

Research Article

Artificial Intelligence in the Protection and Inheritance of Cultural Landscape Heritage in Traditional Village

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To continue to protect and inherit the cultural landscape heritage of traditional villages, starting from the perspective of artificial intelligence (AI), literature review methods are used, and related theories are collected. Then, Wuyuan County in Jiangxi Province in the traditional villages is taken as the research object. By analyzing the tourism income of this place from 2016 to 2020, the overall income of this county is relatively good. In fact, due to the weak protection of traditional villages in Wuyuan County, the lack of supervision awareness, the implementation of the “immigrant and relocation” policy, and the backward thinking of residents, the cultural landscape of traditional villages has collapsed and destroyed. Up to now, there are 113 ancient ancestral temples, 28 ancient mansion houses, 36 ancient private houses, 187 ancient bridges, and only 12 ancient villages. Finally, AI technology is applied to the cultural landscape of traditional villages. Through image restoration technology, traditional villages can be restored to a certain extent. Intelligent positioning and radio frequency (RF) technology can also realize real-time monitoring of traditional villages from the perspective of weather and service life to achieve the purpose of protecting cultural landscape heritage. Therefore, AI technology is applied in the protection and inheritance of traditional village cultural landscape heritage, which has great reference significance for the management of various historical and cultural heritage.

1. Introduction

As China enters a new stage of transformation and development, it is the new requirements of this new stage to promote the great development and prosperity of socialist culture, promote the excellent traditional Chinese culture, and enhance the self-confidence of the national culture. Traditional villages are important carriers of traditional culture. Protecting the cultural landscape of traditional villages and promoting the development of traditional village tourism functions are important ways to inherit and promote traditional Chinese culture. Meanwhile, the cultural landscape heritage is the epitome of the development of different eras and the manifestation of the continuous progress of human civilization. However, there are some problems in the cultural landscape protection and tourism development of traditional Chinese villages. The rapid development of artificial intelligence (AI) has been widely used in robotics,

economic and political decision-making, control systems, and simulation systems. Similarly, AI technology can also be applied to the protection and inheritance of the cultural landscape heritage of traditional villages. The cultural landscape heritage is diverse. As a major country of cultural landscape heritage, the Chinese nation must not only continue to carry forward its cultural spirit but also consider how to protect and inherit this cultural landscape heritage [1–3].

Qiu (2018) combined cultural landscape with ecological economics and studied how to realize the common development of cultural ecological landscape and human beings under the premise of ecological protection [4]. He emphasized that human beings should make a scientific plan for tourism development from multiple perspectives, multiple aspects, and multiple fields, combining the actual situation. Roger (2018) established Canada’s geographic information positioning technology by Canada’s regional location. Later, after researching with experts and

scholars, he introduced the positioning technology to the protection of cultural landscape heritage, and the restoration technology of images slowed the disappearance of cultural landscapes to a certain extent [5]. Livio (2019) proposed to use image information analysis technology in the artificial neural network model to establish a modern digital network operation platform. In addition, he also integrated Augmented Reality (AR) with traditional villages, striving to use image information analysis technology to design more vivid traditional villages. Finally, he analyzed and summarized the future development of traditional villages [6]. Li (2019) researched traditional Chinese villages by consulting literature on cultural landscape heritage. He used 3D digital technology to display cultural landscape heritage in a digital museum. Although the traditional village no longer exists, after entering the digital museum, people can be immersed and enjoy the local customs at that time [7]. Peter (2018) proposed a new traditional village protection method in his published paper. He emphasized ecological balance, advocated the preservation of different cultural elements, and opposed cookie-cutter styles, styles, and colors. In addition, he also proposed that while protecting the traditional villages, the roads, facilities, and buildings around the villages should be harmonious and consistent to avoid the emergence of overly exaggerated scenes [8]. Scholars have expounded on the related theories of traditional village cultural landscape heritage from different angles. However, their research fields are relatively single, and they do not start from a global perspective. Meanwhile, some necessary analysis tools and technologies require more funds. In practical applications, funding issues need to be considered.

In this context, Wuyuan County in Jiangxi Province is taken as the research object. Firstly, data to understand the development status of traditional villages in Wuyuan County are collected. Then, artificial intelligence (AI) technology is used to realize the restoration of the cultural landscape heritage of traditional villages and the protection of cultural landscape heritage of traditional villages by smart sensing technology and radio frequency (RF) identification technology. This has far-reaching reference significance for the inheritance and protection of the cultural landscape of traditional villages. The first section is the introduction. The background of traditional village cultural landscape heritage, the status quo of domestic and foreign research, and the significance of research are introduced. The second section is the theory and method. Cultural landscape heritage, AI technology-related theories, research methods, and traditional villages in Wuyuan County, Jiangxi Province, are summarized. The third section is the results and analysis. Through the collection of relevant data, the current situation of the development of tourism and traditional village cultural landscape heritage in Wuyuan County is analyzed from different perspectives. Finally, AI technology is applied in the protection and inheritance of traditional villages. The fourth section is the conclusion. Through analysis, relevant conclusions are drawn, and future directions for improvement are proposed.

2. Construction of Traditional Village Cultural Landscape Using AI

2.1. AI Model Construction by Cultural Landscape Research. Cultural landscape generally refers to the human landscape familiar to the public, which is the result of the cocreation of nature and mankind. These cultural landscapes can reflect the unique cultural heritage and connotation of the region from the side [9–11]. The cultural landscape can be embodied in many ways, including clothing, architecture, religion, and food. Cultural landscapes mainly include the following types: (1) landscapes designed and constructed intentionally by humans, such as Suzhou gardens in Suzhou, the Great Wall of China, and Xidi Hong village; (2) organically evolved landscapes, including various fossil landscapes and rocky landscapes; (3) relevant cultural landscapes, including the Leshan Giant Buddha in Sichuan. Cultural landscape heritage refers to the rare and irreplaceable cultural landscape recognized by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the World Heritage Committee (WHC). It is recognized by all mankind as a “common work of nature and mankind” with outstanding significance and universal value [12]. The villages in the cultural landscape heritage area are an important part of the cultural landscape [13, 14]. The specific composition of the World Heritage Site is shown in Figure 1.

Villages mainly refer to large-scale settlements or groups formed by multiple settlements. This group is mainly by the primary industry agriculture as the main production and lifestyle [15–18]. As a relatively primitive way of living in groups, villages are formed earlier, mostly retaining traditional material and nonmaterial forms, and carrying a certain local culture [19].

AI is a technical science used to simulate human intelligence theory methods and application systems [20, 21]. There are two different ways to realize AI on the computer: one is the engineering method, and the other is the simulation method [22]. Artificial Neural Network (ANN) is a simulation method. Its operating principle is to simulate certain human learning behaviors through corresponding computer technology. The specific ANN model is shown in Figure 2.

In Figure 2, a_1 , a_2 , a_3 , and a_4 represent the input signal of the neuron. The calculation method of the relationship between output and input is as follows:

$$A = z \left(\sum_{i=1}^4 a_i b_i + c \right), \quad (1)$$

where z represents an activation function, a_i represents the input information of the neuron, b_i represents the weight value corresponding to the neuron information element, and c represents the intercept.

According to equation (1), the weighted sum of neurons can be obtained, and the specific calculation method is as follows:

$$H_i = \sum_{j=1}^n b_{ij} a_j + c_j, \quad (2)$$

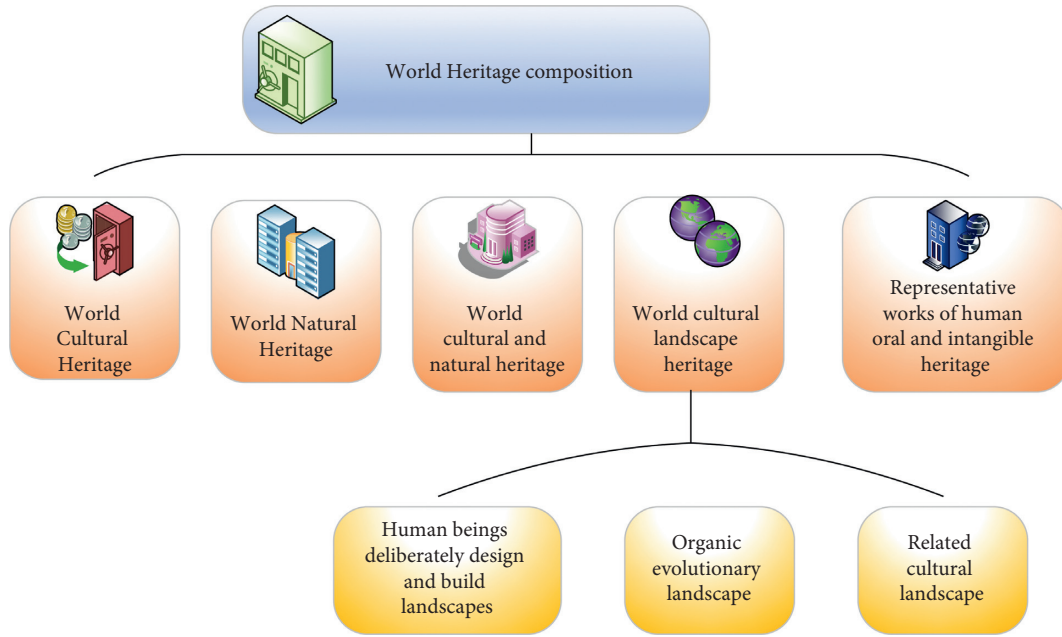


FIGURE 1: Composition of world heritage.

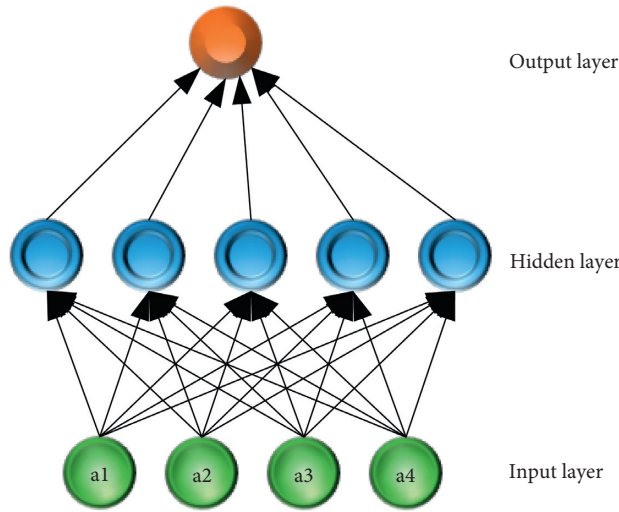


FIGURE 2: ANN model.

where H_i represents the weighted sum of neurons, j represents the j -th neuron information element, b_{ij} represents the i -th weight value corresponding to the j -th neuron information element, and a_j represents the input information corresponding to the j -th neuron information element. c_j represents the intercept corresponding to the j -th neuron.

The activation value of the neuron is obtained according to equation (2), and the specific calculation method is as follows:

$$e_i = z(H_i), \tag{3}$$

where e_i represents the activation value of the i -th neuron, z represents an activation function, and H_i represents the weighted sum of neurons.

The backpropagation algorithm is an important algorithm for neural network training. But before using this algorithm, a cost function needs to be set. The specific cost function calculation method is as follows:

$$J(b, c) = \left[\frac{1}{n} \sum_{i=1}^n \left(\frac{1}{2} \|h_{b,c}(x^{(i)} - y^{(i)})\|^2 \right) \right] + \frac{\lambda}{2}, \tag{4}$$

where J represents the cost function, b represents the weight value corresponding to the neuroinformation element, c represents the intercept, n represents the number of layers, $x^{(i)}$ and $y^{(i)}$ represent a different training set, λ represents random, and h represents the magnitude of the weight. According to equation (4), the gradient descent algorithm can be used to

update the network parameters, and the specific calculation method is as follows:

$$b_{ij} = b_{ij} - \beta \frac{1}{b_{ij}} J(b, c), \quad (5)$$

where the specific meanings of b , J , and c are the same as equation (4), i and j represent different neurons, and β represents the learning rate.

$$c_i = c_i - \beta \frac{1}{c_i} J(b, c). \quad (6)$$

where c_i is the intercept corresponding to the i -th neuron information element, and the meanings of the remaining letters are the same as equation (5).

The partial derivatives of equations (5) and (6) are calculated, and the result is shown as follows:

$$J(b, c) = \left[\frac{1}{n} \sum_i^n J(b, c; x^{(i)}, y^{(i)}) \right] + \lambda b_{ij}. \quad (7)$$

In equation (7), the meaning of the letters is the same as equation (6).

$$J(b, c) = \frac{1}{n} \sum_{i=1}^n J(b, c; x^{(i)}, y^{(i)}). \quad (8)$$

In equation (8), the meaning of the letters is the same as equation (7).

Meanwhile, the calculation method for the neuron residual of the output layer is shown as follows:

$$\begin{aligned} \eta_i &= \frac{1}{2} \|y - h_{b,c}\|^2 \\ &= -(y_i - a_i). \end{aligned} \quad (9)$$

where η represents the residual, y represents the training set, a represents the input information, and the meanings represented by the remaining letters are the same as those represented by equation (8).

The partial derivatives of equations (8) and (9) are calculated, and the result is shown as follows:

$$J(b, c; x, y) = a_j \cdot \eta_i. \quad (10)$$

In equation (10), the meaning of letters is the same as equation (9).

$$J(b, c; x, y) = \eta_i. \quad (11)$$

2.2. Research Methods. (1) Comparative analysis method: it refers to the multiparty comparison of two or more research objects to explore the similarities and differences between them. The purpose of analyzing and learning good methods is to continue to inherit the cultural landscape heritage of the village [23–25]. (2) Case study method: through the collection of data, the representative cultural heritage of traditional villages in society has been found. Take them as analysis cases, combine various problems existing in current social reality, establish a corresponding research framework,

and make the paper more scientific [26]. (3) Expert interview method: by visiting experts in this area of cultural landscape heritage management, they will be invited to interview. And these experts will be asked about their views on the current status of cultural landscape heritage management in society in recent years. Additionally, continue to listen to experts' suggestions and opinions in this regard to increase the scientific and rationality of the paper [27, 28]. (4) Document method: due to writing needs, firstly, use CNKI, Google Scholar, Wanfang Data, and other channels for data query. Secondly, there are many articles and works from columnists and related Internet information. In addition, some journals and books related to the paper in the school library, *Into the World of Cultural Landscape Heritage*, *Illustrated Chinese Geography Encyclopedia*, and *Protection of Rural Heritage in the Perspective of Cultural Landscape*, have also been inquired and reviewed. Through the collection and summary of this series of data, it provides a favorable theoretical basis for research ideas and methods [29]. The data used comes from the website of the Wuyuan County Government in Jiangxi Province. The relevant parameters in the ANN model are shown in Table 1.

2.3. Introduction to Traditional Villages in Wuyuan County, Jiangxi Province. Wuyuan County is in Shangrao City, Jiangxi Province, and is one of the birthplaces of Huizhou culture in China [30, 31]. The historical and cultural heritage of this place is very profound, and it is one of the typical traditional village cultural landscape heritages. Wuyuan County currently retains many traditional villages. The traditional villages here are very different from other villages (such as Xidi Hong village). It retains the most primitive Huizhou architectural style in ancient times, and it pursues the harmony between man and nature [32–34]. In addition to traditional villages, there are also many cultural sites, memorial halls of famous people, “ghost dances,” and so on [35, 36]. The specific list of cultural landscape heritage of Wuyuan County is shown in Figure 3.

3. Analysis of the Application Results of AI Technology by the Protection and Inheritance of Cultural Landscapes

3.1. Status Quo of Tourism Development in Wuyuan County. Wuyuan County is a representative of the cultural landscape heritage of traditional villages, and tourism is also a pillar industry in the area. By using the method of document collection, the tourism income of the place from 2016 to 2020 is found. The specific data results are shown in Figure 4.

In Figure 4, the comprehensive tourism income of Wuyuan County in 2016 was 5.63 billion yuan. Among them, ticket revenue was 431 million yuan, catering revenue was 821 million yuan, and entertainment project revenue was 1.029 billion yuan. In 2017, Wuyuan County's comprehensive tourism revenue was 6.21 billion yuan. Among them, ticket revenue was 592 million yuan, catering revenue was 1.195 billion yuan, and entertainment project revenue was 1.201 billion yuan. In 2018, the comprehensive tourism

TABLE 1: ANN parameter settings.

Parameter	Meaning	Setup
Maxlen	Text length, greater than this length, truncated, less than filled	300
Embedding_size	Embedding word vector dimension	300
Kernel_size	Size of the convolution kernel	2
Filters	Number of convolution kernels	412
Batch_size	The number of samples required for one training in gradient descent	156
Dropout_rate	Dropout ratio	0.1
Verbose	Log display	1

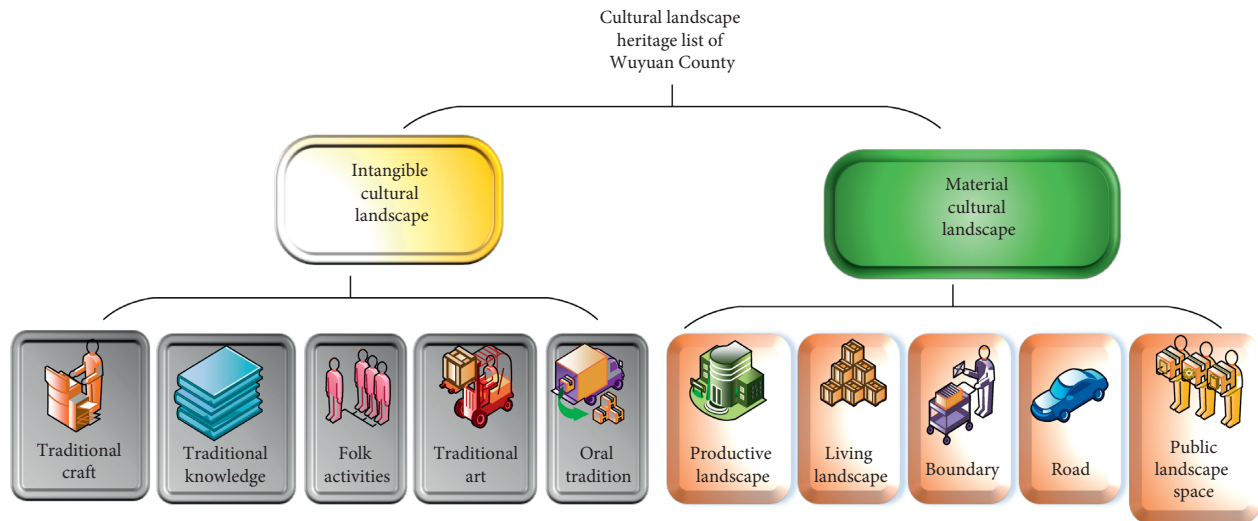


FIGURE 3: List of cultural landscape heritage of Wuyuan County.

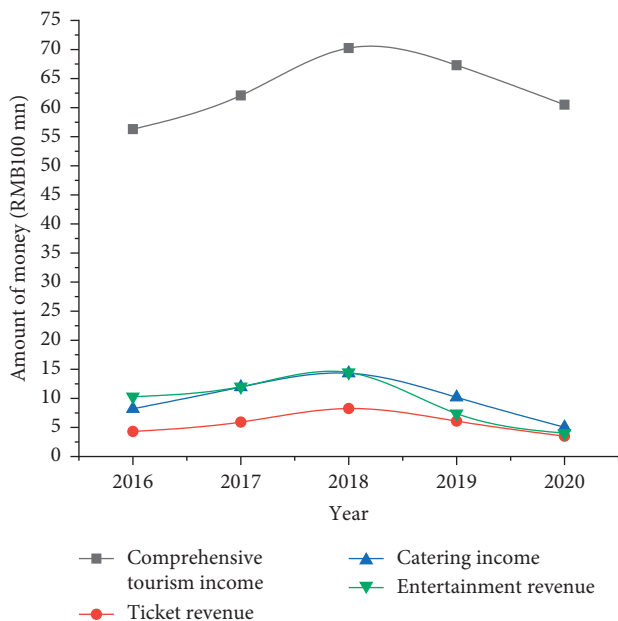


FIGURE 4: The tourism income of Wuyuan County from 2016 to 2020.

income of Wuyuan County was 7.25 billion yuan. Among them, ticket revenue was 826 million yuan, catering revenue was 1.433 billion yuan, and entertainment project revenue was 1.446 billion yuan. The comprehensive tourism income

of Wuyuan County in 2019 was 6.73 billion yuan. Among them, ticket revenue was 610 million yuan, catering revenue was 1.018 billion yuan, and entertainment project revenue was 739 million yuan. This shows that, from 2016 to 2018, whether it is ticket revenue, catering revenue, or entertainment revenue, Wuyuan County has been on a rising trend. But since 2019, tourism revenue has declined. Compared to 2019, the village’s tourism income has experienced the largest decline in 2020. The reason for this phenomenon has a lot to do with the Corona Virus Disease 2019 (COVID-19) epidemic that broke out at the end of 2019. The advent of the epidemic has brought a crisis to the development of tourism in Wuyuan County.

From 2016 to 2020, the number of tourists and the income of local farmers in Wuyuan County are shown in Figure 5.

Figure 5 shows that, in 2016, Wuyuan County had 11.236 million tourists, and the per capita income of farmers was 7086 yuan. In 2017, the number of tourists in Wuyuan County was 12.634 million, and the per capita income of farmers was 7,502 yuan. In 2018, the number of tourists in Wuyuan County was 13.988 million, and the per capita income of farmers was 8,011 yuan. In 2019, the number of tourists in Wuyuan County was 13.504 million, and the per capita income of farmers was 7631 yuan. In 2020, Wuyuan County had 11.201 million tourist trips, and the per capita income of farmers was 7,203 yuan. In the three years from 2016 to 2018, the number of tourists in Wuyuan County and

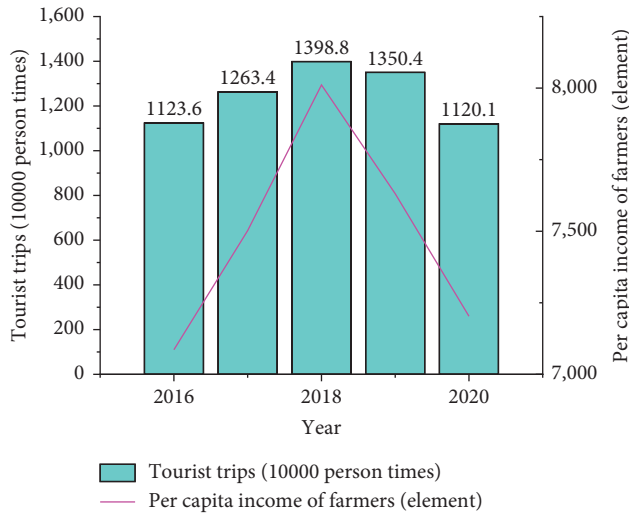


FIGURE 5: The number of tourists and farmers' income in Wuyuan County from 2016 to 2020.

the per capita income of local farmers have been increasing. However, since 2019, the number of tourist arrivals has declined. The reason for this situation in the local tourism industry is that it has been hit hard by the COVID-19 epidemic.

From the above data results, the unique cultural landscape of traditional villages in Wuyuan County can attract many tourists to a certain extent. So, the local landscape heritage must be protected and inherited.

3.2. Status Quo of the Development of Cultural Landscape Heritage in Wuyuan County. From the perspective of tourism income and the number of tourists, the tourism industry in Wuyuan County continued to develop steadily from 2016 to 2020. However, according to relevant research records, the local traditional village cultural landscape sites are slowly disappearing over time. This is mainly reflected in the following aspects: (1) The protection is not strong. Up to now, the specific situation of the existing ancient village ruins in Wuyuan County is shown in Figure 6.

In Figure 6, there are currently 113 ancient ancestral temples, 28 ancient mansion houses, 36 ancient private houses, 187 ancient bridges, and only 12 ancient villages. Although there are a lot of cultural landscape sites, many villages, ancient mansion houses, and so on have disappeared compared to before. Traditional Huizhou buildings are dominated by civil structures, and the longer they exist, the slower they will collapse. With the continuous development of the social economy, more and more people choose to live in cities, leading to many traditional villages being abandoned. In addition, some old houses are demolished and destroyed, new modern houses are built on the land, and so on. These actions are destroying monumental architectural sites. (2) There are few records of traditional villages in Wuyuan County. Since there are few recorded documents and architectural design drawings, this has brought difficulties for the use of

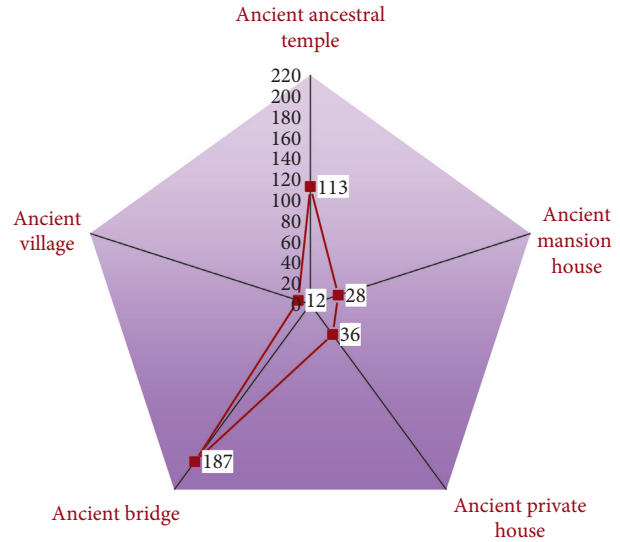


FIGURE 6: The number of existing cultural landscape sites in Wuyuan County.

modern AI technology to restore cultural landscape sites. The original houses are now asking residents, and they are built on what they remember. The house built in this way lacks a certain degree of authenticity. (3) The “immigrant relocation” policy hinders the development of the cultural landscape of traditional villages in Wuyuan County. According to the results of the Seventh National Census, the current permanent population of Wuyuan County is only about 300,000. The massive evacuation of residents has left more traditional villages abandoned, changing the original development goals. The ancient towns, ancient private houses, and ancient ancestral temples are short of people to manage and clean them. (4) There is a lack of innovative spirit. At present, Wuyuan County is still developing in accordance with the traditional tourism model, which will undoubtedly be eliminated by the times. To a certain extent, intangible cultural heritage can complement the cultural landscape of traditional villages. The specific list of intangible cultural heritage is shown in Table 2.

Table 2 shows that there is a total of eight intangible cultural heritages in Wuyuan County. Among them, there are five traditional skills and three folk customs. However, due to the traditional ideology of the residents, the customs of “passing on men but not women” have caused some intangible cultural heritage to gradually withdraw from people’s vision, such as tea art, ghost dance, paper umbrellas, and carving techniques in Wuyuan County.

3.3. Application of AI in the Protection and Inheritance of Traditional Villages. The cultural landscape of traditional villages in Wuyuan County has been damaged to a certain extent by the outside world. To continue to inherit the cultural landscape of the place, AI technology is needed to restore the damaged buildings. The specific operation steps are shown in Figure 7.

TABLE 2: List of intangible cultural heritage of Wuyuan County.

Type	Serial number	Name
Traditional skills	1	Wuyuan pineapple lacquerware making technology
	2	Wuyuan emblem embroidery technique
	3	Traditional refining techniques of Wuyuan camellia oil
	4	Wuyuan huiweimingcheng secret spicy sauce making technology
	5	Traditional making techniques of Wuyuan rice spoon
Name and custom	1	Zhu Zi's family motto
	2	Wuyuan Wengong sacrifice
	3	Wuyuan Zhan family motto

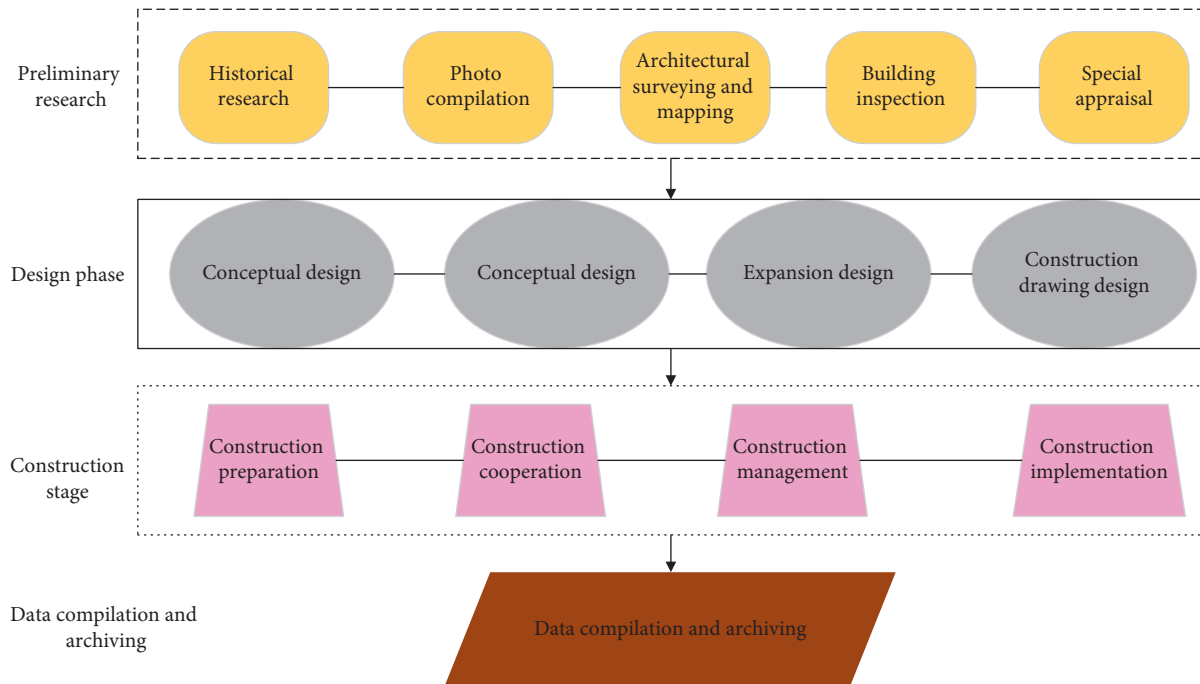


FIGURE 7: Restoration steps of traditional village cultural landscape.

Figure 7 shows that the restoration of the traditional village cultural landscape needs to go through four stages: preliminary investigation, design stage, construction stage, and data compilation and filing. These four stages are indispensable, and problems in any of these stages will have a serious impact on the restoration of the following traditional villages. The results of the design stage have important implications for the restoration of the entire traditional village, which means that the design stage is the most important of these four stages.

Meanwhile, the restoration of the cultural landscape of traditional villages is inseparable from the research and analysis of village images. The analysis mainly involves traditional village similarity detection, village-style classification, selection of the main color of the village, automatic image sorting, and automatic recognition and restoration of image damage. The specific operation method is shown in Figure 8.

Figure 8 shows that there are many projects involved in image analysis research. The neural network model calculation method in the AI algorithm is also used. In the entire image research and analysis, in addition to the

analysis of the image of the traditional village, there is also the study of drawing and restoration. AI technology is of great significance to the inheritance of cultural landscape heritage.

In addition, after analyzing the images of traditional villages, it is necessary to manually review the images before entering the next stage. In the scene of manual review processing, ANN technology is needed to realize the recognition of pictures. ANN technology mainly reviews the following aspects of pictures: (1) The angle of picture drawing should be consistent with the angle of traditional village construction. (2) The style of picture drawing should be consistent with the style of the original traditional village. (3) The color of the drawn picture should also be like the original village's tone as much as possible, there should not be too much difference, and so on. If there is any discrepancy, it will be deleted. The implementation of ANN technology for image review is shown in Table 3.

Table 3 shows that there is a total of six neural layers. Each layer has its unique functions to ensure the normal operation of the image review program. Similarly, each layer cannot be replaced or deleted.

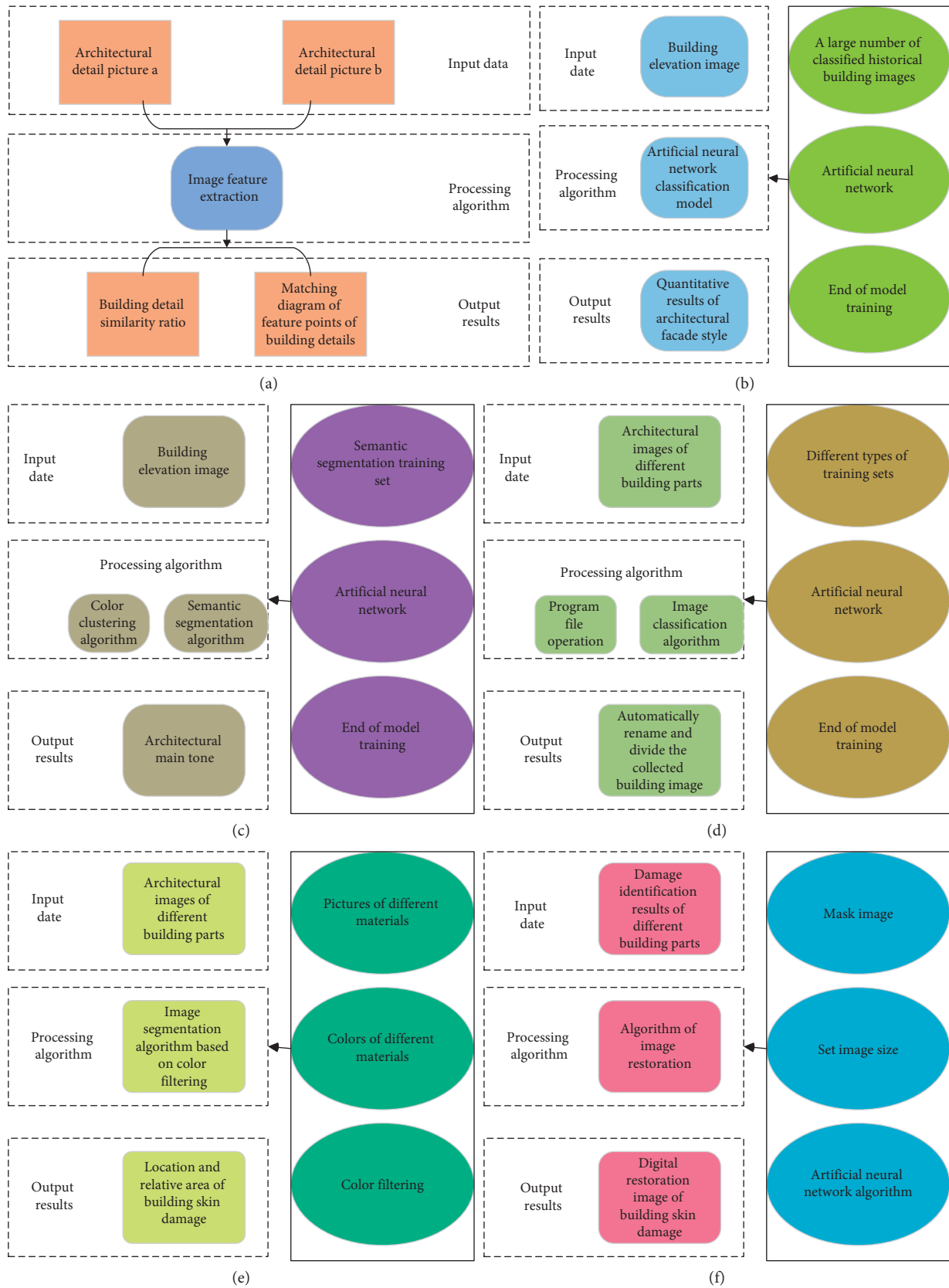


FIGURE 8: Analysis of images in the restoration of traditional village cultural landscape. (a) The similarity detection of traditional villages, (b) the classification of traditional village styles, (c) the selection of the main colors of traditional villages, (d) the automatic image collation, (e) the automatic recognition of image damage, and (f) the automatic restoration of the image.

TABLE 3: Functions of each layer of ANN in image review.

Nerve layer	Function
Input layer	Preprocess the input image data for subsequent calculation
Convolution layer	Different convolution kernels are used to filter the image data and obtain the feature set of the image
Active layer	The above linear calculation operation is transformed into a nonlinear calculation
Pool layer	It is usually placed between and continuous convolution layers to compress the image
Full connection layer	It is usually located at the last level of the neural network and connects the above-extracted feature set
Output layer	Output the classification result of image recognition

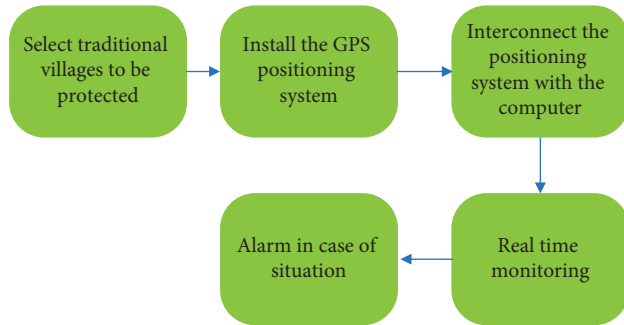


FIGURE 9: The application method of intelligent sensing technology in the protection of cultural landscape.

The cultural landscape of traditional villages in Wuyuan County must not only be inherited but also be protected. In the protection of cultural landscapes, intelligent perception and RF identification technology can be applied. The specific application method is shown in Figure 9.

Figure 9 shows that the first step is to select the traditional villages that need to be protected. After selecting the village, the Global Positioning System (GPS) is installed. After the installation is complete, the system will be associated with the computer, and then the system will transmit the required data to the computer in real time, including weather, temperature, existing age, and the service life of the building. In this way, it is possible to learn various specific data information without the need for relevant management personnel to arrive at the site of the traditional village. If the building is damaged or there is a risk of collapse, the system will also issue an alarm to remind the management staff. AI technology plays an important role in the protection of the cultural landscape of traditional villages.

4. Conclusion

Applying AI technology to the protection and inheritance of the cultural landscape heritage of traditional villages, the following conclusions can be found: (1) taking Wuyuan County in Jiangxi Province as the research object in the traditional villages from 2016 to 2018, tourism income shows a rising trend. However, due to the outbreak of the epidemic in 2019, tourism revenue has declined to a certain extent. (2) Although Wuyuan County’s tourism income has been relatively optimistic in recent years, in fact, the traditional villages in this area have gradually disappeared, and the protection of traditional villages is not strong. Due to these reasons and the implementation of the “Immigration and Relocation” policy, Wuyuan County has lost its previous

“vitality.” (3) Applying AI technology to traditional villages can roughly restore traditional villages by previous images. In the restoration process, the involved stages are particularly important. Not only must the image be drawn and repaired, but also the drawn image must be reviewed and processed by ANN. (4) The application of intelligent perception and RF identification technology in traditional villages can monitor and analyze cultural landscapes in real time and realize the protection of traditional villages. AI technology is used in the protection and inheritance of traditional village cultural landscape heritage. This provides a basis for further analysis and resolution of problems in heritage protection. Mainly literature collection methods such as the literature analysis method and questionnaire survey method are used. AI technology can not only draw images of traditional villages but also restore existing cultural relics. This has great reference significance for the management of various historical and cultural heritages.

Due to limited energy, there are certain limitations in data acquisition, leading to deviations in some analysis of related data. The application of AI technology to the inheritance and protection of traditional village cultural landscape heritage has not been discussed in terms of economic investment. The follow-up research can conduct benefit evaluation according to the specific situation so that this technology can bring certain beneficial effects to the protection and inheritance of the traditional village cultural landscape heritage in the future.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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