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Dynamic Settlement Assessment of Rural, Regional Cultural Evolution: A GIS-driven Data Mining Method to Support Architecture and Heritage Management Research

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Abstract

This paper studies the development process of rural regional culture and architectural heritage management and probes into the GIS spatial analysis method and its application in architecture and heritage management. The use of GIS technology to assist the collection and visualization of rural landscape heritage spatial information includes four steps: 1) Heritage landscape research: to sort out the heritage value, landscape characteristics, spatial scope and components of rural landscape, etc., to provide a basis for spatial model research. 2) Data collection: Select appropriate methods, technologies and equipment to collect spatial information according to different spatial scales, spatial characteristics and accessibility factors. 3) Data processing: Building spatial models through image processing and GIS processing software. 4) Practical application: Re-develop the spatial model according to different application requirements. Through digital technology, the protection of Chinese rural regional culture can be carried out, and the sustainable inheritance of rural architectural cultural heritage can finally be realized.

Keywords: Rural regional culture; GIS; Heritage protection.

With the rapid development of computer technology and information technology, the application of digital technology has become more and more extensive and in-depth, penetrating all fields of production and life and becoming an omnipresent technology promoter. The protection of cultural heritage through digital technology has not only become the direction advocated by UNESCO for many years but also a sign to measure the developed level of basic technology and facilities for the protection of cultural heritage in a country[1].

Figure 1 shows the primary objectives and framework of the research on the digital protection and management of rural regional cultural buildings and heritage. The use of digital technology to carry out cultural heritage protection can not only realize the sustainable inheritance of cultural heritage, but also enable the cultural heritage to be disseminated better, faster and more widely. China has a large number of historical and cultural villages and towns with rich types, which are essential cultural heritages. To protect them digitally, it is

necessary to comprehensively utilize surveying and mapping technology, remote sensing technology, computer technology, 3D technology, virtual reality technology, and physical and chemical technology to obtain the current data on cultural heritages. Using information technology to digitally record, monitor, repair, rebuild and recreate, to achieve digital archiving and reuse, and ultimately to realize the sustainable inheritance of its spatial form and cultural heritage[2-3].

This paper combines GIS-driven data mining methods to study rural architecture and heritage management methods in order to provide a reference for the management of rural regional cultural heritage in the later period.

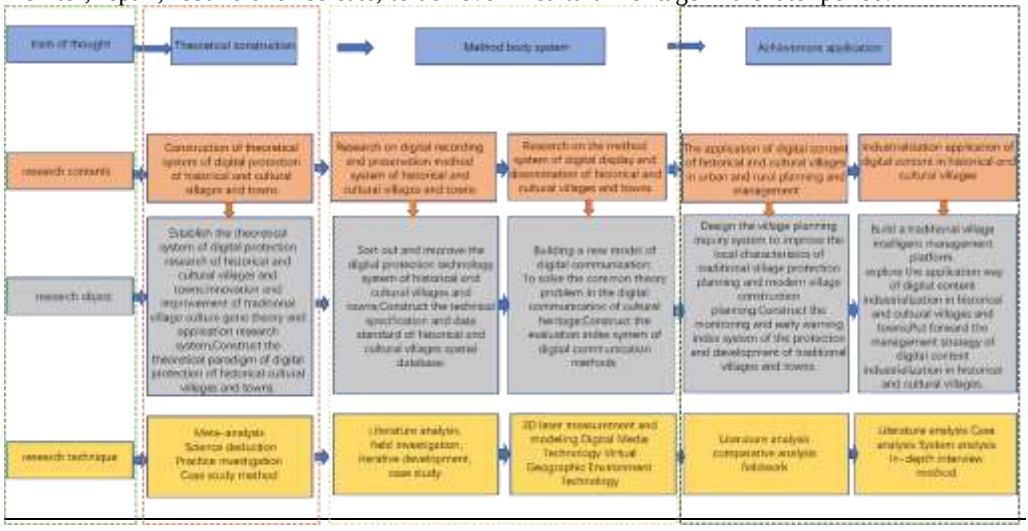

Figure 1. The primary goal and framework of the research on the digital protection and management of rural regional cultural architecture and heritage

Connotation and evolution of regional culture

2.1 The concept of regional culture

Culture is a historical category; different social periods have corresponding cultures, and it will develop with the development of social material production. In the process of cultural evolution, the historical continuity of the development of social material production is the cornerstone of cultural change. Culture, as an ideology, reflects the political economy of its time and also acts on the development of political economy[4]. For example, along with the emergence and development of the nation, culture also has the corresponding national character. Through the integration and development of the country, the cultural tradition with national characteristics is formed.

From the analysis of the broad concept of culture, the connotation of culture includes three layers: material culture, behaviour culture and psychological culture. (Figure 2) Material culture is the sum of human material production activities and products[5]. It is a tangible cultural thing with an apparent externality that can be felt. The behaviour culture layer is the behaviour pattern gradually formed in the form of local conditions and people's feelings, which is also what we usually call "habits".

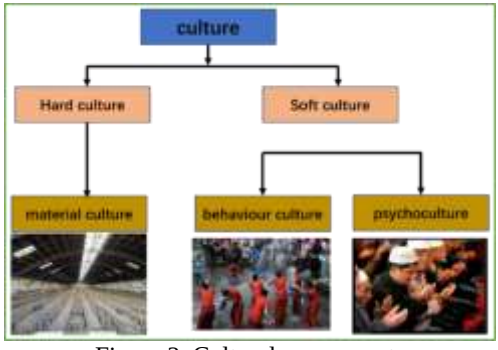

Figure 2. Cultural components

The development of culture has continuity, and the historical continuity of the development of social material production is the basis of the historical continuity of cultural development[6]. Culture is divided into narrow sense and broad sense, material and spirit. Culture, in a general sense, refers to the sum of material wealth and spiritual wealth created in the course of human history. In a narrow sense, it relates to the ideology of society, as well as the system and organizational structure corresponding to it. [7] Culture has a unique regional nature, with different cities multiplying in specific regions and forming clear and firm cultures. Archaeological results have proved that the Chinese culture in history is actually the integration and development of a variety of settlements again and again, thus forming what we know as "subcultures", such as Hemudu culture, Longshan culture, Erlitou culture, Sanxingdui culture, Bayu culture, etc. (See Figure 3) The different features of regional culture are the result of people's differences in specific geographical environment and historical conditions. The result of creation, management and integration. One side of the soil and water nourishes one side of the people, nurturing and forming a unique regional culture; each characteristic regional culture blends and influences each other to combine the colourful kaleidoscopic picture of Chinese culture[8]. The particularity of regional culture lies in that it is not a cultural concept in the traditional sense, nor is it a reaction to the level of material production. Still, it is directly subject to regional restrictions and expressed through the natural environment, local conditions and people's feelings. It must be noted that regional culture is highly inclusive and creative and will remain the same in the development of history. Some scholars call global culture a "hybrid" culture. Regional culture itself also has a "hybrid" nature, and with the story of history, regional culture has shown different faces in different historical periods[9].


Figure 3. Ancient regional culture

2.2The concept of regional culture

Rural, regional culture represents the spiritual and cultural features of a region. "One side soil, one side culture" exists in rustic materials with natural artistic conception, and these materials can show the regional characteristics of cultural spirit[10]. Rural, regional culture is rich and diverse, with its features, which not only exist in physical material forms such as buildings but also maintain local regionalism in tangible and intangible aspects such as attachment to the natural environment, historical development and living habits of human settlements.

2.3The exploration value of rural, regional culture

China has a history of thousands of years of farming culture, and the countryside is a fundamental combination unit of our society. So far, most of the vast villages have retained the historical civilization of the development of The Times, and each has its own charming regional culture and rich and diverse cultural legacy products. A large number of invisible rural cultures exist in rural areas[11].

The ecological value and economic value of rural, regional culture, the ecological environment of the countryside is the ideal space for human habitation; the country has a compound ecosystem, with villages and courtyards as spatial carriers, and the natural environment in the town is the survival concept of the unity of nature and man, maintaining the harmonious unity of man and the natural environment. The ecological value of the countryside is reflected not only in the green mountains and green waters of the living environment brought by the geographical location but also in the civilized life system inside the countryside. The slow pace of life brings physical and mental pleasure and relaxation[12-13].

Architectural heritage and its development process

3.1 Architectural heritage

The concept of "architectural heritage" has not yet been really defined, and it was first proposed in the Venice Charter in the 1960s. The Charter is the first international Charter to put forward the "authenticity" of the protection of historic buildings and elaborated the concept and principles of the protection of "historic buildings". "Historical buildings should include not only individual buildings, but also buildings that bear witness to a civilization, a meaningful historical event or reflect the development of some urban or rural environment, not only for great works of art, but also for buildings that acquire cultural value over time." [14] In 1990, the Modern Movement Record and Conservation Organization defined "modern architecture conservation", proposed feasible methods for the protection of modern architecture, and put forward specific suggestions for the protection, restoration and reuse of architectural heritage. This "modern architecture" has three dimensions: aesthetic, technological and social innovation[15].

3.2 Architectural heritage

The related work of China's architectural heritage started not later than that of other countries. Since the 1930s, relevant departments have been established to record and register architectural heritage. In 1928, the Central Committee for the Protection of Cultural Relics was formally established as a specialized agency for the management and investigation of cultural relics in the Republic of China, with the purpose of surveying and researching the protection of architectural heritage. [16] After several years of efforts, it has conducted a comprehensive investigation of important architectural heritage in many provinces in North China, obtained relatively complete first-hand data, and published a number of research results with high theoretical value. [17] In 1929, the Society of Chinese Architecture was formally established, and China really began to investigate, map and record traditional architecture from the perspective of modern science and technology. From 1929 to 1947, more than 2,000 groups of buildings in more than 200 counties and urban areas in 15 provinces were surveyed and mapped. Based on these data, the society compiled a more specific architectural table, which provided the initial data support for future architectural heritage research. At the beginning of its establishment, the community was equipped with specific full-time personnel and relevant implementation systems, and this series of preliminary work laid solid data support for the mapping work of architectural heritage in the future. At the same time, the society also collates and analyzes the measured and photographed data by various means and combines the data into

charts. In addition, a variety of academic methods are adopted to conduct theoretical exploration and research on architectural heritage protection, and finally, such data are converted into research success reports. [18] Its research success report still serves as a guide and reference for architectural heritage protection. After the founding of the People's Republic of China in 1949, the scale of the National Construction Society continued to grow, and the technical level continued to improve. In the 1950s, 1980s and early 20th century, they conducted three national cultural heritage surveys across the country. These census results have important guiding significance for finding out the distribution and protection of cultural relics in our country and carrying out the phased work. In addition, our country has also organized unique and focused surveys for some special regions and hot topics. For example, in 1988, after The State Council issued a notice on the protection of excellent buildings in critical areas, China and Japan conducted a joint survey on modern Chinese architecture, carried out detailed mapping and census throughout the country, and finally recommended a group of representative modern excellent buildings to the country. [19] In 2000, Kunming City conducted a unique survey in the area with the theme of "Architectural Heritage of the Anti-Japanese War period" and collected cultural relics of this period nationwide, and finally achieved good results. After nearly 80 years of efforts, the protection of architectural heritage has attracted more and more attention from all walks of life. The depth and breadth of its research have been increasing, and many departments such as cultural protection, construction and universities have conducted in-depth research on it from their fields. The development of this work gives us not only a more accurate understanding of the protection of ancient architectural heritage but also a more profound understanding of the generation, use, and experience of architectural heritage[20]. At the same time, it also provides solid theoretical and technical support for the development of architectural heritage protection. Through the efforts mentioned above, our country has also made some achievements in the protection of architectural heritage. See Table 1 and Table 2.

Table 1. Books published on the administration of the estate

Time	author's unit	title
1977	Natural History, Chinese Academy of Sciences	History of ancient Chinese architectural technology
1978	Relevant universities and research departments	A multi-volume collection of Chinese architectural history
1979	Relevant universities and research departments	Architectural ethnography
1979	China Architectural History Committee	History of Ancient Chinese Architecture

Table 2. Activities related to estate administration

Time	activity
2001	Cultural Relics Database construction activity
2003	A database of architectural heritage archives was established for the first time
2006	The standardization of historical building heritage records shall be applied to the State for the National Natural Fund project

GIS spatial analysis method and its application in architecture and heritage management

Geographic Information System (GIS) is a computer system for collecting, storing, managing, analyzing, displaying and applying geographic information. It is a general technology for analyzing and processing massive geographic data. The study of land use change, especially spatial change, cannot be separated from GIS spatial analysis. The database of this method is mainly the land use map of vector raster data and the result of remote sensing interpretation. The data map is analyzed and calculated, and the corresponding attribute data is obtained by using MapInfo, Excel, SPSS and

other software. Through the integration, storage, retrieval, operation and analysis of geographic data, various geographic information is generated and output so as to provide new knowledge for land use, resource management, environmental monitoring, transportation, economic construction, urban planning and administrative management of various government departments, and serve for engineering design, planning and management decision-making[21].

4.1 The information processing process of the GIS spatial analysis method

The information processing process of the GIS spatial analysis method involves the data conversion function, graph data editing function, spatial analysis function, database operation function, spatial statistical analysis function and graphic primary body display function of the GIS system (Figure 4).

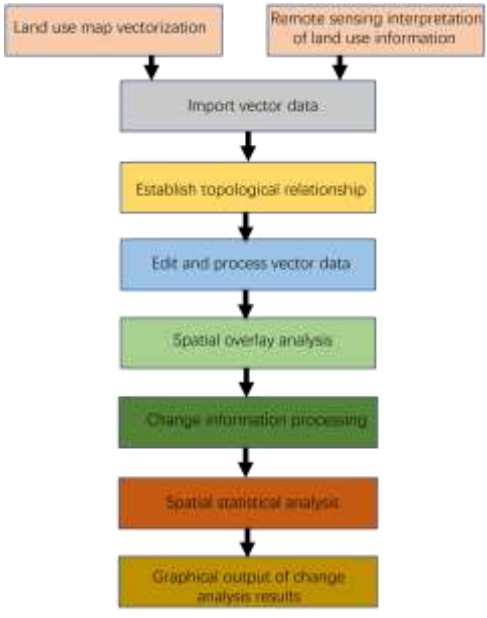

Figure 4. Structure diagram of power grid model

4.2 Establishment of GIS

(1) Data input

In the ancient village of Baojiatun Ming Dynasty in Anshun, Guizhou Province, we experimented with the digital collection of landscape spatial information[22]. Baojiatun is located in Daxiqiao Town, Xixiu District, Anshun City, Guizhou Province. Its history can be traced back to the 14th century, and it is one of the essential unfoldments established by Han immigrants in Guizhou under the military intervention of "transferring north to the south" in the Ming Dynasty. The existing ancient village covers an area of about 3.8 km2. It includes critical elements such as the surrounding karst terrain, the town of Tunpu, the old water conservancy project of the Ming Dynasty, the garden design of Shuikou, and the Feng Shui cemetery (see Figure 5).

Firstly, the study deeply discusses the cultural heritage value of the ancient village of Baojiatun. It classifies and collates its spatial patterns in three different scales: landscape, traditional town and rural architecture[23]. Next, considering the spatial attributes of different scales and the characteristics of landscape elements, we comprehensively use cloud technology at various points to collect and analyze spatial information. Finally, the results of the analysis were visualized to show the style of the countryside better.

About the spatial properties of landscape. After the case study, we developed a GIS-based method for recording and visualizing spatial information on rural landscape heritage.

Table 3. The longitude and latitude coordinates of the fitting point

Registration point	latitude	longitude
1	38	109
2	38	110
3	36	109
4	36	110

Data enhancement and connection :(1) Spatial information modifying and attribute code input: Using the image modifying feature of

MapInfo, entire map records editing, topological relationship establishment, spatial overlay and corresponding attribute code input. (2) Verification and sorting of attribute data: After the statistics entry is completed, on the foundation of the completion of the legitimacy test, it has to be checked in accordance with the traits of land location accumulation to ensure the absolute accuracy of the data. Data can be prepared by means of a map or administrative unit. (3) Linking: spatial records and attribute records are carried out through a frequent and unique consumer identification code[24].

(2) Establishment of database

The database of geographic facts device (referred to as a spatial database or geographic database) is a series of statistics about certain geographical aspects in a positive region. In a GIS spatial database, a range of factors with specific attribute sorts have to be included. In order to perceive the elements and their meanings, a practical classification coding device ought to be drawn up, which is a fundamental hyperlink in the institution of spatial database[25].

Encoding is the classification of statistics with a gorgeous wide variety (string or numerical value) to represent, additionally recognized as coding. The coding technique of the attribute data is comparable to that of the traditional transaction administration data machine without the key phrases used to join with the space, which roughly follows the following ideas :(1) uniqueness; (2) Simplicity; (3) Extensibility; (4) Easy identification; (5) Integrity. The attribute coding of spatial factors typically consists of a primary code and subcode, which can be divided into an identification code, description code, and reference wide variety in accordance with its function[26].

Each logical document describing a map factor consists of a predominant code, an identification code, a number of description codes and a number of reference numbers. Suppose a map thing no longer requires or has no facts to describe its first class or quantity similarly. In that case, the description code and reference quantity may additionally be defaulted at the same time or either.

4.3 Digital collection of rural architecture and heritage information: A case study of Baojiatun, Anshun, Guizhou

The experiment of landscape spatial information digital collection was carried out in Baojiatun, an ancient village of the Ming Dynasty in Anshun, Guizhou. Baojiatun is located in Daxiqiao Town, Xixiu District, Anshun City, Guizhou Province. It was built in the 14th century and is one of the fortresses built by Han immigrants in Guizhou under the military operation of "transferring North to the South" in the Ming Dynasty. The existing ancient village covers an area of 3.8 km2, including the surrounding karst geomorphic environment, Tunpu Village, the old water conservancy project of the Ming Dynasty, Shuikou Garden and Feng Shui cemetery (FIG. 5).

Figure 5.Rural landscape heritage elements of Bao’s Village

First of all, they learned about the heritage cost of the historical village of Baojiatun. They sorted out the standard spatial patterns below three scales: panorama environment, regular town and rural architecture. Secondly, combining the spatial traits and panorama facets of a range of scales, cloud science at particular factors is built-in to gather and analyze spatial information. Finally, the analysis consequences are visualized to characterize the countryside. Spatial traits of landscape. Through a case study, a set of GIS-based totally spatial data recording and visualization strategies of rural panorama heritage are summarized [27].

(1) Spatial information collection and visualization of landscape environmental scale in Baojiatun

In order to thoroughly file the spatial sample of panorama surroundings in Baojiatun, the records series wants to have a giant insurance range so as to cover a number of panorama elements. On the other hand, this scale consists of a couple of karst cone peaks. It has prosperous vertical variations, so it is necessary to acquire third-dimensional spatial information. In this paper, the creator adopts the UAV close-range photogrammetry science and makes use of the six-axis multi-rotor UAV outfitted with an orthographic digicam to diagram a whole of five routes overlaying all rural panorama elements. In the later stage, photograph processing and GIS registration software program were used for whole facts processing, and a 3-dimensional factor cloud mannequin of panorama environmental scale in Baojiatun was generated (FIG. 6). The factor cloud accuracy of the form is controlled inside 1m. The diploma of element characterization can meet the necessities of panorama spatial sample recording at this scale. Through the evaluation and visualization of the model, the standard spatial sample of panorama environmental scale can be without delay displayed: 1) "Wenfeng and jade instances are organized in A herbal way" - the south of the village is shaped with the aid of the mountain pass, Daqingshan, Huangshan and Dajing Mountains, which have A sure protection feature (FIG. 6, area A-A); 2) As the "backer" of the total village, the northwest Fairy Mountain has A peak ratio of about 1:6 to the depth of the historic village, which realizes the sight occlusion and control, and this sample is generally acknowledged as "fairy casting net" (FIG. 6, part A-A); 3) The essential entrance to the south of the historic village faces the mountain ignore shaped by using Dajing Mountain (Xiangshan) and Huangshan Mountain (Shishan) in the south, which is additionally the path of the water mouth of the river flowing out of the village, and Xiaoqing Mountain (Luoxing Mountain) is precisely positioned between the two mountains, forming the perfect geomantic sample of "lion elephant gate and Luoxing water" (FIG. 6, B-B section).

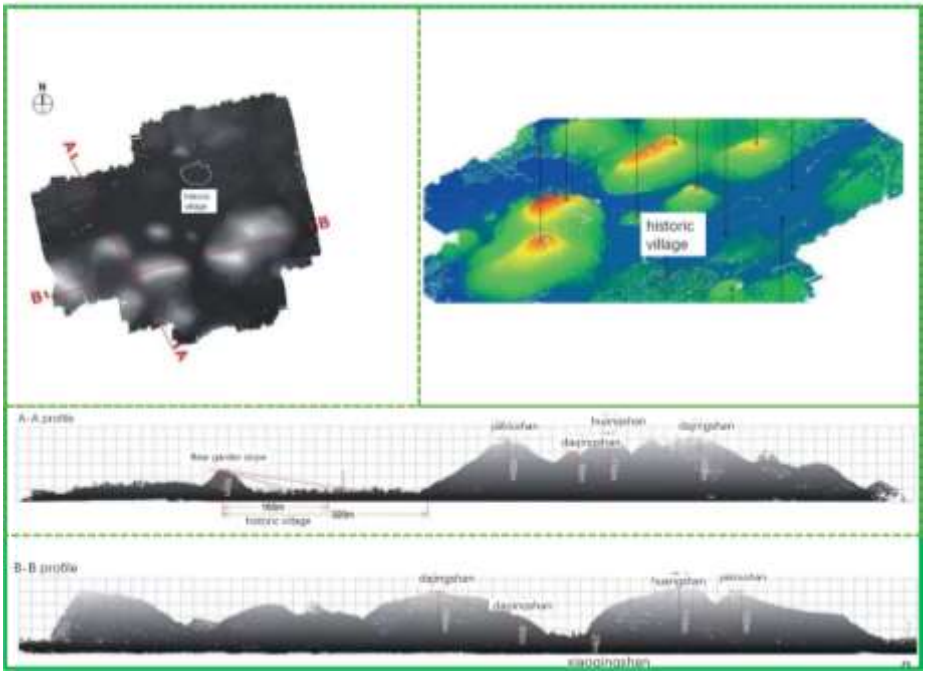

Figure 6.3D point cloud model of Bao's Village at the environmental scale and spatial scale measurement

(2) Spatial information collection and visualization of traditional village scale in Baojiatun

Through the elevation evaluation and visualization of the GIS model, the spatial shape of the historical village can be rapidly found (FIG. 7): The GIS mannequin intuitively displays the diagram of the central axis of the historic town of Baojiatun with "the core is large", and the fishbone spatial shape of "one gun linked with the courtyard" (FIG. 7). The planar design of the laser factor cloud mannequin can absolutely characterize the three-stage form of the central axis. The elevation design can immediately signify the vertical top distinction of the three-stage platform and the spatial relationship between the central axis and the department street (Figure 8). The scale factor cloud mannequin achieves centimetre-level accuracy and can precisely measure the spatial traits of historic villages, supplying a scientific foundation for the safety of historic spatial patterns[28].

Figure 7.Elevation analysis and plan extraction of Bao's Village based on a 3D point cloud model

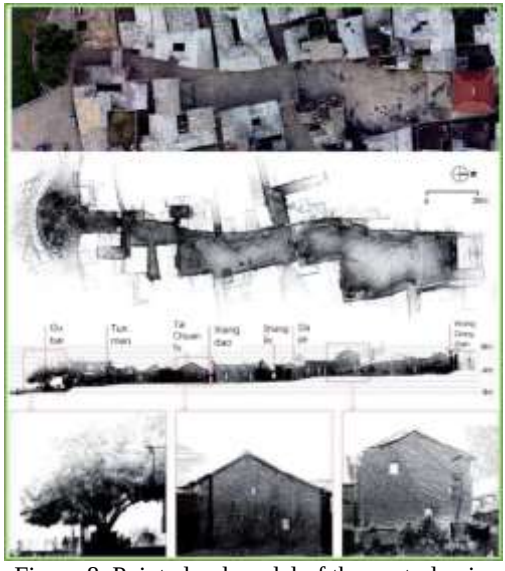

Figure 8. Point cloud model of the central axis of Bao's Village

(3) Collection and visualization of spatial information on rural building scale in Baojiatun

The spatial traits of architectural scale are additionally essential carriers of cultural data and ecological wisdom. Baojiatun Mill House is a consultant of the average environmental knowledge of Baojiatun. In order to block water for irrigation and overflow discharge, Bao's ancestors in the Ming Dynasty divided the river in two with the aid of "fish mouth diversion". They constructed six DAMS and five diversion channels[29]. Next to every dam is a water mill, which makes use of water electricity to mill rice and flour. At present, a well-preserved water mill residence is placed in the new river (Figure 5). The construction is a timber bucket shape with a fish-scale SLATE roof and stone floor. There is one room on the ground, one room for the east and the other for the east, and one stone mill in the residence is linked to the water wheel in the underground trench through the power shaft (Figure 9). When the water falls from the river in the north of the mill residence to the low south, it will use the dam drop to have an effect on the water wheel at the backside of the building, riding the stone mill work, which is an energy-saving, low-carbon and environmentally pleasant water conservancy facility.

Figure 9. Visualizing point cloud model of the water mill in Bao’s Village

The lookup proves that GIS technological know-how can rapidly and efficaciously document categorical spatial statistics of unique scales of rural panorama heritage and elevate our quantitative dimension and analysis. Compared with typical guide mapping, the effectivity and precision of the approach are noticeably improved. In addition, the GIS mannequin can immediately visualize the spatial sample of rural panorama besides guide modelling, which saves the safety fee to a positive extent. Throughout the acquisition process, the mapping instrument does not contact the measured object, which is safer and more dependable for the extra susceptible factors in the rural landscape[30].

Conclusion

Digital science has penetrated every subject of cutting-edge life, profoundly affecting people's questioning mode and way of life so as to promote the development and improvement of social civilization. Using digital technological know-how to elevate cultural heritage safety can now not solely understand the sustainable inheritance of cultural heritage; additionally, it makes the cultural heritage better, quicker, and more disseminated.

GIS science has added a new viewpoint and device for finding out about the rural panorama heritage spatial model. The use of GIS science to help the series and visualization of rural panorama heritage spatial records consists of 4 steps: 1) Heritage panorama research: to find out the heritage value, panorama characteristics, spatial scope and aspects of rural landscape, etc., to supply a foundation for spatial mannequin research. 2) Data collection: Select terrific methods, applied sciences and gear to acquire spatial records in accordance with exceptional spatial scales, spatial traits and accessibility factors. In the case of Baojiatun, the rural panorama is numerous in scale and wealthy in elements, which requires a range of gear to work together. 3) Data processing: Building spatial fashions via picture processing and GIS processing software. 4) Practical application: Redevelop the spatial mannequin in accordance with one-of-a-kind utility requirements, such as the extraction of the plane, elevation and area of the spatial environment, as well as the improvement and diagram of digital truth and augmented fact environment. In this method, the attention of heritage panorama values and spatial patterns usually courses the series and processing of data, and the consequences of the record similarly validate and deepen the appreciation of heritage landscape.

To lift the safety of China's historical and cultural villages and cities through digital technology, it is vital now not solely to construct the fundamental theoretical gadget and approach system but also to construct the corresponding technological know-how software device and standards. It is now not exclusively to recognize the primary facts of recording, accessing, monitoring, and restoring rural architectural and cultural heritage, but additionally to remember the improvement and utilization of three-dimensional digital and digital presentation of historical village and city data. Finally, realize the sustainable inheritance of rural architectural cultural heritage.

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