crafts and building traditional techniques, the forms of Rockery-Pile skill are not fixed, accurate paradigm cannot be obtained with 3D scanner. Since listed in the national intangible cultural heritage project for a shorter period of time, the digital display of traditional stacking technique has not been fully developed. In view of this situation, this paper will discuss how to construct 3D modelling based on observation and measurement.

2. Rockery-Pile heritage

2.1. ROCKERY-PILE

In order to make the digital conservation of the Rockery-Pile discussed in this paper have the general reference significance, the discussion is carried out from the perspective

of intangible cultural heritage. Fig. 2 shows the total residual disturbance of the ADRC controller in the mining city landscape index.

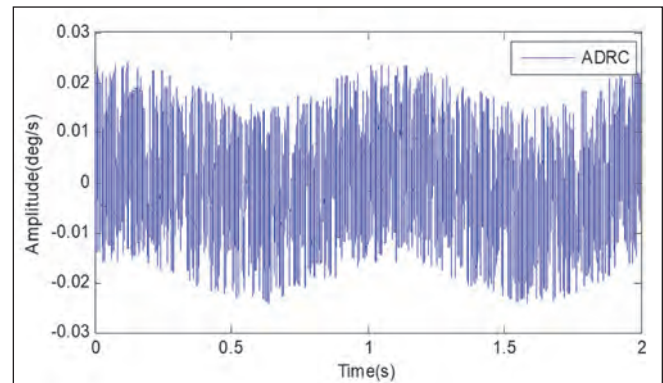


Fig.2: Total residual disturbance of ADRC controller for mining city landscape index

Skills in Rockery-Pile arts, as a kind of traditional art in intangible cultural heritage, which is the sum of the generation and production of knowledge, is the basis of productive activities. The “skill” refers to the production activities that are produced in the material; The “art”, in ancient times, is the equivalent of the present technology. “Skill” and “art” are the knowledge between experience and wisdom, the summary of experience produces “skill” and “art”, while the practical judgment of “skill” and “art” generate universal knowledge. Fig. 3 shows the amplitude frequency and phase frequency diagram of the Kaiser filter designed for the landscape index of the mining city.

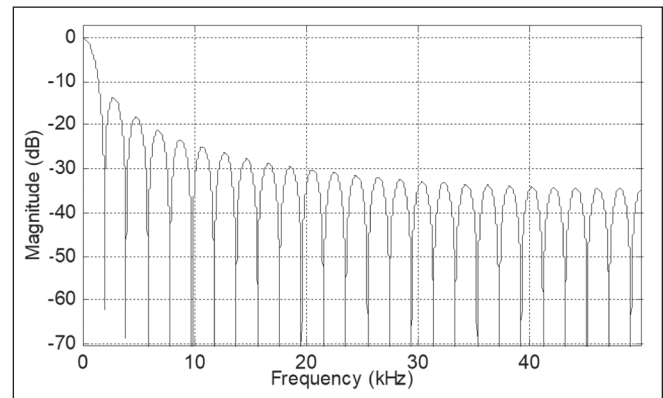


Fig. 3: Amplitude frequency and phase frequency diagram of Kaiser index for mining city landscape index

With the development, the behavior of “art” is shifting from the realm of material creation to the realm of spiritual creation, and gradually deduces the meaning of “art”. Combining with Rockery-Pile techniques, not the rock itself, but the traditional techniques of Rockery-Pile, the piling process and the reflection of cultural concept, aesthetic consciousness, value identity, history and the grant of the oral folk knowledge, etc. are studied, among which, stones and tools of Rockery-Pile are the material basis of the technique

of stacking mountains. Craftsman skills are the technical elements, and the comprehensive application of techniques produces the spatial change and artistic value of the rockery and forms the art. From this point of view, Rockery-Pile skill includes "skill" and "art", and "skill" is the foundation of Rockery-Pile. Fig. 4 shows the gas and hydrogen content of the reactor during the operation of the landscape index of the mining city.

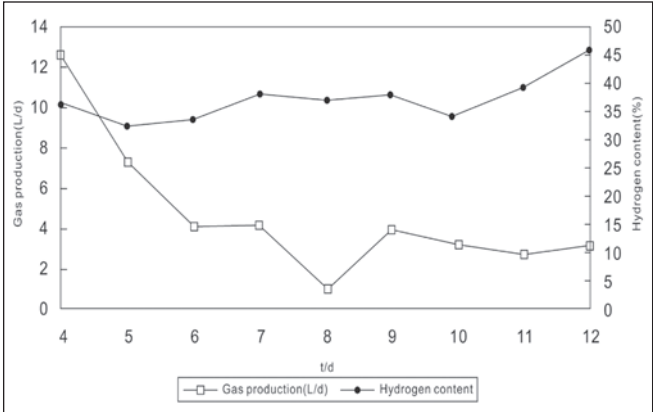


Fig. 4: Gas production and hydrogen content in the operation of a mining city landscape index reactor

2.2. INHERITANCE OF TECHNOLOGY: ROCKERY-PILE TIPS

The technique of Rockery-Pile has been passed down to present day by Rockery-Pile tips, summarizing the technical foundation of the Rockery-Pile. It is the typical technique of the masonry in the construction of rockery. The formulas of Rockery-Pile have similar principle. It can be conclude that the craftsmen screen out the universal combination way of stone, which takes the structure and form of artistic quality as the standard. Influenced by regionality, symbolic and functional differences, the formulas of Rockery-Pile has now been handed down, including "10-word strategic" from Beijing Shanzi Zhang, "30-word strategic" and the "9-word strategic" from Jiangnan.

TABLE 1. ROCKERY-PILE TIPS

Source	Content
10-word strategic	An , Lia , Jie, Dou, Kua, Pin, Xuan, Jian, Ka, Chui
30-word strategic	An Lian Jie Dou Kua, Pin Xuan Ka Jian Xuan, Tiao Piao Fei Chuang Gua, Ding Dan Gou Sun Zha, Tian Bu Feng Dian Sha, Da Kao Zhuan Huan Ya
9-word strategic	Die, Shu, Dian, Pin, Tiao, Ya, Gou, Gua, Cheng

There are three kinds of tips, among which, some are same words and some are different but actually same meaning. Developed up to now, the original formula has been supplemented by illustrations, photographs and other

images. However, the current information is based on the plane media, and the present mode of display is obviously ambiguous for the rocks with six different morphological faces. Therefore, this paper tries to explore how to realize the Rockery-Pile in VR, three-dimensional laser scanning system, digital sculpture, and computer graphics technology. Fig. 5 shows the pitch angle of the mining city landscape index.

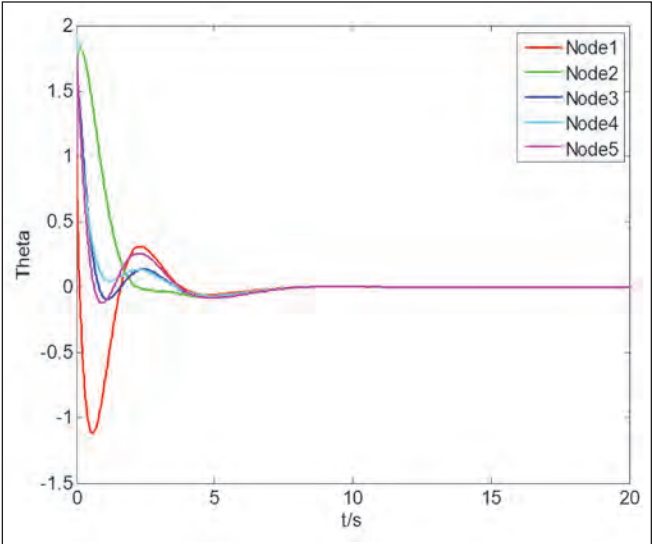


Fig. 5: The pitch trajectory angle of the landscape index of the mining city

3. Digital model of Rockery-Pile

Digital means, used as record the intangible resources of intangible and dynamic, has its irreplaceable advantages. Besides, in result of maximize resource conservation and protection, it also need to be flexible and diverse the recording techniques appropriate to the rigorous as a support.

3.1. DIFFICULTIES

The main body of the Rockery-Pile in Chinese classical garden is natural stone, and the 3D laser scanning is commonly used. Although 3D laser scanning can make up the weakness in techniques about surveying and mapping Rockery-Pile, but in refining Rockery-Pile techniques, the rockery generated directly by 3D laser scanning model still cannot meet demand of expressing Rockery-Pile techniques. There are three main difficulties:

1. A variety of skills are covered with Rockery-Pile, and most of which are combined.
2. Natural rock formations are complex and the plants will block the rockery, therefore, leading to the large number of blind areas and difficult to reduce noise. In the process of production, there will be partial data loss. Fig. 6 shows the auto-correlation and partial correlation function mapping of landscape index of mining cities.

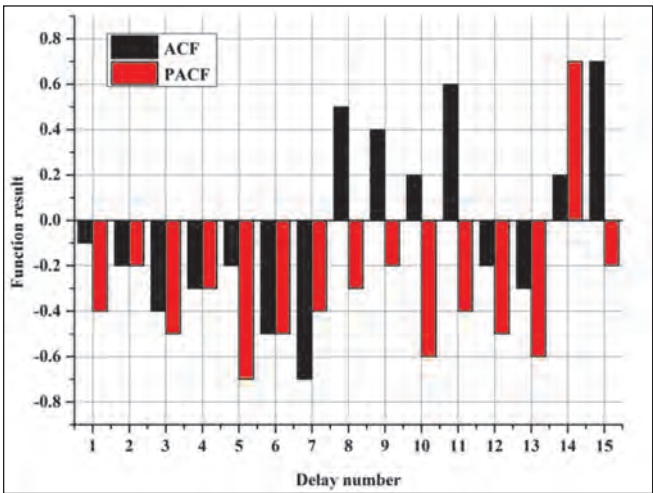


Fig. 6: Auto-correlation and partial correlation function mapping of landscape indices in mining cities

3. The outer shells can be collected by current acquisition methods, while the inter structures are unable to be got.

In view of the above points, based on the traditional literature, picture, photo collection and traditional garden rockery, as well as the digital collection, according to "participatory digital protection" concept, the idea is that, as an integrated carrier of intangible cultural heritage, inheritance people should be involved in digital protection. Based on further negotiation with inheritance people,

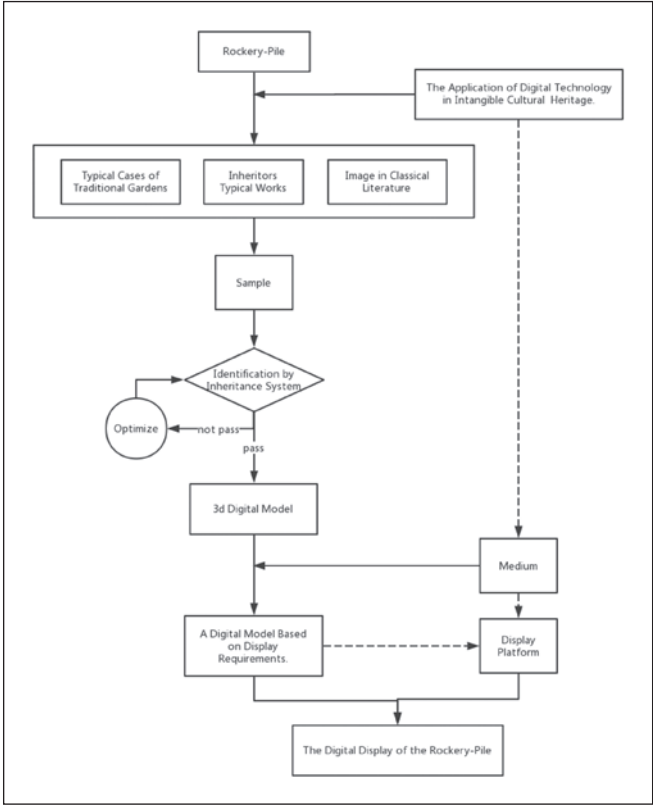


Fig. 7: Made by author: 3D model procedure of intelligent exhibition platform of Rockery-Pile Scen

intangible cultural heritage will be converted to digital form, so that the classification and explanation of inheritance people are expressed. Therefore, this article combines this idea, the paper introduces the link of the inheritance people participate. With the help of traditional literature, classical case with the traditional Rockery art and inheritance system, this paper conducts a study on showing the Rockery-Pile based on existing techniques of Rockery-Pile skill. Fig. 7 shows the 3D model program of the intelligent display platform for rockery piles constructed by the author.

3.2. DIGITAL SAMPLING AND DATA ANALYSIS

Digital files are mainly collected according to the principles of fidelity, integrity, system and extendable application.

TABLE 2. DIGITAL SAMPLE

Source	Work detailed
Document research	The words and illustrations related to the Rockery-Pile skill.
Fieldwork in classical gardens	Photo, video, select classic case for 3d scanning, and establish a digital model.
Inheritor interview	Inheriting people's works, interview audio, etc.

Collecting is relied on the interpretation of the inheritors, the field investigation and literature research.

TABLE 3. DATA PROCESSING

Step	Work detailed	Goal
Classify	pictures and text descriptions in monograph.	To summarize and compare the use of same Rockery-Pile skill in different regions, factions and dynasties.
Disassemble	Classic case of Rockery in traditional gardens.	Disassemble different Rockery-Pile skills.

Based on inheritance system, all kinds of typical Rocky-Pile techniques are extracted after the data sampling and data classification. Therefore, in order to lay the foundation for the creation of digital models the invisible form of rocky is identified. Fig. 8 shows the data set of mining city landscape index and the calculation of experimental FW.

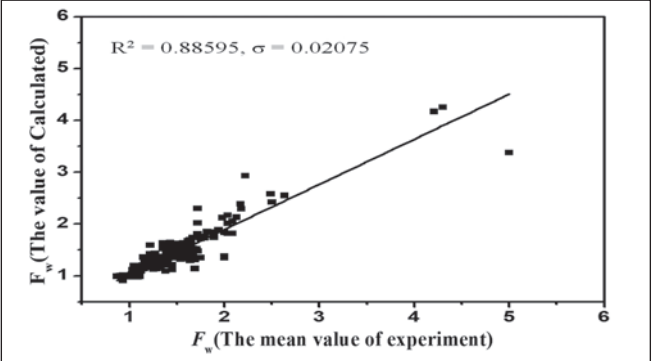


Fig. 8: Data set of mining city landscape index and calculation of experimental FW

3.3. MODELING AND PRESENTATION

In this paper, the authors' mountain stone model, obtained by using digital engraving modelling and 3D laser scanning, converts the intangible heritage into digital form. And finally gains acceptance from the lineage system to ensure the classification and explanation of inheritance people are expressed. As a result, it establishes a complete digital model with action, and ensures the standard and typicality of the 3D model of Rockery-Pile skill.

TABLE 4. TECHNICAL ROUTE OF MODELING

Step	Details	Digital format
Mold repair	According to the characteristics of the Rockery-Pile tips.	model
Digital sculpture	Digital sculpture	model
Model optimization	Switch high precision model to low precision model.	Model, chartlet, light...

4. Applications

4.1. BASIC DATA ACQUISITION

This paper takes the example of "Convex (Tiao), Pressure (Ya) and Flying (Piao)" to carry out digital display. After comprehensively analyzing the traditional literature description, typical local photos of classical garden and image of "Convex (Tiao), Pressure (Ya) and Flying (Piao)", the 3D model with "Convex (Tiao), Pressure (Ya) and Flying (Piao)" has been finally set up.

TABLE 5. DESCRIPTION OF "CONVEX, PRESSURE AND FLYING" IN TRADITIONAL LITERATURE

Text description	Source
...I used the balance method not to concentrate but scatter the weight of the convex stone, what's more, in order to make it stronger for the sake of the back, I could use a long strip of rock to make the stone hanging.	Yuanye
...there is one convex stone in three in each layer. From the extant garden works, the most convex ones are more than 2m...	Landscape Engineering
...A stone which is put at the edge of a convex stone is named "Piao", which means "Flying". The function of a flying stone is mainly enrich the change of the edge of a convex stone, the used stones are generally thin, curved, long feature is the first choice...	the Ancient Construction of the Rockery
...That is, a long strip of rock stretch out from the mountain, which is called "Tiao", and the stone which is held horizontally on top of it is called "Piao"...; In order to maintain the balance of the "Tiao" stone, a rock should be pressed on the tail of the "Tiao" stone, which is called "Ya", which means "Pressure"...	the Theory and Technique of Rocky-Pile

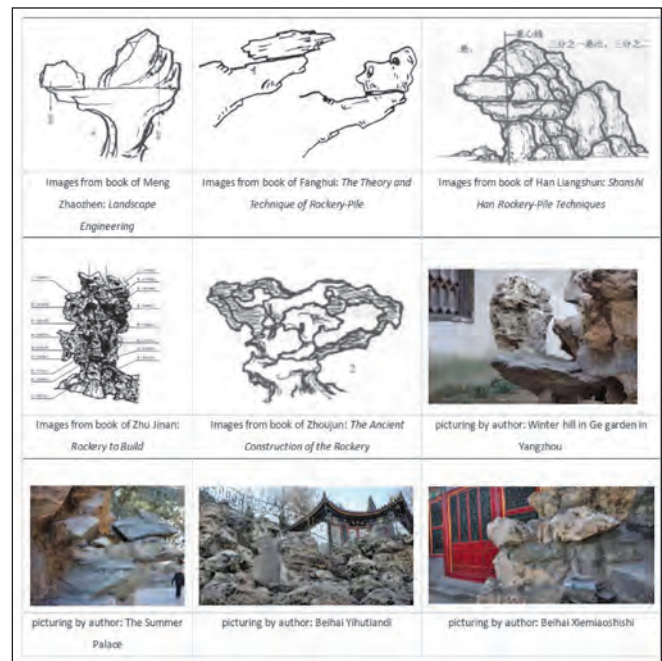


Fig. 9: Images and photos of "Convex, Pressure and Flying"

4.2. DIGITAL MODEL OF "CONVEX (TIAO), PRESSURE(YA) AND FLYING (PIAO)"

In this article, digital sculpture is adopted to make digital mode. Compared to the traditional modelling method, digital sculpture can get rid of the parameter, directly sculpture with the help of the computer, what is better, freely convert the image of Rocky-Pile technique in classical literature into 3D model. On the other hand, digital sculpture can be based on the model of 3D laser scanning, and supplement and perfect the missing details according to Fig. 10.

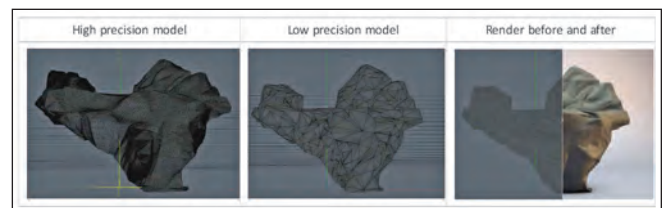


Fig. 10: Made by author: 3D model step screenshots

However, the high precision model needs to be converted into the low precision model after the high precision model with "Convex (Tiao), Pressure (Ya) and Flying (Piao)" is made. Therefore, ensure it can be used in the 3D interactive software to display Rocky-Pile technique. And texture mapping is performed on the constructed 3D model, texture image path is loaded in the texture ball, and then set various parameters such as diffuse reflection and transparency. The material ball is given to the model to finish texture mapping so that the model has a texture. The bump mapping technology is adopted to model the normal map, so as to achieve the concave and convex texture and lighting results that a large number of polygons used to be needed, and therefore, to make the model to have physical and optical sense of reality.

Finally to shading model, due to make a good model will be imported into the scene, according to the environment according to its natural state of light and shade, therefore when modelling simply adjusting the parameters of the material in the material editor, such as spontaneous light, transparency and visibility. Complete the following steps: modeling → optimize → unfold UV → texture → chartlet → render. What is obtained: Low precision model by topology, High quality map by bake, light rendering, stone assembly and the data source of "Convex, Pressure and Flying". Fig. 11 shows (the photographs taken) by author: Contrast.



Fig.11: Taken by by author: Contrast

As shown in Table 8, the table takes the typical selection of the classical selection and the technique image of the landscape engineering as an example, which is compared to the 3D model.

4.3. INTERACTION DESIGN

In this paper, the game thinking is introduced to design the action of showing Rocky-Pile techniques and Unity3D is used to complete the interaction design, as well. In the interaction design of Rocky-Pile technique, the functions of physical system, rendering system, animation system and game logic writing are mainly used.

Setting the material: first of all, the rock density needs to be obtained by physical experiments, and then, the quality of the rock in the virtual space is calculated by combining the model form through $\rho=M/V$, build the rigid body in Unity3D which is quality input. As a result, the stone in the virtual space can accept friction and gravity like real objects.



Fig.12: Made by author: Step screenshots of putting stone

TABLE 6. MADE BY AUTHOR: OBJECT PROPERTIES

Element	Class	Interaction	Functional	physical property
Stone	A	non-interactive: immobilization	Initial	/
Long Stone	B	Interactive: move	Convex	quality

Element	Class	Interaction	Functional	physical property
Big Stone	C	interactive: move	Pressure	quality
Small Stone	D	interactive: move	Flying	quality
Pole	E	non-interactive: self-motion	Support	/

The gravity acceleration in the physical property is 9.8m/s, and the center of gravity is the geometric center. There are three different types of BCD in each category. The restricted interaction order is B - (E) - C - D. Setting feedback: according to the center of gravity in the user placement process, the safety and collapse reactions are given.

4.4. UNITY3D AND VR

Because there are six degrees of freedom in the three-dimensional space, both web and mobile terminals interact with the mouse, the keyboard or the touch screen. That is why the planar motion cannot map out the free movement in 3D space. However, further interaction can be achieved with the help of the virtual reality technology.

Virtual reality technology in the protection of intangible cultural heritage, will not be like the intangible cultural heritage in the normal circulation of the loss of defects or even lost. The final VR model includes: scene size, unit, classification collapse, naming, node edit, texture, coordinate, texture size, texture format, texture ball.

5. Conclusions

Man and nature are indispensable components of the ecosystem. Man and nature are interdependent, harmonious coexistence and joint promotion. Although the mining heritage cities will take place and develop, most of them are based on mining production. Therefore, the late development is not enough to withstand the crisis caused by the exhaustion of resources, and ultimately, it is difficult to escape the fate of decline. The influence of mining production on the landscape pattern of the mining heritage city is determined, and the control and guidance can be carried out on the management and planning to avoid the endemic landscape value falling into the damaged outcome. We must pay attention to ecological civilization and firmly establish the concept of ecological civilization with sustainable development. In the middle and small cities at the stage of development, the greening mode of other cities cannot be used, but the urban ecological garden system with good ecological conditions can be constructed through the continuous efforts of its own. The landscape replacement of mining heritage cities is a phased change in a specific period, and the final landscape freeze will be regenerated and utilized in the new era. However, the factors that affect the landscape form of mining heritage cities are very complicated. This article is a preliminary summary of the mining cities in the world heritage.

Firstly, digital collection and storage technology has provided the safeguard for protecting the intangible cultural heritage completely. Secondly, digital reconstruction and reproduction technology has provided the supporting for inheriting the intangible cultural heritage effectively. Thirdly, digital display and transmission technology provides a platform for sharing the intangible cultural heritage widely. To make a long story short, virtual reality technology has to provide a space for the development and utilization of intangible cultural heritage. The established 3D model is a complement and perfection to the current method of inheritance. Combined with the experience of VR dynamic interaction, people can further experience the sense of scale that the screen and other media cannot give. And also avoid the safety hazards of visiting the site of the construction site.

In the process of digital display in the later stage, according to the Rockery-Pile skill, different platforms for display can be selected. On the basis of the 3D modelling method, we integrate the technology of roaming and interactive control, and promote the introduction by means of "teaching and entertaining" from the perspective of visual and auditory sense. Such as image, video, and interactive display, etc, in the result of which, the digital interactive platform is established, including mobile terminal APP, web page, and virtual reality. Later, it can be applied to popularization of Rockery-Plie techniques, vocational teaching of rockery and virtual tour of classical gardens, etc.

Acknowledgements

Scientific research projects of Beijing Municipal Education Commission, 2017 (Item Number: KM201710009013)

References

- Huang Chunhua, Wang Xiaochun, Fanghui, etc (2011): "Yanzhou Rockery-Pile" Design and analysis. *Journal of Yangzhou University* (Agricultural and Life Science Edition), (3), 89-94.
- Yanghong, Zhanglie (2016): "Digital Applications in the Physical Exhibition Space or Intangible Cultural Heritage". *Heritage and conservation research*, v.1(5), 20-24.
- Tan Biyong, Zhangying (2011): "A Comparative Study of Sino-foreign Digital Protection of Intangible Cultural Heritage". *Books and information*, (04), 7-11.
- Li Chunxiao, Sun Ruizhi, Dai Yizhou, Cai Saihua, Liqian, Li Jiayao (2017): "Based on Unity 3D China ancient agricultural virtual scene intelligent display platform". *Transactions of the Chinese Society of Agricultural Engineering*, 33(S1), 308-314.
- Zhangli, Zhurong, Niuchao, etc (2016): "Study on the Protection and Propagation of Intangible Cultural Heritage by 3D Digitalized Method: Taking Huishan Clay Figurines for Example". *Decoration*, 280(8), 126-127.
- Ma Zhouzhou (2004): "Education Technology, Art, Dao". *Electrochemical education research*, (05), 12-18.
- Liu Xinran, Wang Caiping (2014): "The Essence and Value of Competitive Concept are Discussed". *Journal of Beijing Sports University*, 37(04), 15-20.
- Yanghong (2015): "The advantages and disadvantages of digital records of intangible cultural heritage". *Cultural heritage*, (2), 9-13.
- Yu Mengzhe, Linxi (2017): "Based on the 3D laser scanning and the technique of close-range photogrammetry, some methods of surveying and mapping are analyzed". *Landscape architecture*, (2), 117-122.
- Wang Mingyue (2015): "Digital Risk and Path Reflection of Intangible Cultural Heritage Protection". *Cultural Heritage*, (03), 32-40.
- Song Junhua, Wang Mingyue (2015): "The Status and Problem Analysis of Digital Protection of Intangible Cultural Heritage in China". *Cultural Heritage*, (06), 1-157.
- Zhang Dianhua, Chen Yimin (2014): "Design and implementation of multi-platform virtual campus based on Unity3D". *Computer Technology and Development*, (2), 127-130.
13. Chen Guohua (2007): "An interactive design technique of 3Dkey-frame animations". *Computer Simulation*, 24(4), 221-224.
- YangHong, ZhangLie (2016): Digital Applications in the Physical Exhibition Space for Intangible Cultural Heritage Study on Inheritance and protection, v.1(5), 20-24.
- Guo Q, Li X (2015): "Integrated Conservation of the Cantonese Opera Art Museum and Intangible Cultural Heritage". *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 7(1), 187-193.
- Ross S G (2016): "Preserving Canadian Music Culture: The Case of the Silver Dollar Room and the Intangible Cultural Heritage Management of Urban Spaces of Culture". *Architecture_MPS*, 10(2), 1-30.
- Petronela T (2016): The Importance of the Intangible Cultural Heritage in the Economy. *Procedia Economics & Finance*, 39, 731-736.
- Noardo F, Spanò A (2015): "Towards a Spatial Semantic Management for the Intangible Cultural Heritage". *International Journal of Heritage in the Digital Era*, 4(2), 133-148.
- Svetlana- Husnutdinova, Safonova M (2016): Intangible Heritage as a Social Factor of the Development of Urban Areas in a Service Economy. 10(3), 18-25.
- Yang W B, Ye Y N (2017): Planning by Using Digital Technology in the Reconstruction of Cultural Heritage Sites - a Case Study of Qiong-Lin Settlement in Kinmen Area. 5, 719-724.