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Spatial Form Analysis and Sustainable Development Research of Traditional Residential Buildings

Hai-fan Wang ^{1,2,*} and Shang-chia Chiou ²

¹ School of Art and Design, Taizhou University, Taizhou 318000, China

² Graduate School of Design, National Yunlin University of Science & Technology, Yunlin 64002, Taiwan; chiousc@yuntech.edu.tw

* Correspondence: whf@tzc.edu.cn

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Abstract: Three courtyards nine halls is an important cultural asset in eastern Zhejiang. This paper takes Three courtyards nine halls dwellings in the eastern part of Zhejiang province of China as the research object, collecting data with field research, measurement, interviews and other research methods, to analyze the spatial characteristics and construction culture of traditional dwellings. Research findings: First, influenced by the natural environment, artificial environment and social environment, three courtyards nine halls is a complex of residential buildings with san-ho-yuan as a unit, extending vertically and horizontally. Second, with the influences of the Confucian culture, the architectural layout is symmetrically distributed along the central axis, and the architectural space presents a high degree of consistency. Third, the architectural complex was formed by the same clan. The last one is that the architectural form and culture show consistency, which implies the idea of harmony between man and nature, the farming and studying hand down from generation to generation. On the one hand, with the acceleration of the urbanization process, living conditions have been greatly improved. On the other hand, due to the weak awareness of residents' protection of traditional residential cultural assets, lack of systematic study on traditional residential construction methods, construction techniques and space culture, new buildings are not in harmony with traditional dwellings, therefore, traditional dwellings are seriously damaged. This paper discusses the sustainable development of traditional residential culture by studying the construction and environmental elements of Three courtyards nine halls, taking the residential space as a principal part to analyze the characteristics, functional attributes, organizational principles, order, and sense of place.

Keywords: traditional dwelling; cultural asset; spatial characteristics; residence culture

1. Introduction

1.1. Traditional Dwelling

“Traditional dwellings” are terms used in academic research at home and abroad. The term “dwelling” is often understood as a civilian’s housing. It is an architectural form built by folk craftsmen with local building materials within the same cultural or linguistic circle. The living environment of traditional dwelling houses is a community of social, spatial, ecological and cultural self-awareness. Traditional architecture discussed in this paper refers to the concept of vernacular architecture. In the *Encyclopedia of Vernacular Architecture of the World*, Paul Oliver pointed out several characteristics of “vernacular architecture”: indigenous, anonymous (i.e., no architect), spontaneous (i.e., unconscious), folk (unofficial), traditional, rural and so on [1].

Human Settlements are a holistic system, which are not only a space system, but also a cultural system, a social structure system and an economic system. It is a form of residence that people

in the same cultural circle coordinate with the natural environment in the long-term, and sets up a mutual emotional mechanism between the context of communication, culture and social ethics. Traditional residential houses are affected by the natural environment, social environment and artificial environment [1] (p. 225). The relationship among the three factors is a dynamic process, which influences each other. Only in the constant change and development can the traditional residential culture be inherited and continued, and succeed in making the traditional residence sustainable development. Traditional residence is a whole concept. From the perspective of space environment, there are three levels: performance level, structure level and spiritual level [2]. Three courtyards nine halls buildings contain these three levels. The performance level is a complex composed of san-ho-yuan. The structure level is a brick and wood structure with an exquisite architectural structure. The spiritual level is embodied in the concepts of harmony between man and nature, social ethics and order.

1.1.1. The Composition of a Three Courtyards Nine Halls Building

Three courtyards nine halls building is a combination of vertical or horizontal splicing of san-ho-yuan (Figures 1 and 2). When the scale of the residence gradually expands, san-ho-yuan will develop in depth according to different base sites, forming shapes like “日”, “目”, and then expand to the left and right, forming a combination of “田”, “田” or larger. In a regular and symmetrical large residence, san-ho-yuan is actually a kind of standard unit that can be pieced together vertically and horizontally, which can adapt to the different shapes of the site. It is convenient to expand and connect in stages. No matter how much it is expanded, it is neat and complete [3]. Taking a san-ho-yuan as a monomer, the one is connected with the other to form a group of buildings, which has a certain scientific nature. Firstly, from an economic aspect, the construction of residential houses requires a large amount of capital. Building a san-ho-yuan first and then developing gradually can alleviate the pressure of construction funds. Secondly, in the era of farming civilization, prosperity of population and family is particularly important. The architectural form of Three courtyards nine halls can make the same tribe live together and form an inter-connected courtyard group. The number of houses to be built can be determined by the number of children. The last one is that it can adapt to the changes of different terrains. Under the condition of terrain leveling, it extends vertically and horizontally from a single courtyard to a regular. When encountering irregular terrain, it can be extended freely but is still connected with the main building. The change in the unit form of san-ho-yuan is limited, but the extension of a basic unit is infinite, which is a combination of “limited” and “infinite”.



Figure 1. Evolution intention map of san-ho-yuan [4].



Figure 2. Existing residential buildings.

1.1.2. Architectural Form and Culture Are in the Same Vein

The patio of a Three courtyards nine halls building is a courtyard. Three patios are connected together as “three courtyards”, and each patio has three halls, a total of nine, which is called Three courtyards nine halls. The building is a brick-concrete structure residence with Hui-style architecture as its foundation. The overall style is simple and elegant, and the space system is complete (Figure 3). The residence is mainly composed of two floors, with a sloped roof. The main hall and foyer are bright. There are cornices on the side near the courtyard, supported by wooden pillars with colors of black, white, gray and log. Most of the existing Three courtyards nine halls buildings were built in the Ming and Qing Dynasties. According to the investigation, the buildings in Xianju are the most intact. There are Jishan hall, Rixin hall, Xinde hall, etc., in Gaoqian village, and Kangle hall, Heqin hall, Hele hall, etc., in Lizhai village. Taking Xingshen hall in Gaoqian village (Figure 4) as an example, it was built by Xi-guan Wu, who strictly observes sentiment and is highly respected by others. The name of the hall is taken from the analects of Confucius, “three provinces in a day”. It is binary and is divided into a lobby, front yard and back yard, which form a “cross courtyard” pattern with the same binary compound in the west. The entrance is located on the central axis of the house, with the first floor being a lobby. The main hall and the wing rooms on the left and right are three rooms in width and two floors in height. The south side of the wing rooms in the front yard is used to seal the volcanic wall, which is connected with the entrance door wall as a whole. The gable facade is rich in contour.



Figure 3. Three courtyards nine halls buildings [5].



Figure 4. Xingshen hall.

1.1.3. The Spatial Nature of the Courtyard

A courtyard is an enclosed space. “San-ho-yuan” is not only a substantial space, but also a spiritual and cultural connotation, including the enclosure of space, the harmony between human and nature, family harmony and cultural harmony.

Enclosure in the Sense of Space

Moholy-Nagy defines space as “the relationship between the positions of objects”, indicating that it can be experienced by all human senses. Emphasizing that space is a dynamic field and architecture is no longer an exhibition between individuals, but a building group relationship: the group edge line becomes a kind of fluid; space has fluidity and it is a series of innumerable relation sequences [6]. Three san-ho-yuans are connected with each other by corridors, thus preventing people from getting wet during the rainy season when they walk through the buildings (Figure 5). The Ma Tau Wall, made of grey bricks, plays a decorative role on the one hand, and has the function of fire prevention on the other hand. The first floor has stone windows with small openings, while the second floor has round windows with only one head protruding out. San-ho-yuans are connected to form a closed space, surrounded by a wall with a height of 5–6 m. Open doors in the east, west, north and south form a large enclosed courtyard. It can be seen from the elevation and plan of the building (Figure 6), that when the door is closed, the inside and outside are separated to prevent theft and attack. The closed courtyard can play a role in security.



Figure 5. The connective corridor.



Figure 6. Residential defense function [7].

Harmony between Man and Nature

In addition to harmony with the environment, geomancy is also an important aspect of the harmony between man and nature in Three courtyards nine halls buildings. *Lao-zi* contains two important concepts: nature and space. Mixed clay is used to make utensils, because the middle is empty, so we implement effect. Carved doors and windows cover into a house, because the middle is empty, and have the function of a house. Professor Yi-diao Zhang interprets the “none” of *Lao-zi* as an intangible substance, which is not only space in essence, but also geomancy of architecture [8]. Each of the four corners of the courtyard in Three courtyards nine halls is equipped with a large water tank to collect water. In traditional culture, “water” and “wealth” are in line with the traditional concept of geomancy. Secondly, *san-ho-yuan* is composed of a hall and wing room. From anthropomorphism of spaces and names (Figures 7 and 8), the analogy of space and form, view of Yin and Yang and five elements to analyze the Chinese traditional body, is how thinking is viewed in *san-ho-yuan*. Through transformation and interpretation, a space of heaven-human ratio, heaven-human unity, and heaven-human isomorphism is formed [9].

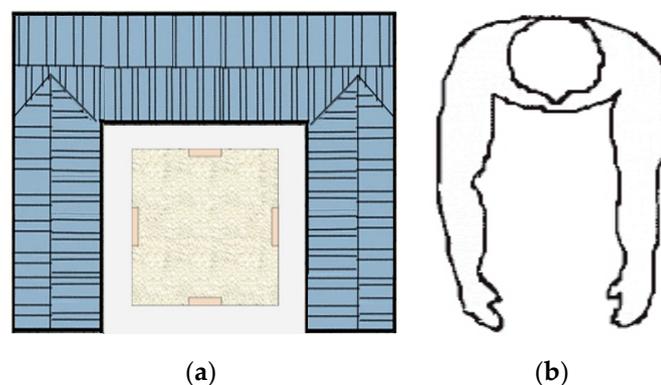


Figure 7. The spatial anthropomorphic characteristics of *san-ho-yuan*. (a) is *san-ho-yuan*; (b) is human body [7] (p. 1).

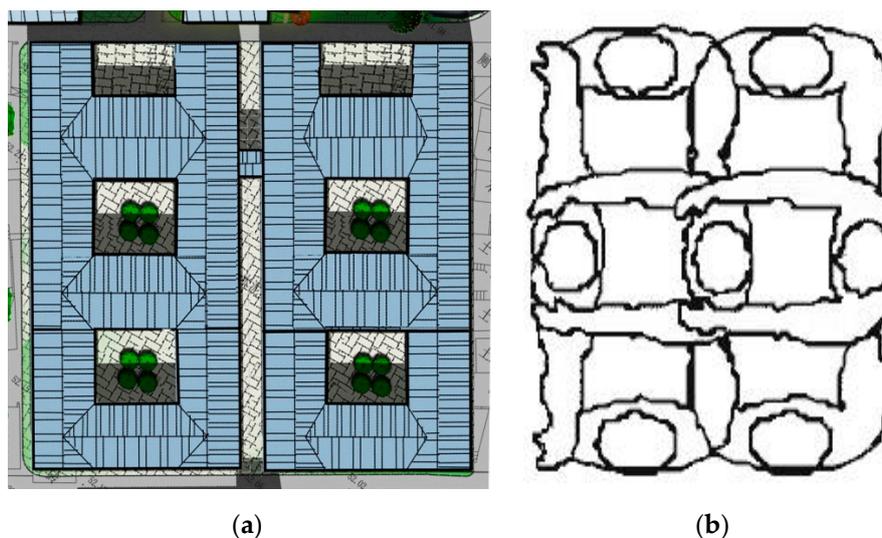


Figure 8. The spatial anthropomorphic characteristics of Three courtyards nine halls. (a) is Three courtyards nine halls; (b) is human body [10].

Geomancy is the scientific wisdom that traditional craftsmen build with the dimensional nature and the person to be in harmony. The observation of the natural environment is not a completely objective view of nature, but a human starting point [11]. Chinese culture has long combined man and nature. The residential buildings are the bridge between man and earth, forming a harmonious coexistence between man and all things on earth, which is the heaven-human unity advocated by Taoist philosophy.

Family Harmony

Three courtyards nine halls buildings are constructed with the concept of patriarchy and the residential buildings are the materialization of the lifestyle of the times. As an orderly symbol to convey information, the external visible objects record the material state system of the era in which the symbol subject lives, cultural psychology and human values, as well as the relationship between people and things, people and people, and people and society [12]. The formation of early traditional families often relies on the consanguinity as the link to form the same clan and live together. It is formed by blood and marriage and the basic form is clan, branch and family. Almost all buildings in Three courtyards nine halls are of the same clan. For example, Lizhai village is the residence of Li people while Fengshuqiao is mainly of Zhou people, and Wu people are the main group in Gaoqian village. The congregations of the same clan are mainly families, expanding and maintaining the same clan for several generations, which is conducive to the expansion of the labor force and family power. The characteristic of familyism reflected in space is central. Based on the principle of independence and integrity within the family, its spatial schema is centripetal [13]. It is manifested in two aspects; one is the architectural complex which is derived from a single courtyard and the other is taking the ancestral hall as the core of ethics. Clan often set up an organizational system in strict accordance with the ethical pattern of a “clan-branch-family”. The expansion of the building is consistent with the clan, forming the ethical order of the family.

Cultural Harmony

The traditional Chinese society is a pattern of difference that is derived from the inside and pushed out at different levels. Traditional residence is one of them. It is not merely a “container” to live in, but a “home” which corresponds to, carries and specifically represents a human nature, containing the power and passion of life. In people’s concept of living, the traditional residence is an organic structure composed of life, belief, value and ethics, which can best reflect the survival wisdom of “unity of

heaven and man” and the continuous life character [1] (p. 171). In the investigation, the researchers found that there were high-ranking officials in the village of Three courtyards nine halls architecture groups in history. Such as Yi-han Li, from Lizhai, who was the Vice Chief Imperial Supervisor in the Ming Dynasty. In the history of Gaoqian, there were many outstanding talents, such as Fu Wu, a great scholar of Long Tuge in the Northern Song Dynasty; Jian Wu, the Prime Minister in the Southern Song Dynasty; and Shi-lai Wu, the Chief Imperial Supervisor in the Ming Dynasty. Xianju is greatly influenced by Neo-Confucianism. Its concept of benevolence, filial piety and harmony is deeply rooted in people’s minds. In the residential buildings, the couplets and murals that promote reading, diligence, and benevolence are everywhere.

Secondly, the layout of Three courtyards nine halls is based on the courtyard as the core organization space. The central axis-symmetric layout (Figure 9) consists of the patio-hall-wing room-corridors. It also shows a fixed pattern in function. The main hall has three rooms (one central hall and two transverse halls), and the left and right wing rooms also have three rooms. The patio is inlaid with pebbles into various auspicious patterns. On the central axis, there are usually three layers of the hall, with wing rooms and small courtyards on both sides. The court contains another court, and each hall is connected with the outside by separate gates. The residential concept of middle parents and respect for seniority (the older on the left and the younger on the right) is designed to maintain a clear and complete family order in space. In terms of residential function, the entrance is the spatial node of the internal and external connection of the house. The front yard and hall are used for hospitality, while the back yard is the private space for family, which constitutes the public space between family members and the external connection. The architectural space presents a high degree of axis features: entrance > courtyard > court. The central axis space is the space of transportation organization of the whole residential house, and also the space carrier of connection between members of the family, with the highest overall integration degree. The front and back yard is the main connecting part of the court, hall, wing room and other architectural spaces [4]. There is a common and frequent space in the middle of the depth axis, and the use frequency of the space to both sides becomes lower and lower. It not only adapts to the organic construction of nature, but also is in line with the order and hierarchy and the Confucian patriarchal system thought of by the traditional big family. Enclosed space formed by a courtyard is a combination of specific historical, environmental, cultural and climatic factors, and is a carrier of local residents’ material, culture and life.

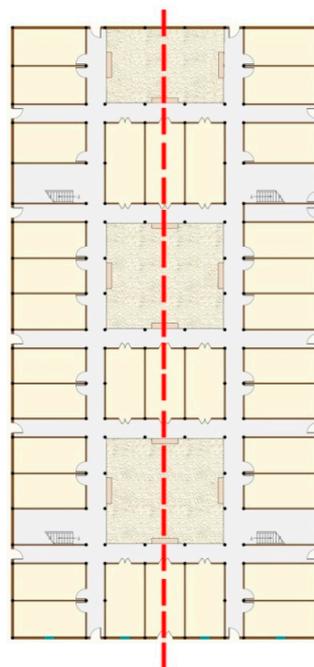


Figure 9. Axis map.

1.2. Research Object

The research sites of this paper are Gaoqian village, Lizhai village and Fengshuqiao village in Xianju County, Zhejiang Province, China (Figure 10). Gaoqian village is located in the eastern part of Baita town, about 20 km away from Xianju County. It is one of the settlements of the Wu family, a distinguished family in regions south of the Yangtze River. The village was founded in the Yuan Dynasty and was built between 1350 and 1900 AD. There are 1074 households in the village. The existing buildings retain the style of the Ming and Qing Dynasties, which are the most representative traditional houses in eastern Zhejiang. Gaoqian is a village formed by the same ancestor. The earliest of Wu's ancestors, Bai-yan Wu and Ying-yan Wu, built the house and expanded to form the current architectural pattern. The scale of the building is large and the overall layout is preserved. Lizhai is 45 km away from Xianju County, which is dominated by the Li family. Residential buildings in Lizhai are typical Three courtyards nine halls buildings and the village was included in the traditional Chinese village. Fengshuqiao village is located in the middle and east of Xianju County, 20 km away from the county. The three brothers of Zhou's family settled here from 1506–1521, and it has been nearly 500 years. The existing “Three courtyards nine bright halls” dwellings are large in scale, uniquely constructed, exquisitely carved, elegant and clean, and rich in cultural connotations.



Figure 10. Research site.

In the field research, the study found that the construction of Three courtyards nine halls was seriously damaged, which is embodied in the following aspects: First, traditional dwellings are poorly protected. Many traditional dwellings are increasingly destroyed and declined due to natural and man-made factors. Second, the new concrete dwellings are not in harmony with traditional brick-and-wood dwellings in terms of architectural modeling, materials, colors and volumes, as shown in Figure 11. Third, residents' awareness of protection is weak, and the emphasis on traditional residential cultural assets is insufficient. Lastly, local traditional cultural resources are gradually disappearing. Traditional dwellings were demolished because of being old and broken, and were replaced by urban-style dwellings. The traditional residential culture and style of the architectural form has gradually disappeared.

In view of the current problems faced by Three courtyards nine halls buildings, strengthening the study of traditional residential culture, protecting the historical and cultural heritage of traditional dwellings, and excavating historical and cultural connotations are conducive to protecting the spatial texture and architectural cultural heritage of traditional dwellings in eastern Zhejiang. The spatial form of traditional dwellings in eastern Zhejiang is influenced by various factors such as building materials, construction technology and culture, which is an important cultural asset. Due to residents' weak

sense of protection of traditional residential cultural assets, traditional dwellings have suffered serious damage in the process of economic development. Owing to the lack of systematic and in-depth research on spatial form of traditional dwellings, traditional construction culture is missing, and the disordered construction of new buildings is not in harmony with the space of traditional dwellings, which separates the construction context of traditional dwellings. Some of the traditional dwellings gradually lose the momentum of inheritance, and disordered development has become an obstacle to sustainable development of traditional dwellings. The purpose of this article is to explore the construction methods, living wisdom and construction culture contained in traditional dwellings. Through systematic research, residents' awareness of preserving cultural assets of traditional residential houses can be enhanced, and suggestions can be provided for cultural inheritance of traditional dwellings, which is conducive to inheritance of traditional residential culture. It is beneficial to realize the sustainable development of traditional residences in eastern Zhejiang to explore the construction concept and form of new dwellings based on the construction culture of traditional dwellings.



Figure 11. New dwellings coexist with traditional dwellings.

2. Literature Review

2.1. Research on Traditional Residential Buildings from Single Discipline to Interdisciplinary

It is generally believed in the academia that the study of traditional Chinese dwellings began with the research on ancient buildings by a group of scholars organized by Society for the Study of Chinese Architecture in the 1930s. Researchers represented by Liu, Liang, Long and Liu, drew lessons from western classical architectural research methods, and investigated typical Chinese dwellings by using architectural monolithic surveying and mapping as a basic operation mode, which laid the foundation for the study of Chinese dwellings [1] (p. 3). Yu (2001) discusses the interaction between architecture, clan organization and family life in southeast China with the method of multidisciplinary research, which analyzes the types and living patterns of dwellings, and conducts a comparative study of dwellings in different regions with typology [14]. Li (2005), intercrossing research of different subjects, has held the main current of the research on vernacular architecture. Based on the thoughts of subject crossing and theories integration, Li's book tries to research combining vernacular architecture with Sociology, Human Geography, Communication and Ecology in order to set up structural frames of different theories, and to open up various fields of vision for research workers [1] (p. 3). Since the 1990s, scholars have gradually applied multi-disciplinary research to study the traditional residential culture. They have analyzed the residents' traditional ideas, lifestyle, economy and religion, and shifted

from the description of traditional residential houses' architectural form to a deeper analysis of space and culture.

2.2. Research on Human Geography

Human geography pays attention to the characteristics of regional distribution and the relationship between human phenomena and geographical environment. Based on the theory of the human–land relationship, it explores the distribution, change and diffusion of various human phenomena, as well as the science of the spatial structure of human social activities [15]. With the help of theories of human geography, human–land relationship, spatial behavior and location, the study of traditional dwellings has expanded the range of study, the angle of finding and putting forward problems, and the method of studying problems, which is of great significance to the study of traditional dwellings. Tuan (2003), attempts to systematize humanistic insights, to display them in conceptual frames (here organized as chapters) so that their importance is evident to us, not only as thoughtful people curious to know more about our own nature—our potential for experiencing—but also as tenants of the earth practically concerned with the design of a more human habitat [16]. Anthropological research on space is related to consanguinity and geography. Huang (1998), puts forward a very important point in *Ancient Law* that consanguinity has a very important reason (especially single surname villages) and geography is another important factor. Besides “ancestral place”, “sacrificial circle” is a specific organization based on geography. Morgan (1881), discusses the relationship between space and relatives of American Indians, which laid the foundation of ethnography for the later study of functionalism and home space, but did not give theoretical significance to space study [17]. Tang (2014), introduces the research method of cultural geography to systematically collect and process the basic data of traditional residential buildings in Meizhou area, aiming to describe and explain the spatial differences and distribution rules of the cultural landscape of traditional residential buildings in Meizhou from a new perspective of geography [18]. Based on the geographical analysis and quantitative research, Du (2016), adopts the methods of description, superposition and dominant factors to divide the cultural divisions of traditional residential buildings in Nanning, which mainly includes the analysis of the types of houses, the evolution of the forms of houses, the layout forms of houses, the forms and structures of houses and the patterns of houses [19]. Phan (2016), describes the folk houses through the research and analysis methods of cultural geography, and analyzes the phenomenon behind them, as well as the residential culture and evolution law of residential culture, explaining the uniqueness of traditional residence and differences between cultural areas which build on local, unique and natural geographical conditions and human geographical conditions [20].

2.3. Research on Spatial Form and Culture

A single building is presented as formal articulation. Architectural form is always understood from the perspective of being between heaven and earth, their stand, rise and open. Stand means the relationship with the earth, rise means the relationship with heaven, open means the interaction with the environment, that is, the relationship between the outside and the inside [21]. The study of morphology is the internal spatial law of architectural form, not just the style of appearance. Guo (1998), points out that form refers to the “general rule” behind group production, which is the average quality and abstracted space law [17] (p. 18). Nelson Wu from Yale University in the United States uses image to study Chinese architecture, combining space and culture, using squares to represent intellectual geometry, and illuminating the main axis to express Chinese space concepts. It is very enlightening to describe the Chinese people's view of living space as round sky and square earth, which is the world in which man and nature reach a balance. Chen (1998), proposes that there is a set of symbolic systems in architecture that can represent the spatial meaning. The various meanings of architecture can be read with some symbolic systems, including the representation of religion, social culture, economy and ideology [17] (pp. 155–164). Chiou (2003), takes Taiwan's traditional residential architecture as the starting point and western thinking as the reference, reviews the unique body concept in ancient China

with reference to western ideas, discusses the body concept embodied in the traditional residential buildings in Taiwan, and understands the deep connotation and cultural structure hidden in traditional residential buildings in Taiwan [22]. Rapoport (2007), discusses the relationship between housing form and culture from the perspective of family, attempts to describe the special aspects of culture more concretely, and points out that culture had a great influence on housing form [23]. Concepts of culture and environment are cited in such studies. Bai, Yang and Zhou (2011), from the perspective of relationship between material cultural heritage and intangible cultural heritage of traditional villages, wrote a paper to discuss theoretical basis, methodology and means to be used in the research process of traditional village culture, which provides a theoretical basis for future cultural research of traditional villages [24]. Tian (2018), focuses on morphological characteristics of Youfang villagers' residences, basic types of plane and typical architectural layout of traditional dwellings, architectural facade characteristics, architectural construction techniques and decorative characteristics, etc. The cultural connotation of traditional dwellings in Youfang village is extracted, including Heluo culture, Fengshui culture and ecological culture, etc. The historical value, artistic value, scientific value, social value and cultural value of the dwellings are discussed in detail, and the protection idea of "authenticity, integrity, coordination and sustainability" is put forward [25]. Gu (2019), studies the layout type and characteristics, functional space and living environment, spatial scale rule and plane construction of traditional residential buildings in South Fujian, analyzes the rationality of layout, diversity of combination, suitability of living environment, etc., to provide reference for the future architectural design, heritage protection and repair work in South Fujian [26]. Li and Shen (2019), take traditional dwellings in the late Qing Dynasty and the early Republic of China in Western Hebei Province as the model, and expound decoration characteristics of traditional houses from aspects of courtyard space, interior space, building materials, carving art, door and window forms, cornice treatment and color relations, so as to provide reference for the research of traditional houses [27].

2.4. Relevant Literature of Three Courtyards Nine Halls

Wang (2006), takes the ancient town of Potan in Xianju as their research object, and introduces the history and architectural style of the town from humanistic, local customs, folk arts, and religious beliefs [28]. Bao and Chen (2018), take Gaoqian historical and cultural village in Xianju, China, as an example, analyze water culture of ancient villages from the perspective of water resources planning, and provide positive suggestions on the inheritance of the village water culture and regional economic development from the aspects of reservation, integration, repair and utilization [29]. Taking Gaoqian ancient village as an example, Wu and Xiao (2003), analyze the preconditions, driving forces and constraints of sustainable development of ancient villages from six aspects: cultural protection and economic development, cultural management and community tourism, ecological security and capacity control [30]. Wang (2017), starts with the traditional residential form in Taizhou, explores the protection strategies of traditional residential buildings during the transition period by discussing the layout, construction concept and existing problems, aiming at providing feasible ideas for the protection of traditional residential buildings in Taizhou [31]. Wang (2013), is drawing lessons from the architectural design of Xianju Vocational Education Center in terms of space composition, modeling elements and colors of "Three courtyards nine halls" architecture, so as to combine traditional residential culture with modern design, which is of great significance to inheritance of traditional residential culture [32]. Chen (2015) on this basic, focusing on analyzing the settlement space, residential space morphology and pattern shape of Gaoqian, including street space, water space and public building space and residential space, and analyzes a typical example. Finally, according to the Gaoqian ancient village, protection problems under the new urbanization form the regional characteristic element of the village culture protection, economic development, moderate protection of ancient villages planning and other aspects, proposing the Gaoqian ancient village space form protection strategies, provides theoretical support and practical guidance for the protection of traditional villages [33]. Pang, Shen and Zhou (2018) introduce the "chuan" river system form, "seven star mound" and "seven star pond" village

pattern, and thirteen “Three courtyards nine halls” in Xianju Gaoqian village, describe living culture of wisdom ecology in Xianju, and discuss the farming-reading culture contained in the village [34]. Tang (2018), clarifies the relationship between the clan cultural spirit and the village landscape space layout, architectural texture, interior layout and village cultural space to reveal the space composition and cultural space elements of Lizhai Village. On the premise of respecting and protecting historical elements, exploring the positive significance of space development in Lizhai Village and the updated research methods for spatial layout will provide reference to the traditional villages’ communication space and the construction of human settlements [35]. Feng, Liang and Ma (2019), targeting the ancient villages of Gaoqian, under the guidance of the concept of digital memory, find that the possibility of constructing “digital heritage” and “digital memory” of ancient villages is to use digital information resources to restore, recreate and reproduce the heritage and memories of ancient villages in physical and psychological worlds, and explore new models of rural Chinese cultural memory based on archival resources [36].

In summary, the research on traditional dwellings has made some achievements in methodology and research works. However, researches on Three courtyards nine halls in eastern Zhejiang mainly describe the current situation of traditional dwellings, and are insufficient on residential culture and lack in-depth analysis and interpretation. Researches on the architecture of Three courtyards nine halls are mostly from the perspective of bystanders. From the perspective of the residents themselves, the distance between the research results and the existing conditions is too long and is not conducive to real solutions to current practical problems.

3. Research Methods and Process

3.1. Research Methods

3.1.1. Field Investigation

Field research is most commonly used for qualitative research. Architectural shape, spatial characteristics and residential culture of traditional dwellings are analyzed by actual investigation of participatory observation, interviews, and residential surveying and mapping.

The survey content includes the relationship between the dwelling form and terrain, construction time, production methods, and social structure. In the field investigation of dwellings, the researchers start from three aspects. (1) Collect, organize, verify and analyze relevant historical documents and materials, and supplement a large number of field investigations, social surveys and oral data to improve the precision of research and the scientificity of research results. (2) The spatial layout of residential buildings and the distance between the spatial nodes of major buildings are recorded by real-world surveying and mapping. The layout of residential buildings is drawn based on the numerical values. (3) With the help of UAV (Unmanned Aerial Vehicle), 3D images are used to obtain the information such as terrain, landforms, spatial textures, residential architecture, and residential architecture scale. The coordinates of the main node buildings are located by GPS to assist in drawing the residential space. The UAV is equipped with high-resolution sensors in the air to take aerial photos. The 360 degree aerial photos are obtained with a wide-angle lens, and the aerial panoramic images are generated through post-processing data. The villages of Three courtyards nine halls under investigation are shown in Table 1.

Table 1. Field investigation sites of Three courtyards nine halls in East Zhejiang.

City	Village	Village	Village	Village	Village	Village
Xianju	Gaoqian	Lizhai	Fengshuqiao	Fangzhai	Guanshan	Butou
Tiantai	Zhangsi					
Linhai	Linggen					

3.1.2. In-Depth Interviews

This research mainly uses qualitative research methods of in-depth interviews and participatory observations. The paper has continued to study the space and cultural sustainable development of traditional dwellings in eastern Zhejiang for many years, and has conducted close and long-term investigations on traditional dwellings. At the same time, a number of government research projects had completed, such as *Research on the Analysis and Inheritance and Protection of Spatial Features of Historical and Cultural Villages and Towns* (Project No. 2017PY007), *Research on the Protection and Development of Civilian Residences in Ancient Towns of Taizhou* (Project No. 16YZ04), and *A Study on the Development Plan of Xianju County's Tourism*. The researchers conducted field investigation and interviews in Gaoqian village, Lizhai village, Fengshuqiao village, Fangzhai village and Guanshan village in Xianju, Linggen village in Linhai, Zhangsi village in Tiantai on May 1 to 6, 2016, July 10 to 16, 2017, November 3 to 7, 2017, May 8 to 10, 2018, August 22 to 25, 2018, July 3 to 6, 2019, and August 15 to 19, 2019. They focused on semi-structured in-depth interviews through the “snowball” sampling method. The sequence of interviews was villagers, tourists, village cadres, county planning bureau staff and experts and scholars. In-depth understanding of historical and cultural, human geography and residential-related information of Three courtyards nine halls architecture, living with local people to record the subjective experience of local residents, examining the relationship between people, people and living environment, from which the essential relationship between environment and architecture, as well as residents’ life and existence can be found.

The interview is mainly divided into 5 levels: (1) Interviews with local residents (such as Granny Wu (82 years old), retired teacher in Gaoqian Village, Xiao-jie Li (49 years old)). Local residents have lived here for a long time and are familiar with the history of dwellings and the evolution of space. (2) Interviews with tourists (such as photographer Cheng Zhu (37 years old); Miss Tian (28 years old)). Through the interview, the tourists’ intuitive experience of traditional dwellings and their understanding of Three courtyards nine halls can be learned. (3) Interviews with traditional craftsmen and repairers (such as Yong Wu (52 years old), Da-hai Wu (38 years old)). As the builders and repairers of traditional dwellings, they have an in-depth understanding of the spatial characteristics, spatial structure and construction techniques of traditional dwellings. (4) Interview with government staff (Planning Bureau, Land Bureau and village cadres, such as Hai-tao Wu (50 years old), director of Gaoqian Village, chief Li (43 years old), Xianju County Planning Bureau). It is helpful to effectively and deeply understand the distribution, graphics, protection and policy information of the traditional Three courtyards nine halls in eastern Zhejiang in the short term. (5) Interviews with experts and scholars. Talk with experts and scholars (such as professor Yue-jun Li (51 years old), professor Shi-rong Wu (50 years old)) who are familiar with Three courtyards nine halls, and acquire knowledge of Three courtyards nine halls from the perspective of experts.

The preliminary survey period of this study is relatively long, with a total of 43 key interviewees. The average length of the interview is more than 1 hour. The content of the interview includes the construction time of traditional dwellings, the spatial layout characteristics, the functions of each space, and the residents. In the later stage, the interview manuscript was anonymously coded. From 2017 to 2019, key interviews were conducted with 131 people (Table 2). The code of the interview data in this article appears in the format of 20170710CVN-I. The first 4 numerals are the year of the interview and the middle 4 are the date. “C” (city) refers to the research city, for example, “TZ” refers to Taizhou, “LH” refers to Linhai, “TT” refers to Tiantai, “XJ” refers to Xianju; “V” (Village) refers to the investigated village, such as “GQ” refers to Gaoqian, “LZ” refers to Lizhai, “FSQ” refers to Fengshuqiao, “FZ” refers to Fangzhai, “ZS” refers to Zhangsi, etc.; “N” (number) refers to the interviewee number; “I” refers to the identity of the interviewer; “G” refers to government staff; “A” refers to traditional craftsmen; “S” refers to scholars; “R” refers to local residents; “T” refers to tourists. For example, “20170710XJGQ01-F” represents the first interviewee in Gaoqian Village, Xianju County on July 10, 2017, and his identity is a farmer. Secondly, the researchers have completed a number of traditional residential design practices. Through discussions with their peers and customer feedback, they have a certain understanding of the

traditional residential culture and construction, and have a more comprehensive understanding of the status quo of traditional dwellings in eastern Zhejiang.

Table 2. Survey interview samples.

Number	Gender	Age	Occupation	Usual Residence
20170711XJGQ01-R	M	53	Farmer	Gaoqian
20170711XJGQ 02-R	F	82	Retirees	Gaoqian
20170712XJGQ 03-A	M	52	Farmer	Gaoqian
20170712XJGQ04-T	F	28	Staff	Taizhou
20170713XJLZ05-R	M	49	Farmer	Lizhai
20170713XJLZ06-T	M	37	Staff	Taizhou
20170714XJLZ07-A	M	42	Famer	Lizhai
20170715XJFSQ08 -R	M	67	Famer	Fengshuqiao
20170716XJ09-G	M	43	Staff	Xianju
20171103XJGQ01-G	M	50	Staff	Gaoqian
20171104XJGS02-R	F	56	Famer	Guanshan
20171105XJBT03-R	M	63	Famer	Guanshan
20171105XJ04-G	M	51	Staff	Xianju
20171106LH05-S	M	56	Professor	Xianju
20180508LHLG01-R	M	45	Famer	Linggen
20180508LHLG02-G	M	47	Staff	Linggen
2017110510LH03-S	M	51	Professor	Linhai
201808022TTZS01-R	F	64	Famer	Zhangsi
201808022TTZS02-R	M	39	Famer	Zhangsi
201808023TTZS03-A	M	46	Staff	Zhangsi
201808024TTZS04-T	F	35	Staff	Hangzhou
20190703XJFZ01-R	F	55	Famer	Fangzhai
20190703XJFZ02-A	M	47	Famer	Fangzhai
20190703XJFZ03-G	M	50	Staff	Fangzhai
20190703XJFZ04-G	M	50	Staff	Fangzhai
20190815XJLZ01-R	F	64	Farmer	Lizhai
20190816XJGQ02-R	M	79	Farmer	Gaoqian
20190816XJGQ03-T	F	44	Staff	Shanghai
20190816XJGQ04-T	M	38	Staff	Taizhou
20190817XJBT05-T	M	45	Staff	Xianju
20190819XJ06-S	M	68	Retirees	Xianju

3.1.3. Grounded Theory

Grounded theory is adopted as the main research method for analysis in this study. Interview materials are obtained through in-depth interviews, then verbatim texts are analyzed in context and main core categories are summarized after the interview. Grounded theory was first proposed by Barney Glaser and Anselm Strauss. In current social science research, Grounded theory is regarded as one of the most scientific qualitative research methods, which can be based on scientific principles (such as inductive and deductive reasoning processes), comparative principles, hypothesis verification and theoretical establishment [37]. In the analysis stage, there are mainly the following steps. Digital display is to conduct an interview and record the recorded content of the interview into a verbatim draft, encode the text material with open coding, axial coding and selective decoding. Axial coding is a paradigm model that represents causal conditions, phenomena, contexts, intermediate conditions, actions or strategic actions and results, connecting main categories and subcategories. Selective decoding is mainly based on the choice of core category, and there is a systematic connection to verify the relationship between categories. In the process of theorization, the decoding still needs to continue to develop the category, making the theory more delicate and complete until “theory saturation” [38]. Gang Li, majoring in architecture, and Mr. Cheng Zhu were invited to participate in the coding and data validation and analysis. Analysis is a method of in-depth study of various aspects

such as appearance and endoplasm of things. On the basis of a comprehensive understanding of the current situation, the paper extracts hidden deep connotations of spatial characteristics of traditional architecture. Through the analysis, the deep connotation is summarized, so as to excavate the beneficial enlightenment to the architectural protection and design.

3.2. Research Framework

In the study of traditional residential culture, appropriate research methods are selected by research problems and research purposes. Based on the literature review, through field research and data compilation, it is analyzed that traditional dwellings are affected by the natural environment, artificial environment and social environment, and are the result of collective wisdom of local residents who have lived for generations. The spatial form of traditional residential buildings presents a unity of performance levels, structural levels and spiritual levels, which contains harmony between man and nature, family harmony and cultural harmony (Figure 12).

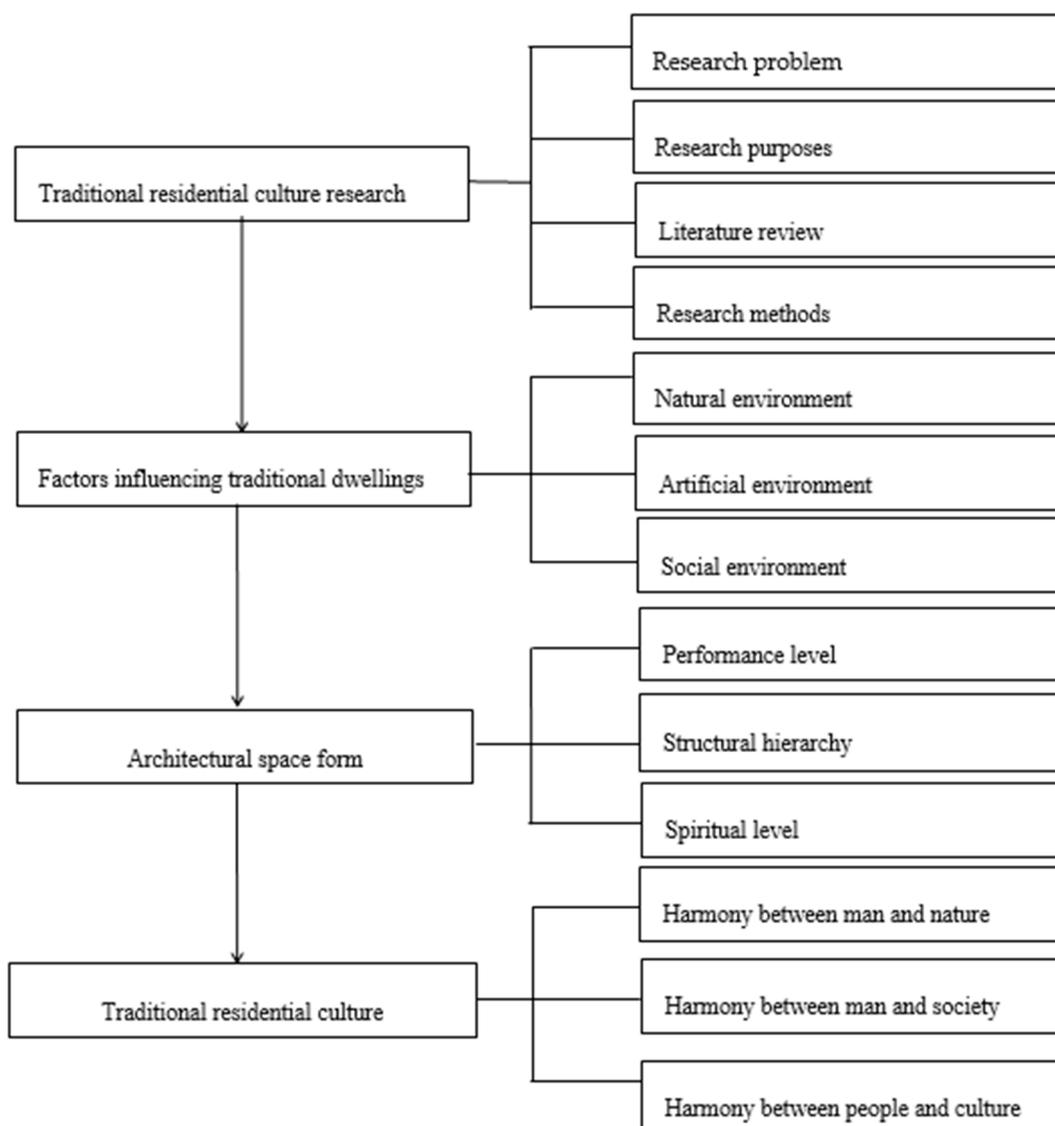


Figure 12. Research ideas of traditional residential culture.

4. Research Analysis

Traditional residence in eastern Zhejiang is a non-renewable cultural asset. The building of Three courtyards and nine halls contains profound cultural connotations. In order to realize the heritage

of traditional residential culture and the protection of cultural heritage in eastern Zhejiang, there are two aspects that need to be achieved: (1) Strengthen the research of traditional residential culture, enrich the cultural connotation of traditional residential buildings; (2) Innovate traditional residential buildings, and apply cultural innovation to the design of residential buildings through heritage of traditional culture. Architectural culture is rooted partly in tradition, partly in the past, and partly in a rapidly changing society, with new functional requirements, new materials and new ideas [39]. This means inheriting the construction culture, ecological wisdom and space philosophy contained in traditional residential buildings, and realizing sustainable development of traditional residential buildings on the premise of maintaining residential culture and architectural form.

Under the direction of sustainable development, newly-built residential buildings adopt ecological and scientific construction technology, starting from the overall ecological planning of residential buildings, on the basis of fully understanding the functions, forms, structures, meanings, traditional context and ecological system of residential buildings, to improve quality of life, balance the circulation of energy and material flow in the residential system, reduce the waste of natural resources and the destruction of natural environment, and inherit the construction culture of traditional residential buildings [40]. Traditional residential buildings adapt to the natural environment, which is reflected in that the residential buildings and settlement layout conform to the terrain, rarely destroy the natural environment, and the buildings integrate with the local natural landform, which is an organic part of the natural environment. The design of architectural appearance is consistent with traditional residential buildings. In the full excavation of regional cultural characteristics, combined with the production and living needs of the villagers, to achieve the integration of traditional and modern, we highlight the regional characteristics of the village characteristics, which adapt to the needs of the times of new residential buildings. The newly-built traditional dwellings in eastern Zhejiang continue the spatial layout and exterior form of the traditional Three courtyards nine halls dwellings, with traditional grey tile roof and white high Ma Tau Wall (Figure 13). In terms of spatial structure, the scientific and reasonable factors of traditional residential buildings are retained to create a pleasant temperature, humidity and well-ventilated environment. While minimizing energy consumption, hygiene standards, building safety and indoor environmental comfort are improved. New buildings are integrated with traditional residential buildings to achieve sustainable development of traditional residential buildings.



Figure 13. Architectural renderings of residential buildings in Gaoqian [41].

5. Conclusions

The traditional Chinese residential space represents two modes of thinking and cultural forms. First, the residential form reflects the concept of harmony between man and nature. Second, the pattern shows a standardized life behavior and ethics order. The former is influenced by Taoism, which concerns health, wealth and safety. The latter is influenced by Confucianism, which is the moral ideal of the upper class [42]. The sustainable development of traditional houses includes the exploration and utilization of traditional cultural resources, the coexistence of human and nature, human and human. Traditional dwellings are formed in the process of understanding the natural and human environment. Residential culture is the accumulation of history and tradition, which reflects the concept and wisdom of living.

This study adopts an interdisciplinary approach, combining the disciplines of architecture, human settlements, and geography to systematically study the space of traditional dwellings, to explore the essence of traditional dwellings in eastern Zhejiang. It is concluded that the traditional dwellings in eastern Zhejiang have quite strict rules in terms of building site selection, specifications and functions with influence of the Confucian ritual system and geomantic philosophy. The dwellings are the private homes of big officials or large families. The building is connected with the courtyard. The hall is the regional center and spiritual center of the whole building, which contains the traditional spatial order. It embodies the cultural concept of “unity of nature and man, respect for seniority” held by the same clan, and is an important cultural asset. The formation of a symbiotic environment is the result of long-term evolution and adaptation, and also the process of continuous evolution and adaptation to the environment. The ecological development of traditional dwellings is promoted by the research on the culture of Three courtyards nine halls, that is, refers to the whole process of human social economy, individual development and biological system, which is the ecological development process [43]. In today’s society, which emphasizes the construction of ecological civilization, traditional residential buildings in eastern Zhejiang provide a lot of ecological experience for reference. In the aspects of site selection, spatial layout, building structure and building materials, traditional residential buildings fully consider various energy-saving, environmental protection and recyclable building technologies and means, such as natural ventilation, sunshade and heat insulation, waterproof and moisture-proof, which provide a good indoor environment for residents and reflect the sustainable development concept of low energy consumption. These ecological concepts can be used for reference in contemporary architectural design and developed in combination with the characteristics of the times [44]. At the same time, traditional residential buildings contain profound cultural connotations and new residential buildings should be consistent with traditional residential culture. Only when they originated from and blend into culture, can they show strong vitality and realize the sustainable development of traditional residential cultural assets.

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