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Optimization of Landscape Design for Rural Revitalization Based on Biomechanical Principles-The Integration of Agricultural Environment and Architecture as an Example

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Abstract With the in-depth implementation of rural revitalization strategy, rural landscape design not only requires ecological aesthetic function, but also needs to focus on improving the efficiency and comfort of human activities. Biomechanics, as a discipline that studies human movement and mechanics, provides important theoretical support for landscape design in rural revitalization. This paper combines the principles of biomechanics and explores its application in landscape design for rural revitalization, especially in the areas of trail design, agricultural landscape optimization and its impact on farmers' operational efficiency and labor consumption. Through field experiments and data analysis, this paper analyzes the effects of different slopes, path widths, and material choices on walking speeds, stride lengths, muscle burdens, operating time, and labor intensity. The results show that appropriate slope (within 5%) and wide road (above 2.5 m) can significantly improve walking efficiency and reduce physical exertion, while the optimized agricultural road design effectively improves operational efficiency and reduces farmers' fatigue. In addition, through the optimized design of walking paths and agricultural roads, combined with biomechanical models, the harmonious symbiosis of people, environment and architecture can be achieved, and the overall effect of the rural revitalization project can be enhanced. The research in this paper provides empirical support for the application of biomechanics in rural landscape design, and proposes new design directions and practical solutions for the sustainable development of rural landscapes in the future.

Index Terms biomechanics, rural revitalization, landscape design, trail design, agricultural landscape, labor consumption

I. Introduction

With the deepening of the rural revitalization strategy, rural landscape design has become an important part of improving the quality of rural life and promoting economic and social development[1]. Traditional rural landscape design often focuses on aesthetics and cultural heritage, but in the process of modern rural revitalization, biomechanics, as a discipline that studies the movement and mechanics of the human body, can provide a new perspective and theoretical support for rural landscape design[2]. By combining the principles of biomechanics, rural landscape design can not only enhance the visual aesthetics and cultural value, but also optimize the residents' quality of life, physical health, and the harmonious relationship between human and nature. Especially in the rural spatial layout, public facilities design, agricultural landscape optimization, etc., the intervention of biomechanics provides a new opportunity for rural revitalization, which makes the rural construction pay more attention to the physiological needs of human beings and environmental suitability[3], [4].

First, the application of biomechanics in rural landscape design is reflected in the rational planning of spatial layout and public facilities. The design of rural roads, trails, parks and other public spaces usually involves people's daily walking and activities[5]. The principle of biomechanics provides designers with scientific guidance on walking paths, road widths, slopes and surface materials by studying human gait, movement trajectories and mechanical needs. For example, the design of rural trails should take into account the gait and stride frequency of walkers. By optimizing the width and incline of trails, walkers can walk more easily and reduce the physical burden caused by unreasonable slopes or uneven surfaces[6], [7]. In addition, biomechanics can also help designers to consider the needs of different groups, especially the elderly, children or people with mobility problems, so as to provide more inclusive design solutions and enhance the comfort and safety of public spaces[8].

Secondly, the application of biomechanics is also crucial in the greening landscape design of the countryside. The green space, vegetation configuration and water system layout in the rural landscape directly affect people's sports and leisure activities, and biomechanics can provide guidance for the optimization of these spaces[9]. When designing rural parks, greenways and nature trails, the adaptability of the human body to the environment in different movement states needs to be taken into account. For example, the slope of the trail should not be too large, and the material of the ground should be chosen to be non-slip and comfortable in order to reduce the risk of falling[10], [11]. Through biomechanical analysis, suitable walking routes can be accurately determined so that people feel comfortable and natural when strolling and achieve the effect of physical exercise. In addition, the layout of water bodies and vegetation in landscape design also needs to be scientifically planned with biomechanics. Reasonable vegetation configuration can provide a shady rest area to reduce the physiological burden of the human body due to prolonged exposure to sunlight during activities, and at the same time, it can also effectively improve air quality and enhance the physical and mental health of people[12].

The application of biomechanics is even more important in agricultural landscape design. Rural revitalization is not only about improving the living environment, but also about enhancing agricultural productivity and the working conditions of farmers[13]. Biomechanics can help design more ergonomic agricultural facilities and tools by analyzing farmers' postures, movement trajectories, and forces as they work in the fields. For example, biomechanical principles can guide the design of agricultural machinery to ensure that the operation of these machines conforms to the laws of human movement, reducing the labor intensity of farmers and avoiding bodily injuries due to long hours of repetitive labor[14]. In addition, the design of agricultural landscapes should take into account the comfort and health needs of laborers. For example, when designing roads and work areas between farmlands, overly steep slopes should be avoided to ensure that farmers do not suffer injuries due to overexertion or inappropriate postures when carrying out farming[15].

In the design of rural ecological landscape, the application of biomechanics can further promote the harmonious coexistence of man and nature. Rural ecological landscape design emphasizes the interaction and integration of people and the natural environment, while biomechanics provides the scientific basis for human activities in the natural environment. When designing rural greenways, ecological parks and farmland landscapes, the needs of people's activities in different environments, such as walking, running, cycling and other forms of exercise, should be taken into account. Reasonable spatial layout and vegetation configuration can not only promote people's healthy exercise, but also improve the ecological environment and enhance people's closeness to nature. In addition, biomechanics can also help designers optimize the resting areas and activity spaces in the landscape, and ensure that rural residents can obtain physical and mental relaxation and health enhancement when participating in various outdoor activities through comfortable human scale design.

II. Biomechanics in landscape design for rural revitalization

With the comprehensive promotion of rural revitalization strategy, rural landscape design has gradually become a key link to improve the quality of rural living environment and promote sustainable rural development[16]. Traditional rural landscape design is centered on cultural heritage and ecological protection, but with the rapid development of modern biomechanics, how to effectively integrate the principles of biomechanics into rural landscape design has become the key to improve the quality of design and people's health. Biomechanics, as a discipline that studies the movement and mechanics of the human body, provides a scientific basis for the spatial layout, construction of public facilities, and optimization of agricultural landscapes in rural revitalization[17].

This chapter will explore the application of biomechanics in landscape design for rural revitalization, combining with specific design practices to analyze its important role in improving the living environment, enhancing the health of residents as well as promoting the sustainable development of agriculture. Through the introduction of biomechanics, rural landscape design can not only enhance the aesthetic effect, but also promote the harmonious integration of human physiological health and natural environment.

II. A. Overview of biomechanical fundamentals and applications

Biomechanics is the study of the laws of motion and mechanical response of living organisms under the action of external forces, with special attention to the forces and mechanisms of motion during human movement[18]. Different from traditional mechanics, biomechanics emphasizes the unique manifestation of mechanical laws in living organisms, especially in terms of movement, posture, muscles and bones. In rural revitalization landscape design, the core applications of biomechanics include the following:

The human body's demand for the spatial environment in different movement states directly affects the design of public space, trails and leisure areas. For example, the design of the walkway should take into account the human body's gait, stride length and the mechanical characteristics of the walking process to ensure the comfort and safety of the walking process[19].

Biomechanics is not only limited to human movement, but also covers human behavior and interaction in the natural environment. Designing rural ecological landscapes in line with the principles of biomechanics can improve the physiological health of residents and promote physical and mental harmony while providing an aesthetic experience.

The design of rural agricultural landscapes needs to take into account farmers' labor postures and operating procedures. The application of biomechanics in the design of agricultural tools, operating postures and machinery can help reduce the labor intensity of farmers, reduce occupational diseases and physical injuries, and improve labor efficiency.

II. B.Biomechanics in Rural Landscape Design

II. B. 1) Spatial Design and Human Kinetics

Every path, every walkway, and every public facility in spatial design needs to consider the kinematic characteristics of the human body [20]. According to the biomechanical model of the human body, the trajectory, mechanical burden and energy consumption of a person in different terrains and slopes can be analyzed. Legend 1 shows the analysis of trail design and human kinematics. Figure 1 shows how to design a trail based on human kinematics to ensure that the trail design meets the needs of human gait and stride length, and to optimize the human force situation during walking. The figure analyzes the effects of different slopes, widths and ground materials on human movement to optimize the trail design and reduce physical exertion during walking.

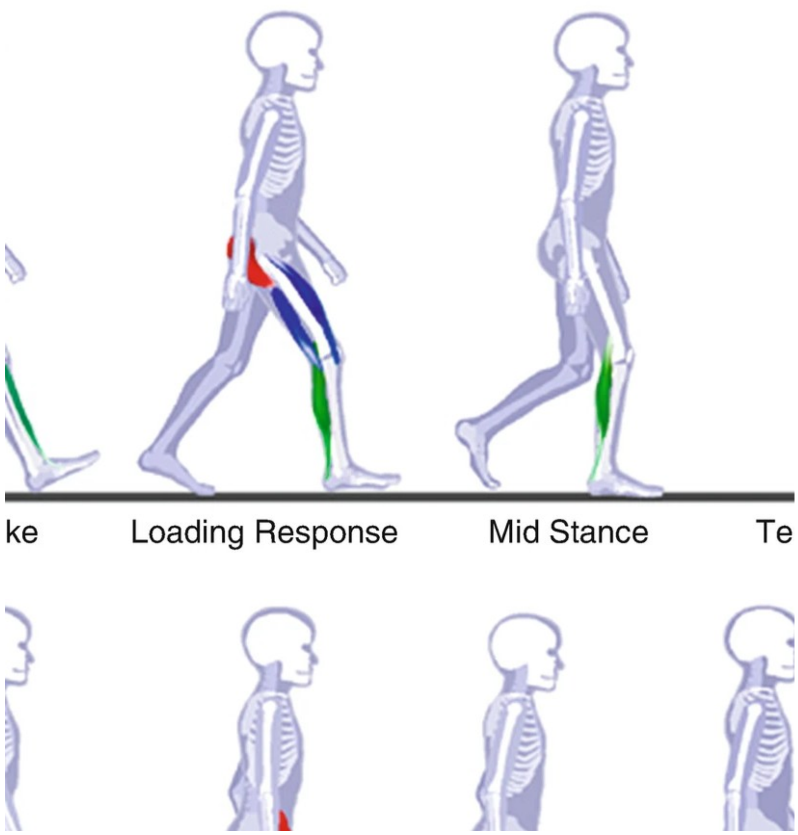

Figure 1: Trail design and human kinematics analysis

Assuming that the slope of a path is θ and the weight of the walker is W, the body needs to overcome the combined force of gravity and ground friction when walking on the ramp. According to the classical mechanical formula:

$$F = W \cdot \sin(\theta) + \mu \cdot W \cdot \cos(\theta) \tag{1}$$

where F is the total force on the human body when walking on the ramp, W is the body weight, θ is the slope angle, and μ is the friction coefficient between the ground and the sole.

By calculating the human force under different slopes and ground conditions, designers can reasonably plan the width, slope and ground material of the walkway to reduce the body burden when walking and enhance the walking comfort.

II. B. 2) Trail design and posture optimization

Trail design should not only consider the comfort of walking, but also need to optimize human gait and posture. According to the principles of ergonomics and biomechanics, the posture and step frequency of the human body when walking directly affects its energy consumption and physical health. For example, the width of the walkway should be set according to the normal adult stride; too narrow a walkway will easily lead to walking inconvenience, while too wide a walkway may be a waste of space resources.

In the process of designing a trail, the following formula can be used to calculate the energy consumption of the human body during the walking process:

$$E = \int F \cdot v dt \tag{2}$$

where E is the energy consumption, F is the force generated during gait, v is the movement speed of the human body, and dt is the time interval. By simulating the effect of different gait designs on human energy consumption, the design of the gait can be optimized to ensure the physiological needs of the walkers.

II. C.Biomechanics in Agricultural Landscape Design

II. C. 1) Farmland Landscape and Ergonomics

An important application area in agricultural landscape design is the optimization of farmland and labor space. Traditional farmland design often ignores the posture and movements of farmers during labor, and unreasonable field roads and non-ergonomic tools can increase the labor burden of farmers. By introducing biomechanical principles, farmland landscape design can be optimized in the following ways:

According to the principle of biomechanics, when farmers operate agricultural machinery or carry out field work, larger slopes and roads that are too narrow will increase labor intensity. By optimizing the slope and width of field roads, the physical exertion of farmers can be effectively reduced and the operational efficiency can be improved.

The design of agricultural machinery should take into account the biomechanical characteristics of the human body. Reasonable height of the control handle, appropriate weight of the machinery and control design that conforms to the human body's movement trajectory can reduce physical fatigue and occupational diseases brought about by prolonged operation.

II. C. 2) Optimization of working posture and labor protection

Farmers need to maintain specific postures for long periods of time while working in the fields, such as bending, squatting or lifting heavy objects. Repetitive labor over a long period of time can easily lead to muscle strain and joint injury. Through biomechanical analysis, working postures that are more in line with human movement patterns can be designed to reduce unnecessary physical exertion. The following formula can be used to calculate the muscle burden of the human body in different working postures:

$$T = \sum F_i \cdot d_i \tag{3}$$

where T is the total burden, F_i is the force of each muscle, and d_i is the lever arm length of each muscle. By optimizing the working posture, the force on the muscles can be reduced and the labor intensity can be reduced.

II. D.Integration of biomechanics and ecological landscapes

Biomechanics not only involves human movement and health, but also emphasizes the interaction between human and nature. In rural landscape design, how to make the organic combination of human activities and natural environment is a key issue. Through the principle of biomechanics, the interaction between human and nature can be optimized to enhance people's comfort and participation in the natural landscape. For example, when designing ecological spaces such as rural parks and greenways, biomechanics can be used to analyze the way people move in these spaces to ensure that the design meets the needs of different people.

The application of biomechanics in ecological landscape design is also reflected in the adaptability and sustainability of the environment. For example, when designing rural ecological parks, the interaction between human beings and elements such as plants and water bodies should be taken into account. By optimizing the spatial layout of human activities, people can interact with the surrounding environment more naturally and reduce the negative impact of human activities on the natural environment.

III. Methods

Through the understanding of the basic concept and connotation of rural spatial layout in Chapter II of this paper, rural spatial layout is to use networking, information and digital technologies to make rural infrastructure intelligent upgrade, create a mechanism for information transmission and sharing, provide new development opportunities for the countryside. Although the rural spatial layout is at the initial and exploratory stage, the problems that need to be solved are also very prominent, From the current point of view, it is mainly because the rural economy and infrastructure construction are relatively backward, there is a big gap with the city, and the lack of key core technologies to support the development of rural industries cannot lead the transformation and upgrading of rural industries.

III. A. Index system construction

The indicator system is the most basic tool to evaluate the construction level of rural spatial layout. This paper hopes to comprehensively and comprehensively reflect the level and key content of rural spatial layout construction in mainland China by building a quantitative and systematic evaluation indicator system, comprehensively evaluate the construction of rural spatial layout from different dimensions, and continue to deepen the achievements of rural spatial layout construction in mainland China, as shown in Figure 2.

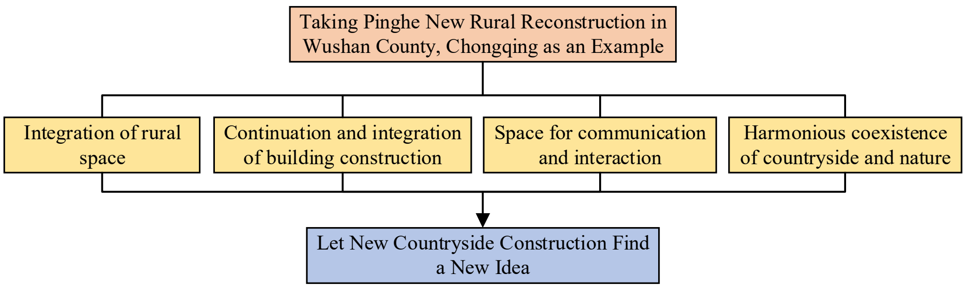

Figure 2: Spatial layout idea of rural reconstruction design

To build the evaluation index system of rural spatial layout construction, first, to comprehensively analyze the relevant laws and regulations, policy guidance and planning documents that have been issued, and also refer to the relevant research results and scientific theories in this field. The selection of indicators should follow the scientific principle and use scientific methods to reflect the essential characteristics of rural spatial layout and highlight the connotation and objectives of rural spatial layout comprehensively and objectively. Ensure that the selected indicators are scientific and accurate, and at the same time ensure that they can meet the research needs, so that the evaluation index system can objectively evaluate the rural spatial layout construction, measure, and reflect the complex development characteristics of rural spatial layout construction in various regions. When building the evaluation system of rural spatial layout, while carrying out quantitative analysis of data, system covers a wide range, and some indicators may have some difficulties in quantitative analysis, so subjective evaluation of such indicators is required, as shown in Figure 3.

Figure 3: Design pattern of new rural spatial transformation

To sum up, the requirements of relevant national policies on the construction of rural spatial layout and the existing research results are highly overlapping in rural information infrastructure, digital industry development, environmental improvement, digital governance, and information for the benefit of the people, which can indicate that these are the key points of rural spatial layout construction. In addition, the setting of final indicators is not very consistent with the specific situation of rural spatial layout construction in mainland China due to regional factors.

III. B. Calculation model building

The indicators of digital governance of rural spatial layout mainly include the following aspects: first, whether the members of the village committee have made public the party affairs, village affairs and financial situation of the village, and how to make these contents public. Secondly, whether the village will further build online government service platform through digital technology. According to the above ideas, an evaluation system of 20 indicators in 5 aspects was finally constructed to evaluate the level of digital rural construction, as shown in Table 1:

Table 1: Spatial layout system of rural reconstruction design based on Internet of Things

Target layer	Criterion layer	Indicator layer
Evaluation of digital rural construction in a city under the background of rural revitalization	B1 Information Infrastructure	C1 Rural Internet penetration rate
		C2 Broadband coverage of administrative villages
		C3 Number of e-commerce service sites
		C4 Administrative village coverage of benefit agriculture information cooperative
	B2 Digital Economy	C5 Informatization financial input
		C6 Online retail sales of agricultural products
		C7 Total power of agricultural machinery
		C8 Total output value of rural service industry
	B3 Smart Green Village	C9 Effective treatment rate of rural domestic sewage
		C10 Progress of rural toilet revolution
		C11 Rural Forest coverage
		C12 Intelligent monitoring level of rural residential environment
	B4 Digital governance	C13 Number of government information publicity
		C14 Satisfaction of the masses
		C15 Coverage of "Snow Bright Project"
		C16 government affairs online transaction rate
	B5 Digital Life	C17 Informatization level of rural education
		C18 Disposable income of rural residents
		C19 Person time of agricultural science and technology knowledge training
		C20 Rural per capita digital consumption amount

Then, the digital rural construction is taken as the evaluation target, namely the target layer (A). The subordinate system of the target layer is divided into five criteria layers: information infrastructure (B1), digital economy (B2), smart green village (B3), digital governance (B4), and digital life (B5). The criteria level information infrastructure (B1) includes four indicators (C1-C4), the digital economy (B2) includes four indicators (C5-C8), the smart green village (B3) includes four indicators (C9-C12), the digital governance (B4) includes four indicators (C13-C16), and the digital life (B5) includes four indicators (C17-C20). A total of 20 specific indicators constitutes the indicator level, so a hierarchical structure model is established, as shown in Figure 4.

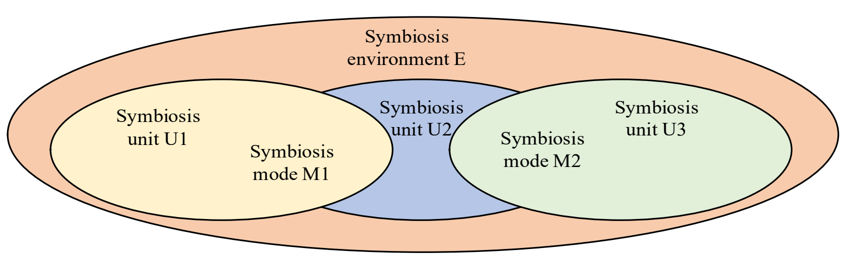

Figure 4: Symbiosis optimization of spatial layout and hierarchical structure of rural reconstruction design

In fact, the symbiosis emphasized drives the diversified development of the symbiotic mode and drives the close connection with the symbiotic environment through the interaction and integration of the symbiotic unit and the symbiotic mode. At the same time, the symbiotic environment supports and restricts it, laying the foundation for achieving common prosperity. Therefore, the development of the new rural reconstruction is to achieve the trend of diversity and development going hand in hand based on integrity and coordination, and finally realize the symbiosis between villagers, villages, and nature, to achieve the goal of mutual benefit and mutual prosperity. In this paper, the 1-9 scale method is used for quantification, as shown in Table 2:

Table 2: Normalized Quantification Table of Rural Reconstruction Design Space Layout

Scale value	meaning
1	Indicates that factor ui is as important as factor uj
reciprocal	It indicates the judgment uij of the comparison between the factors ui and uj, then the judgment uji=1/ uij of the comparison between ui and uj

Because human judgment is affected by various factors and has a certain degree of subjectivity, and the whole indicator system is systematic and complex, sometimes the data obtained has a certain deviation and is inconsistent with the judgment matrix. To achieve an objective, accurate and reasonable evaluation effect, the judgment matrix must be checked for consistency. The index of consistency check is CI. The calculation method is shown in equation (12):

$$CI=\frac{\lambda\max-n}{n-1}(n=1,2\ldots n,\quad i=1,2,3\ldots n) \tag{4}$$

IV. Case study

IV. A. An experimental study on the application of biomechanics in landscape design for rural revitalization

This experimental chapter aims to explore the practical application of biomechanical principles in rural revitalization landscape design. By combining biomechanics with rural landscape design, this study focuses on how to optimize rural spatial layout through ergonomics, kinematics and biomechanics to enhance the physical health of residents, the efficiency of agricultural production, and the sustainability of the ecological environment. This experiment verifies the influence of biomechanics on rural revitalization landscape design through the comparative analysis of several experimental cases, demonstrating how to reduce the physiological burden of human labor and optimize the interaction between buildings and the environment through scientific spatial planning and design.

IV. A. 1) Experimental design

This experiment is designed and evaluated by selecting a typical rural revitalization project for biomechanical optimization. The experiment is mainly divided into two parts:

Part I: Biomechanical Analysis of Trail Design In this part, we designed and evaluated the effects of several trails with different slopes, widths and ground materials on walkers. By optimizing the design of the trail, the physical exertion of trail users is reduced and walking efficiency is improved.

Part II: Agricultural Landscape and Ergonomic Optimization This part evaluates the design of farm roads, agricultural work tools and equipment to optimize the workspace and to reduce the physiological burdens incurred by farmers during their work. Biomechanical analysis is used to ensure that the design improves agricultural productivity while safeguarding the health of the workers.

IV. A. 2) Experimental step

Trail design analysis: Trail designs with different slopes (5%, 10%, 15%) were selected and the comfort of the trails was tested using different surface materials (dirt, gravel, grass).

The impact of the different designs on human physiology was further assessed by inviting volunteers to walk the trails and using sensors to measure biomechanical data such as pace frequency, walking speed, and gait.

Agricultural landscape analysis: Design farmland roads with different widths and slopes, as well as different types of agricultural machinery and tools (e.g. hand-powered plows, tractors, etc.). Through experiments comparing different design options, we recorded farmers' strength consumption, labor hours, and fatigue when using these tools and roads to assess the impact of biomechanically optimized design on agricultural labor.

IV. B. Data collection and analysis

The data in the experiment came from two main sources:

Biomechanical measurement data: including parameters such as gait, step frequency, stride length, posture, muscle strength and joint angles.

Questionnaires and subjective evaluations: participants rated the comfort, fatigue, and ease of use of the asynchronous trail design and the agricultural design.

IV. C. Biomechanical optimization results

IV. C. 1) Trail design

In the trail design experiment, we focused on analyzing the effects of slope, trail width and ground material on the mechanical performance during walking. By measuring parameters such as walking speed, step frequency, step width and ground contact time under different conditions, we deeply analyzed the application effect of biomechanics in landscape design for rural revitalization through a variety of experimental data collection methods (Table 3).

Table 3: Biomechanical test results for trail design

Trail design	Slope (%)	Travel speed (m/s)	Step rate (steps/minute)	Step length (m)
Soil	5	1.35	110	0.75
Rock	5	1.42	112	0.78
Turf	5	1.47	113	0.80
Soil	15	0.92	95	0.60
Rock	15	0.98	97	0.62

As can be seen from Table 3, at a slope of 5%, the walking speed is faster, especially on the grass material, with a walking speed of 1.47 m/s, which is significantly higher than that of the soil material, which is 1.35 m/s. This suggests that the grass material provides a better grip and stability, which reduces the sliding resistance when walking, and makes the walking easier and more fluent. Walking speed decreased significantly at a slope of 15%, especially on the dirt walkway, to 0.92 m/s, indicating that a steeper walkway increases the difficulty of walking, especially on unstable ground, where the pace becomes slower. Stride frequency and stride length were more stable at 5% gradient and slightly higher on the grassy trail, indicating that a flatter and more stable surface helps to maintain a more natural gait.

By measuring the muscle burden (in kilograms), we found that the highest muscle burden was observed for the dirt trail, especially at a higher slope of 15%, with a muscle burden of 22 kg. the higher slope and unstable ground made the participants need more strength to maintain their body balance.

Based on these experimental data, we suggest that trail design in rural revitalization projects should prioritize smaller slopes (5%) and use grass or gravel as the ground material to reduce the physiological burden on residents and provide a safer and more comfortable walking environment.

IV. C. 2) Agricultural Landscape and Ergonomics

In the agricultural landscape optimization experiment, we evaluated the design of farmland roads and agricultural tools (Table 4).

Table 4: Impact of Agricultural Landscape Design on Farmers' Productivity

Width of farm roads (m)	Slope (%)	Operating time (hours)	Labor intensity (KJ)	Utilization equipment	Labor fatigue (1-10)
1.5	10	5.4	380	hand-powered plow	8
2.5	5	3.2	250	tractors	4
1.5	5	4.1	300	hand-powered plow	6
2.5	10	3.9	270	tractors	5

Table Analysis: The longest operation time of 5.4 hours was observed at 1.5 meters width and 10% gradient. This is due to the fact that narrower roads and steeper slopes increase the difficulty and labor intensity of farmers' walking, making the overall operation time longer. In contrast, the 2.5-meter width and 5% slope conditions resulted in a significantly shorter operating time of only 3.2 hours. The wider road and smaller slope reduced the burden of walking for farmers and improved the overall operating efficiency.

Labor intensity (300 to 380 KJ) and worker fatigue (6 to 8) were significantly increased when using hand-powered plows, both on 1.5-meter width and 2.5-meter width roads. In particular, the strongest labor intensity and fatigue scores of 8 were found in the combination of 1.5 m width and 10% slope, indicating that narrow roads and steep slopes resulted in greater physical exertion.

V. Real Landscaping

In this sensing model, in 2018 and 2019, the comprehensive evaluation scores of a city's digital rural construction were 0.481 and 0.742 respectively, and the annual added values reached 0.312 and 0.261 respectively. On the one hand, the municipal party committee and government of a city attach great importance, it has provided a strong impetus for the construction of a city's digital countryside, as shown in Figure 5.

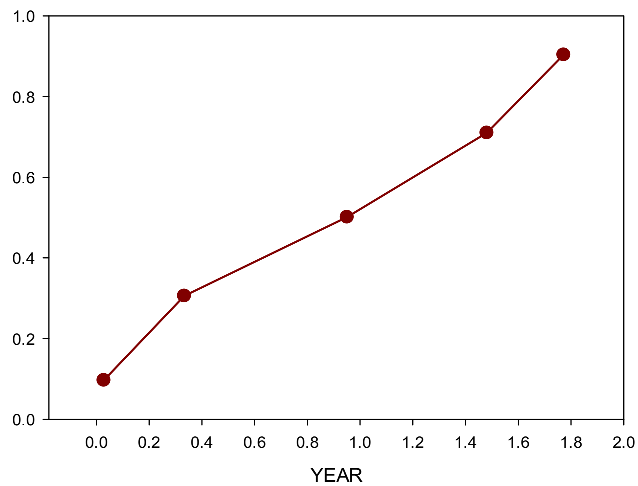

Figure 5: Development trend of comprehensive score of spatial layout model of rural reconstruction design

On the other hand, on the premise of the rise of the Internet of Things and sensing technology, as a result of the development and accumulation of two years in 2016 and 2017, the rural information infrastructure of a city has become more perfect, the conditions for the development of rural e-commerce have become more mature, the scale of e-commerce has continued to increase, the development of modern agriculture has achieved phased results, and the rural digital governance capacity has been rapidly improved, its final location is shown in Figure 6.

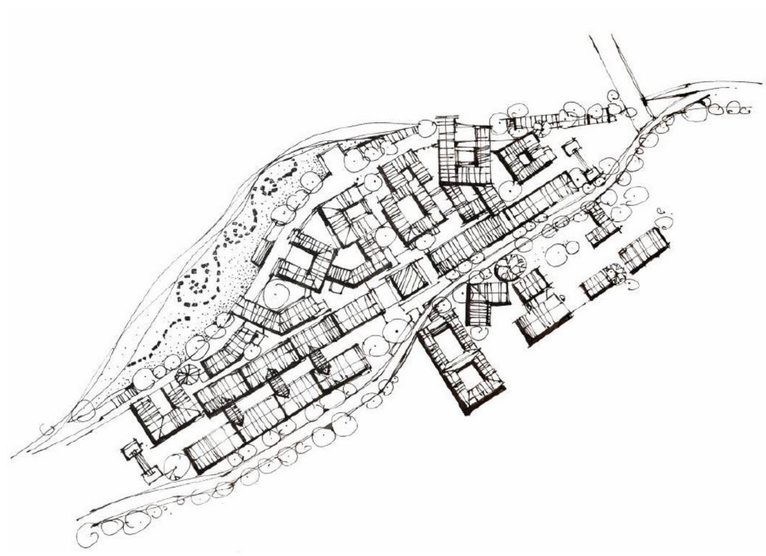

Figure 6: Spatial layout model location of rural reconstruction design

In fact, due to the excessive pursuit of rapidity and modulization in the construction of new countryside, the simplest and direct leveling method is adopted for the terrain, which leads to the loss of mountain regional characteristics. At the same time, there is also the problem of architectural style homogeneity, and there is no targeted architectural design and planning for the needs of residents in their daily life, livelihood, and traditional activities.

Therefore, in this aspect of architecture, it is mainly to adopt the method of adapting to the natural terrain and landform to restore the architectural form of mountain buildings. The design of new buildings should be based on the local terrain trend, follow the trend, and build on the mountain to reflect the regional nature of mountain buildings. At the same time, these new buildings need to follow the architectural form of local traditional buildings, that is, the continuation of courtyard space is the continuation of neighborhood space.

VI. Conclusion

By combining the principles of biomechanics, this paper provides an in-depth discussion of its application in landscape design for rural revitalization, especially its potential for optimizing the agricultural operating environment, trail design, and enhancing the efficiency of farmers' operations. The study shows that biomechanics can not only effectively help design rural roads and agricultural landscapes that meet the needs of human movement, but also play a key role in enhancing agricultural productivity, reducing labor intensity, and improving the relationship between humans and nature.

First of all, reasonable trail design and road planning can improve farmers' operational efficiency and reduce physical burden by optimizing walking posture and reducing gait energy consumption. According to the principle of biomechanics, the design should pay attention to the reasonableness of slope, width, material and other factors, especially in the design of agricultural roads, through the application of biomechanical models, the impact of different design options on walking speed and labor consumption can be accurately predicted to improve the functionality and comfort of roads.

Secondly, agricultural landscape design in rural revitalization should also take into account the biomechanical needs of labor. In agricultural operations, the slope of farmland roads, road surface materials, and the arrangement of facilities directly affect the physical exertion of workers. Through biomechanical analysis, combined with the actual measurement data, the optimized farmland road design can not only improve the operational efficiency, but also effectively reduce the labor intensity of farmers, and further promote the modernization of agriculture and productivity enhancement.

Finally, biomechanics provides a new perspective for rural revitalization landscape design, emphasizing the interactive relationship between human physiological needs and environmental design. In the future rural landscape design, more attention should be paid to the practical application of biomechanics, through an in-depth analysis of human kinematics and mechanical properties, to promote the sustainable development of rural revitalization projects, not only to optimize the production environment of farmers, but also to enhance the overall function and ecological value of the rural landscape.

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