

Digital Computer Technology on Traditional Architectural Decoration Design of Guangfu Windows

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Abstract

Guangfu traditional architecture is one of the representatives of traditional architecture in Lingnan area of China, with a long history and unique architectural style on the buildings. The windows of traditional buildings in Guangfu make the interior space design of traditional buildings to appear rich in connotation and innovation in the regional culture of Guangfu. The architectural designers of Guangfu have always used the decoration of windows as the carrier of cultural symbols, euphemistically and implicitly conveying the beautiful meaning and enriching the culture of Guangfu. With the global development of digitalization and science, scholars and designers are constantly updating the cultural heritage research and practical application of traditional architecture in Guangfu. However, the cultural information and data demonstration about the window in the traditional architecture of Guangfu have not received special attention in the current design and research results, hence, part of the cultural heritage of Guangfu has gradually lost its inheritance. This paper attempts to analyze the cultural theory of traditional window of Guangfu and the current window design application cases, with the use of digital and scientific concepts, including computer visualization technology to establish a digital archive platform, to achieve the sustainable protection of the window cultural heritage of traditional buildings in Guangfu. This paper summarizes the methods of knowledge inheritance and knowledge sharing, inherits and develops Chinese traditional culture extensively, and provides new ideas for the protection and research of regional culture.

Keywords: Guangfu Traditional Window Architecture, Window of Guangfu Culture, Window's Digital Archive Platform, Window Culture Inheritance

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1. Introduction

Window is one of the important components of architecture, it is an important means to create and connect the interior and exterior space of the building, outside could affect the architectural shape, inside could affect the architectural space, at the same time, window is an important medium to introduce light and wind into the building, an important element affecting the sensory comfort of human body.

In different regions, there are different building types due to the dissimilarity of historical periods. Thus, the windows often reflect the regional climate characteristics, architectural culture, economic environment and technological development level. Windows in residential buildings not only play a breathable role in function, but also serve as a variable transition interface between indoor and outdoor buildings.

In terms of aesthetics of architectural decoration, the opening and closing of window sash and permeability create changeable visual effects, which also play a breathable effect that create permeability. The cultural development of the decoration culture of Guangfu residential buildings could not be separated from the characteristics of decorative art of windows, carrying the architectural spirit, which is realized through symbolism and metaphor. For a long time, Guangfu culture is characterized by tolerance of Chinese and western artistry, times, science, regional culture and humanistic spirit. Under the background of globalization in the era of science, construction and trade, the development process, construction process, new technology and practicability of Guangfu residential buildings have been continuously optimized, and the design and application of traditional residential buildings together with architectural decoration have been greatly updated and protected. However, the development of the decorative application of industrial residential buildings also exposed the modular architectural renewal and protection and new architectural design, unified the design style of Guangfu residential buildings, carrying the traditional architectural decoration culture of Guangfu gradually replaced by the modern industrial architectural style, thus causing the residential buildings of Guangfu to lose their local memory.

In recent years, the academic research on the traditional window culture in Guangfu, published in China tend to focus on architecture, and climate, for example, in the paper on the decoration art of doors and windows in Guangfu traditional architecture by Feng (2020), a targeted study is conducted on the window structure of traditional Lingnan buildings. Another study by Tang Guohua, an architecture expert at Guangzhou University, his research of Hot and Humid Climate and Traditional Architecture in Lingnan, has made a corresponding study on traditional doors and Windows in Lingnan from the perspective of their functions and combined with the climate characteristics of Lingnan (Tang, 2005). The content published internationally focuses more on the inheritance and application of Guangfu window culture.

Yi (2019) in 'The Development of Decorative Art in Lingnan House Garden in Macau -- Taking Lingnan Oyster Shell window and Manchuria window as examples', had analyzed the inheritance and development of oyster shell windows and Manchuria windows in Lingnan, Macao, and gave suggestions for protection by analyzing the architectural art of Zheng Family Mansion, Lu family mansion and folk houses in Xingfu Street, Macao. Meanwhile, Ying, et al. (2022) studied on Extraction and Application Standard of "Red" Color Model in Cantonese Color windows, aided by computer software, had analyzed and determined the color of traditional Cantonese window, and establishes a set of standards for the application

of color, so as to attract more scholars' attention to this endangered intangible cultural heritage and discuss its future development.

2. An Analysis of This Concept

2.1 Cultural Heritage Needs to be Passed on and Protected in a Diversified Way

Since the Venice Charter in 1964 proposed the protection of historic buildings, the concept of heritage protection has gone through several stages of development (Collaboration, 2nd International Conference of Architects and Technicians of Historic Sites, 1964). Nowadays, people's concept of heritage preservation not only needs to investigate the real value of architectural history, but also needs to protect the continuity of the original social network and living structure. Guangfu window is an important part of Guangdong traditional culture and a feature of Guangdong architecture. Through scientific and technological means, Guangfu window culture could be introduced to more people and promote cultural exchanges and integration.

Using the information medium of computer could help people to better understand, preserve and inherit the historical and cultural value of Guangfu window. It promotes the development of traditional architectural culture and brings practical and specific effects to the design industry, such as information resource classification, improving the knowledge efficiency of communication, learning and application of the window, the promotion of traditional architectural research paths and methods involving computer vision technology. Through digitization, virtualization and other technological means, it could make people more convenient to understand Guangfu window culture, and could compare and communicate with other cultures around the world, so as to promote the diversified application of culture.

2.2 Digital Preservation of Cultural Heritage is Prevalent Around the World

Denmark has provided a global reference for the digital protection of cultural heritage. Touching on the VILLUM window Collection, the world's first window museum, founder Lars Kann-Rasmussen decided that each window represents the cultural history of the local area and should be recorded and shared (Rasmussen, 2006). The Museum is a comprehensive physical collection of window data on the technology, craftsmanship and historical examples of the development of windows, and currently houses about 300 historical windows dating from the 17th century to the present day. Detailed data is organized and stored in terms of size, production date, frame material, type of glass or "panes", type of opening mechanism, specific hinges or hardware, and others to mention.

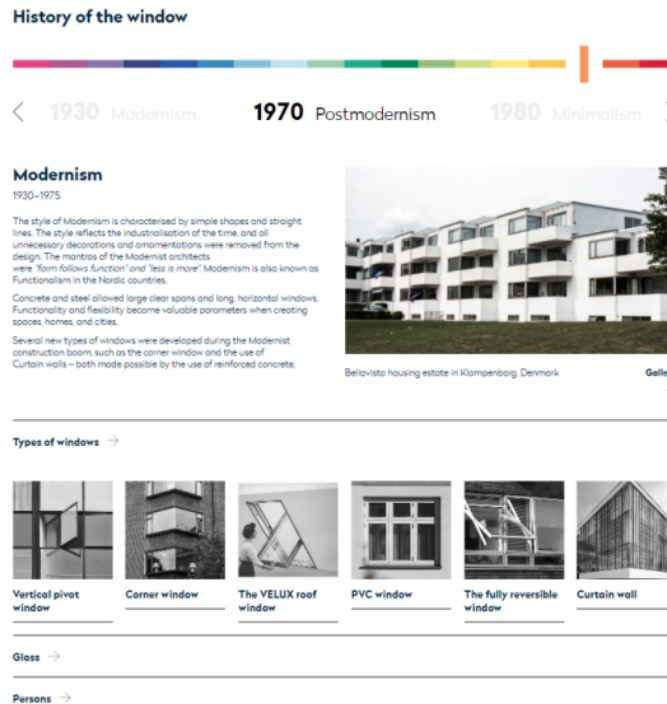


Fig. 1. VILLIUM window Collection shows the history of windows
(Source: <https://en.villumwindowcollection.com/>)

Offline physical space is also set up for corresponding data archives of the museum. The exhibition space displays windows in a chronological order. Unfortunately, although the database has a classification of China, but does not have a single Chinese window system data.



Fig. 2. An exhibition about VILLIUM window Collection
(Source: <https://en.villumwindowcollection.com/>)

3. Background Analysis of Traditional Architectural Window Culture in Guangfu

3.1 The Influence of Guangfu Region

Guangfu is located in the Lingnan region of China. In ancient times, it was called the Baiyue Land, where the Baiyue nationality lived. In the late Qin and early Han Dynasties, it was under the jurisdiction of the State of Nanyue. Nanling Mountains blocked the transportation and economic links between Lingnan region and the Central Plains, making Lingnan region far inferior to the Central Plains in economy and culture, and called "barbarian land" by northerners (Li, 1993). Among the Lingnan ethnic groups, Guangfu, Chaoshan and Hakka have all formed architectural forms with their own styles and local characteristics. In addition, Guangfu region belongs to the southern part of the East Asian monsoon climate zone, which

has the characteristics of tropical and subtropical monsoon maritime climate. Most of the Lingnan region belongs to the subtropical monsoon climate, and the Tropic of Cancer runs through the central part of Lingnan, with high temperature and rainy weather as the main climatic characteristics. In most areas, summer is long and winter is short, and frost and snow are absent all year round, forming a climate characteristic of hot, humid and long sunshine time. Due to the high temperature all year round, abundant rain, abundant light, heat and water conditions, so the trees are lush and evergreen, there are rich native plants, rich tropical and subtropical evergreen forests, biological diversity, a variety of fruits and flowers all year round, plant resources are very rich. The natural environment of Guangfu has a great impact on the space design of Guangfu. People in Guangfu focus on solving the material life function requirements such as shading, heat insulation and humidity insulation, ventilation and fire prevention, and anti-theft of a large area. The optimization and inheritance of these solutions gradually develop into a mature and relatively stable Guangfu residential architecture system (Li, 2013).

As Guangfu region is located in the dividing line between the South and Middle tropics, it has a typical subtropical monsoon Marine climate, which is warm and rainy, abundant light and heat, small temperature difference, long summer, short frost period and other climatic characteristics. Guangfu area is a variety of hardwood, mahogany main producing area, wood products sufficient raw materials. wooden windows are the most used in traditional buildings of Guangfu. The geographical location of Guangfu determines the climate characteristics here. Such geographical environment and climate are the most important external factors affecting the architectural style of Guangfu (Xue ,2012).

3.2 Influence of Guangfu Culture

Since Tang Dynasty Prime Minister Zhang Jiuling built the Meiguan Ancient Road in Dayu Ridge, the region was gradually developed under the influence of the Central Plains culture. Although the sea lies to the east and south of Lingnan, in order to survive, the Lingnan people had to break the blockade of the sea, go out to sea to fish and do business in Southeast Asia. Therefore, there was maritime trade in Guangzhou since the Qin Dynasty, gradually forming an important commercial city and maritime culture. The most essential characteristic of Marine culture is that the sea is for commerce. Through the sea, they engage in commercial trade with overseas countries and regions. To trade, they must fight against the sea wind and waves. Guangfu people have courage, and wisdom, they have transcendence, competition, market consciousness, full of adventure, positive character, which are caused by the marine culture environment, and commercial competition environment. Through time, Chinese and western cultures meet and collide in various ways in Guangfu, and the Guangfu culture eventually forms a diversified, complex and open cultural system (Li, 2013).

Marine culture lays the foundation of Guangfu culture and provides the conditions for regional development. The Guangfu area has its own unique system in philosophy, drama, music, painting, folk customs, medicine, gardens and architecture. The design form and style of the traditional architectural windows of Guangfu are influenced by the natural, social, technological, artistic and historical factors of Guangfu region, forming the window culture with regional characteristics. Influenced by the environment of Guangfu, the exterior windows of Guangfu buildings respect folk customs, emphasize practical effects, comply with nature, and organically combine with landscaping. The layout of the interior window is flexible and the shape of the window is diverse. The decoration design of the window is

based on the requirements of sunshade, heat insulation, ventilation, windproof, anti-theft and other material life functions.

3.3 The Influence of Guangfu Society

The openness of Guangfu culture is mainly reflected in the long-term edification and influence of foreign culture, the mutual learning and integration of local and foreign architectural elements, thus enriching the architectural style of Guangfu. Specifically, the mutual acceptance, learning and integration of the traditional architectural culture of Guangfu with the early foreign culture and the modern western architectural culture promoted the development of the architecture of Guangfu, thus creating an inclusive and excellent architectural culture of Guangfu. The openness embodied in modern Guangfu traditional architecture is the result of gradual evolution in a long period of time. It has experienced a development process from resistance to western architectural culture, to learning of western architectural culture, and then to integration of Eastern and western architectural culture. This complicated course shows that the development of Guangfu architecture was accompanied by the social and economic changes in Guangfu area since modern times.

Human social production experiences six scientific and technological revolutions, namely the birth of modern physics, the revolution of steam engine and machinery, the revolution of electricity and transportation, the revolution of relativity and quantum mechanics, the revolution of electronics and information, and the new biology and regeneration revolution to be entered (Form Spencer, 2019). As an additional, every scientific and technological revolution has promoted the great development of the world economy, military, political and social life. The development of high technology makes the traditional social production mode tend to be low pollution, low consumption and low energy consumption, which greatly promotes the improvement of product quality and labor productivity. In order to avoid blindly imitating the high technology of developed countries, China should seek "appropriate technology" according to the traditional technology, low and medium technology and high and new technology to promote the development of architectural space design.

At present, the Guangfu society advocates the implementation of "appropriate technology" and "innovative reference" in architectural design, and the design of architectural windows in Guangfu needs to create "appropriate technology", or "appropriate technology combined with high technology" and other ways to plan. The principle of "appropriate technology" is to take local conditions as the core to consider the natural climate conditions, economic conditions and actual needs of the design project, and selectively combine traditional technology with modern technology.

4. Modern Application of Traditional Architectural Window Culture in Guangfu

The traditional architectural window culture of Guangfu has rich artistic value. It could provide creative materials and design ideas for modern design, no matter it is modeling design, color expression, decorative theme, or highly skilled carving technology. These elements are integrated and extracted, and their contents and forms are translated. Through the redesign, re-innovation and re-application of traditional elements, a design language more in line with modern aesthetics is formed. The traditional cultural elements of Guangfu are injected into the modern architectural design, and the cultural connotation is extended to the decorative elements. It provides rich cultural connotation for the modern design and realizes the combination of design form and cultural connotation, which is also conducive to

promoting the innovation of traditional culture and the inheritance and development of traditional culture.

In the current architectural design cases of Guangfu, "appropriate technology" is taken as the design concept, and "ecological appropriate technology" such as the wind pulling effect of small patio in the traditional residential buildings of Guangfu region, the cold reservoir storage effect of courtyard, the ventilation mode of courtyard against windows, hot pressure ventilation of cold alley and climate buffer space is fully adopted. At the same time, the traditional residential buildings should extend the cultural connotation to the decorative form, in order to achieve the design requirements of "both quality and culture". The ingenious use of local materials and their unique construction technology makes the interior material texture, color and environment perfect integration, to save transportation costs, and form the architectural style and decoration culture with regional characteristics.

4.1 Panxi Restaurant Store Design

Panxi Restaurant is located in Liwan Lake Park in Guangzhou, designed by the famous Chinese landscape architect Mo Bozhi. Together with North Garden Restaurant and South Garden Restaurant, it is named as one of the three garden restaurants in Guangzhou (Wang, 2017). Panxi Restaurant combines the elements of traditional Guangfu culture with modern aesthetics from the door and window decoration, integrates modern architectural design thinking with the traditional garden concept of Guangfu, and shows the characteristics of The Times of the traditional architectural decoration of Guangfu.

Each place of the restaurant has different characteristics, Guangfu traditional black brick and wooden doors and windows match very coordination, gray green ceiling and red leaky window design is very bright, the overall look is not only spacious and bright, but also comfortable. The dining area of the restaurant is separated by window splints made of traditional window and window elements such as window stud, window stud and partition screen. Traditional geometric decorative elements of doors and windows are embellished in every detail, echoing the brick walls and eaves and the bonsai decoration full of green, giving people a sense of shuttle between the past and the present. The corridor also adopts the corresponding ancient style design, such as the row of window screens, which integrates the four famous flower elements of plum, orchid, bamboo and chrysanthemum, and uses light yellow or gold color to match, highlighting the traditional Chinese style. Panxi restaurant integrates ancient and modern elements in the design. The injection of traditional Guangfu door and window elements in the store design makes the whole more design sense, spatial sense and three-dimensional sense. The combination of exquisite Chinese style and modern simplicity makes the restaurant very stylish.



Fig. 3. Panxi Restaurant (photo by author)

Panxi Restaurant makes people feel the characteristics of Guangfu space system, such as compact layout, flexible spacing, air penetration, light weight and liveliness. The shapes, colors and lines of the traditional window decoration culture of Guangfu are also well used here. In order to make the space more hierarchical and decorative, the partition screen or Manchurian window is used to divide the space, which not only separates the space, but also plays a decorative effect. Manchurian windows are widely used in Panxi restaurants. In particular, the decorative color of Manchurian windows is in harmony with the overall decoration. whether it is matched with the indoor furniture and furnishings, or reflected with the outdoor pool water, flowers and wood, it could be integrated into them, highlighting the delicacy.



Fig. 4. Panxi Restaurant (photo by author)

4.2 Dongguan Intercontinental International Hotel

Intercontinental Dongguan is the first five-star luxury brand hotel in Dongguan, designed by Cheng Chung Design (HK), a renowned hotel space design team. The hotel is located in

Dongguan city design team through the Guangfu auspicious culture, Guangfu folk culture, Guangfu life culture three aspects of the preliminary thinking, interior design concept reference one of the four Lingnan garden, Guangfu painting school and Dongguan Huangqi Mountain as the main elements. The design of the hotel hopes to interpret cultural symbols through the current design language, and present the quaint and exquisite Lingnan culture and modern exquisite life interwoven resonance charm.



Fig. 5. Dongguan intercontinental International Hotel
(photo by Cheng Chung Design HK)

The window is one of the most important elements in the interior design of Dongguan Intercontinental Hotel. The design not only achieves the effect of dividing space in function, but also makes the space distinguish between inside and outside through the boundary generated by space separation. In order to break the static space of binary opposition, the designer hopes to achieve a dynamic intercommunication between the inside and outside of the space and this is built through the door and window openings, so, when visitors check into the hotel, they could see the main window, which serves as the visual center. They could see the high window with decorative ceiling, the transparent French window, the long window with peep, and the sill window with dancing light and shadow.

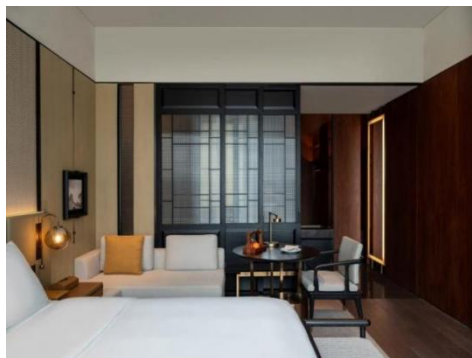


Fig. 6. Window of Dongguan intercontinental International Hotel
(photo by Cheng Chung Design HK)

5. The Process of Establishing Digital Archives of "Window of Guangfu"

5.1 *Obtaining Basic Data*

In addition to the network media, library access to the basic data of Guangfu traditional building window. This study is based on data collection through field investigation. Qing

Long and Chen Jie (2022) "Practice and Research on Data Archives of Manchurian window Cultural Resources for Cultural Resources" Lingnan Arcade Intangible Cultural Heritage Block Renewal gives great reference value. In order to make the original data of digital archives more accurate, the scope and display content of digital archives of window decoration of traditional residential buildings in Guangfu historical and cultural districts could be determined only through field investigation, numbering and photographing of these buildings. Regarding the acquisition of this data, the following limitations are made: (1) The Guangfu regions emphasized in the research scope are Guangzhou, Foshan, Dongguan, Jiangmen, Zhaoqing and Shenzhen of Guangdong Province, China. The reason for choosing these cities are that they are located in the Pearl River Delta region of China and belong to the "Guangfu" historical environment. As far as possible, the survey pictures would be marked with the corresponding geographical information, color, form, time, material, elevation, window, wall ratio and other parameters. (2) The research scope is Guangfu Historical and cultural Block. As for the definition of historical and cultural blocks, the Standards for the Protection and Planning of Historic and Cultural Cities, published by China in 2019, states: "Historic areas of a certain scale that have been approved and published by the people's governments of provinces, autonomous regions and municipalities directly under the Central Government are particularly rich in preserved cultural relics, have concentrated historical buildings, could reflect the traditional pattern and historical style more completely and truly, and have a certain scale" (Standards for protection planning of historical and cultural cities, 2019). (3) The period of research objects is the modern period (about 1616 to 2023). As many buildings were destroyed or rebuilt, many of the architectural decorations that exist today were actually built during the Qing Dynasty or even later, as determined by the characteristics of the subjects themselves.

5.2 Computer Technology for Digital Conversion

Through image recognition, the information of the patterns, colors, materials and dimensions of Guangfu architectural window culture is digitized and sorted out, and then the computer image processing software, virtual reality and computer three-dimensional drawing technology are used for digital reconstruction, which is convenient for designers to carry out real-time preview and later application. Digital reconstruction could provide better guarantee for the inheritance of architectural decoration. In order to save data more conveniently and for a long time, besides using EXCEL and basic software related to architectural design for record keeping, other innovative software would also be utilized. It will also refer to MySQL workbench, Oracle SQL Developer, Microsoft SQL Server Management Studio, and PostgreSQL database management software. In order to help the later identification and innovative application, vector transformation of frame structure was carried out for each window. Each window is marked by two parts: the window cover (lintel, window post, window sill) and the window core. Quantized color proportion, vector frame and function label help computer vision to judge and develop.

According to the window vector data conversion, the need for data archival processing includes the type information of Guangfu window, window decoration information, window material information, window designer information. Taking the classic sill windows of Guangfu residential houses as an example, the digital file system of "Guangfu windows" would list the description labels of the window core structure, window mullioned, painting heart, substrate, mullioned bar and lattice heart of sill windows. These label data constitute the important parameters of "Guangfu window". The obtained data would be analyzed and labeled. Among them, data such as the color of the window is eroded by rain for many years,

the surface is partly damaged, and the paint finish of the window cover and the window core glass appear faded and aging, so the color record needs to be further demonstrated.

5.3 Construct Digital Archives of Traditional Architectural Window Culture of Guangfu

The name of this digital file is "Guangfu window" digital file. The digital archives would construct a database of Guangfu window culture, which is applied to the reconstruction of traditional architecture and modern architecture design in the historical and cultural city of Guangfu. The contents include the cultural origins of Guangfu window, formal archives, material archives, high-precision two-dimensional graphic library, three-dimensional information and other special databases. In order to build the digital archives of "window of Guangfu" in a standardized way, the author conducted research on the special website of intangible cultural heritage and international common ontology models such as VRA Core Categories, CIDOC CRM and CDWA metadata application specifications. According to the characteristics of the traditional building window cultural heritage of Guangfu, this study refers to and selects the data application specification of CDWA category to form 11 basic units, and attempts to classify the traditional building window culture of Guangfu. (1) History Culture unit: comprehensively summarizes the history, culture and evolution of traditional architectural windows in Guangfu. (2) Titles unit: Titles that describe the names of the windows. (3) Date unit: when the window is applied to the facade of the building. (4) Measurements unit: The scope of measurement is the spatial information of the size, shape and window wall area ratio of the Guangfu window, including the composition number of Windows in the building, building height, building width, and the proportion of buildings and Windows. (5) Materials/Techniques unit: the physical materials that make up the window and the technological techniques that these materials are used. Materials include structural support materials (wood or glass), media (shielding materials), and hinges. Such as monochrome smooth glass, pineapple slice, monochrome etched glass. Techniques are reflected in colored glass paintings, such as carvings and etchings. (6) Location unit: The name of the location of the window, which should correspond to the building number. (7) Non-genetic inheritors unit: Collect and interview video and audio recordings of experts and scholars related to the Manchurian window, as well as digital records of the inheritors' crafts. (8) Drawing heart pattern unit: Drawing the categories of things described by heart pattern, such as plant pattern, animal pattern, geometric pattern and text pattern. (9) window mullion pattern unit: the window mullion is the center part, composed of wood mullion pattern, such as: cross begonia pattern, ice crack, treasure pattern and so on about 35 categories. (10) Shape unit: different shapes formed by the restriction of function and shape of windows, such as: transverse window, partition window, branch window, transom window, mullion window. (11) Use mechanism unit: the way the Guangfu window is opened. (12) Application unit: For the modern design application of windows, quality would no longer be used as a single measurement standard, but to comprehensively consider its energy saving, safety, air tightness, water tightness, sound insulation, durability, beauty and a series of comprehensive performance.

5.4 Let "Window of Guangfu" Digital Archives Produce More Interactive Ways

For cultural expression, digital archive promotes the protection and inheritance of local cultural heritage in the digital age. The vision of the digital archives of "windows of Guangfu" is to encourage local residents, foreign tourists and professional scholars living in Guangfu to look back on the history, and to compare and supplement the digital archives of "windows of Guangfu" by recording their personal culture, so as to better protect and inherit

the cultural heritage of traditional architectural windows of Guangfu. Through the magazines, newspapers and media platforms in recent years, it could be found that the cultural forms of the buildings and window mullions once passed away have been inadvertently integrated into the image materials spontaneously taken by the people and the stories of their personal belongings, which have a unique and powerful perspective.

The digital age has given people more convenient and powerful tools, allowing them to express culture and create content more freely. In social media, people could record and share what they see and hear, record local cultural heritage twice and exchange it in virtual communities, which could not only promote the inheritance of local culture, but also strengthen social identity and collective memory. However, the digital age also brings some challenges. Local cultural heritages may lose some of their original historical and cultural background in digital archives, and the retrospective history of local cultural holders could provide more comprehensive and accurate information for digital archives system. Therefore, in the research of digital memory archives of Guangfu windows, local culture holders should be encouraged to participate in the retrospective and supplement of history, so as to enrich and perfect the digital archive system and better record and inherit local cultural heritage.

6. Conclusion

The digital construction and application of Guangfu traditional architectural decoration integrated with computer technology is a long project that requires a lot of manpower and material input, and many aspects still need to be improved. If the amount of metadata is small, it needs to be further collected and sorted out. The innovative design of Guangfu window is still in the stage of exploration and attempt, to further deepen the research on its connotation and organizational elements in the future, so as to obtain more accurate grasp on the knowledge characteristics of the original data of Guangfu window. It is hoped that through the construction of data archives, intangible cultural heritage protection could be added to the discussion of production and life, and Guangfu window could realize the connection and communication with international and modern windows.

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