Research on the Application of Artificial Intelligence in Teaching Landscape Design Hand Drawing

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ABSTRACT

The application of Artificial Intelligence in the teaching of hand-drawing in landscape design through hand-drawing sketch segmentation by analyzing the pixel modality and point set modality of the segmentation module to obtain the pixel feature maps, and point set fusion feature maps with point features, stroke features and global features, with the help of hand-drawing and painting to provide materials for Ai to re-creating, and finally completing the work, and finally joining the fusion network module to aggregate these feature maps. It is a brand-new course that integrates Ai drawing and art design. It fully uses AI's advantages and effectively solves students' problems in modelling ability and creative thinking to improve their artistic cultivation and creative ability.

Keywords: *Artificial intelligence, Landscape design, Hand-drawing teaching.*

1. INTRODUCTION

In the current digital age, artificial intelligence (AI) technology is developing at a rapid pace and is being widely applied across various fields, including education. With the advancement of educational informatization, the application of AI in teaching has gradually become a research focus, injecting new momentum and development opportunities into traditional teaching models.

Landscape design, as a discipline that integrates art and technology, relies on hand-drawing skills as an essential tool for students to express design concepts and showcase creativity. However, traditional hand-drawing teaching in landscape design faces several challenges. For example, there are significant differences among students in terms of modeling ability and creative thinking, and the teaching resources are insufficient to meet the needs of individualized learning. The rise of AI technology offers potential solutions to these issues.

Introducing AI technology into hand-drawing teaching in landscape design holds significant practical significance [1]. Through the powerful computing and analytical capabilities of AI, students can receive precise learning feedback and personalized guidance, helping them to rapidly improve their hand-drawing and design skills. Moreover, interaction with AI can stimulate students' innovative thinking and creativity, thereby cultivating high-quality design talents capable of meeting future societal demands.

2. ANALYSIS OF THE CURRENT STATUS OF HAND-DRAWING TEACHING IN LANDSCAPE DESIGN

Hand-drawing teaching in landscape design, as an important part of landscape design education, directly relates to the cultivation of students' design expression abilities and creative thinking levels. However, with the continuous changes in the educational environment and student needs, traditional teaching models and learning methods have gradually revealed some issues in practical applications. To gain a deep understanding of the current situation of hand-drawing teaching, this paper will analyze the characteristics and limitations of traditional teaching models as well as the problems students face during the learning process.

2.1 Characteristics and Limitations of Traditional Teaching Models

Traditional hand-drawing teaching in landscape design mainly relies on the teacher's lectures and demonstrations, with students practicing through copying and sketching from life. In teaching, the focus is on explaining basic hand-drawing techniques, including the use of lines, principles of perspective, color matching, and so on. Through blackboard demonstrations or examples from paper textbooks, students can intuitively understand the methods and steps of hand-drawing. Subsequently, students master skills by imitating excellent works and apply the knowledge they have learned to the drawing of real scenes through on-site sketching.

Although this teaching method has certain effects in cultivating basic hand-drawing abilities, its limitations are also very apparent. First, the teaching method is monotonous, centered around the teacher, with students mainly passively receiving knowledge and lacking autonomy and creativity. The teacher's explanations and demonstrations usually take up a lot of time, leaving relatively little time for students to think independently and practice, which is not conducive to the cultivation of innovative abilities. Second, teaching resources are relatively scarce, with students having limited exposure to excellent hand-drawing works and practical cases. Moreover, due to limitations of time and space, there are difficulties in obtaining learning materials. Additionally, in traditional teaching models, teachers' corrections and feedback on students' assignments are often not timely or precise enough, making it difficult for students to identify and improve problems in a timely manner, thereby limiting the improvement of learning outcomes.

2.2 Problems Students Face in Hand-Drawing Learning

In the learning process of hand-drawing in landscape design, students generally face several challenges. First, in the cultivation of modeling ability, many students find it difficult to accurately represent the shape, proportion, and spatial relationship of objects, resulting in a lack of accuracy and expressiveness in their hand-drawing works. Second, a common phenomenon is the insufficiency of creative thinking. Students often lack unique ideas and novel concepts in their designs, making their works prone to homogenization and failing to meet the requirements for innovation in landscape design.

Moreover, improving aesthetic ability also faces certain difficulties. Many students lack a keen sense and judgment in color matching and composition layout, which affects the artistic appeal of their hand-drawing works. More importantly, due to differences in basic abilities and learning progress among students, traditional teaching models find it hard to meet individualized learning needs. For students with weaker foundations or slower progress, this teaching method may lead to a gradual loss of interest and confidence in learning, further affecting their learning outcomes and growth.

3. TECHNICAL FOUNDATIONS OF AI IN HAND-DRAWING TEACHING FOR LANDSCAPE DESIGN

3.1 Hand-Drawing Sketch Segmentation Technology

Hand-drawing sketch segmentation technology is a core component in AI-assisted hand-drawing teaching for landscape design. Its goal is to accurately extract the characteristics of different regions or elements in a sketch through technical means, providing support for further analysis and teaching applications. In this process, pixel modality analysis and point set modality analysis serve as two main technical paths, analyzing from the dimensions of image color and texture features, as well as point coordinates and connection relationships. Pixel modality analysis focuses on the color distribution and texture characteristics of the image, providing an intuitive basis for regional segmentation; point set modality analysis focuses on the structural framework of the sketch, extracting shape information through the spatial relationships and connection features of points. The combination of these two analysis methods not only improves the accuracy of sketch segmentation but also provides strong technical support for enhancing students' hand-drawing abilities and optimizing design expression.

3.1.1 Pixel Modality Analysis

In AI-assisted hand-drawing teaching for landscape design, pixel modality analysis plays a significant role. Its core lies in the extraction and analysis of image color and texture features to achieve precise segmentation of hand-drawing sketches.

From the perspective of color features, each pixel in an image contains independent color information, such as the values of red, green, and blue color components in the RGB color mode. By statistically analyzing the color data of a large number of pixels, it is possible to identify the commonalities and differences of different regions in the sketch. For example, vegetation areas usually show a greenish hue, water bodies are often blue, and building areas have a relatively diverse but recognizable color distribution. Based on these color features, the system can clearly distinguish various functional areas in the sketch.

Texture feature analysis further enhances the accuracy of segmentation. Different regions or objects in a hand-drawing sketch exhibit their own texture characteristics. For example, grasslands typically show fine, irregular line textures, while brick buildings display more regular and repetitive patterns. By applying algorithms such as the gray-level co-occurrence matrix, the spatial correlation of pixel gray levels can be captured, thereby describing and extracting these unique texture features.

In terms of application, pixel modality analysis provides a scientific basis for the segmentation of hand-drawing sketches through the extraction of color and texture features. For example, when separating landscape elements in a sketch, the technology can accurately locate the specific color and texture features of a particular area, effectively segmenting these design elements. This process not only lays the foundation for AI to recreate on hand-drawing sketches but also provides students with intuitive guidance on the use of color and texture, helping them improve their hand-drawing expression and enrich their design expressiveness.

3.1.2 Point Set Modality Analysis

Point set modality analysis parses hand-drawing sketches from a spatial structure perspective, providing important support for sketch segmentation. Its core lies in extracting the structural information of the sketch through the coordinates and connection relationships of points.

In a hand-drawing sketch, each drawn point has a definite coordinate position. These points are not isolated but are connected to each other in the form of lines, forming the contours of various shapes and objects. Point set modality analysis organizes and analyzes the coordinate data of these points to clarify their spatial relationships. For example, it analyzes which points form line segments and which points enclose a closed polygon. At the same time, based on the connection order and density of points, the structural characteristics of objects can be determined. The point connections of building contours are usually regular and orderly, while the contours of natural forms such as trees show random and flexible connection patterns.

Point set modality analysis can effectively extract the structural framework of the sketch, intuitively presenting the constituent forms of each element. For example, in a sketch containing various landscape elements, this analysis method can accurately identify the structural characteristics of the road network (through the coordinates and connection relationships of road contour points) and the division of functional areas (based on the distribution and connection of area boundary points). This clear structural information not only provides a basis for the rational segmentation of complex sketches but also facilitates subsequent teaching. For example, it allows for targeted guidance to students on optimizing design expression for different structural parts, enhancing the relevance and effectiveness of teaching.

3.2 Feature Map Acquisition Technology

Feature map acquisition technology plays a crucial role in AI-assisted hand-drawing sketch analysis. By extracting pixel feature maps and point set fusion feature maps, it presents both the local details and the overall structure of the sketch. Pixel feature map extraction focuses on local features such as color and texture, using convolutional neural networks (CNNS) to mine the expressiveness of design elements from the subtle information in the sketch. Point set fusion feature map extraction, on the other hand, integrates point features, stroke features, and global features to systematically depict the spatial structure and design intent of the sketch. The combination of these two technologies provides a solid data foundation for sketch segmentation and subsequent recreation, and also offers new pathways for multi-dimensional analysis of hand-drawing works in teaching.

3.2.1 Pixel Feature Map Extraction

Pixel feature map extraction is an important step in analyzing hand-drawing sketches using advanced technologies such as convolutional neural networks. It reflects the feature information of the sketch from local to global perspectives, providing a key data foundation for subsequent analysis and creation.

Firstly, the convolutional layer is the core of pixel feature extraction. By setting convolutional kernels with specific functions, these kernels slide step by step over the sketch image, multiplying each local region's pixel values element-wise and summing them to extract the region's features. For example, a convolutional kernel can capture changes in edge pixels, reflecting local contour or texture features. Through multiple slides, the convolution operation covers the entire sketch, generating a preliminary feature map.

Next, the activation function performs a nonlinear transformation on the feature map, enabling it to represent more complex features. The commonly used ReLU function emphasizes key information in the feature map by setting negative values to zero. After processing by the activation function, the originally linear feature distinctions become clearer, helping to reinforce the unique features of different regions and elements in the sketch.

Then, the pooling layer performs a downsampling operation on the feature map to reduce dimensions and simplify calculations. For example, in max pooling, the maximum value in each pooling window is selected as the output. This method reduces the computational load while retaining the most important features, ensuring efficient information transfer.

Through the combined action of the convolutional layer, activation layer, and pooling layer, the final pixel feature map comprehensively reflects the characteristics of the hand-drawing sketch. From local details such as the shape and texture of landscape elements to global features such as layout form and functional area distribution, this information provides foundational support for subsequent steps, including integration with other features and AI-driven creative applications.

3.2.2 Point Set Fusion Feature Map Extraction

Point set fusion feature map extraction generates information-rich feature maps by integrating point features, stroke features, and global features, showcasing unique technical advantages. This method not only covers the detailed features of hand-drawn sketches but also reflects the overall design intent and structural relationships from a macro perspective.

In point feature extraction, the coordinate position of each point and its distance relationship with surrounding points are analyzed in detail. This information accurately describes the attributes of points, especially the coordinates of key points, which often represent important structural parts of the sketch and are crucial sources of feature data. In stroke feature extraction, the focus is on the thickness, length, direction, and intersection and connection relationships of lines. For example, smooth and long curves usually correspond to road or river elements, providing important morphological information for the sketch. Global feature extraction starts from the overall layout, focusing on the compositional balance of the sketch and the distribution density of elements, grasping the design structure of the sketch from a macro level.

To achieve the fusion of point features, stroke features, and global features, specific algorithms and strategies are employed. Weighted summation is a common method, where different features are assigned weights and calculated according to their importance to the overall design. Multi-scale fusion strategies are also commonly used, integrating features at different scales to highlight both microscopic details and macroscopic design structures in the fused feature map.

The significant advantage of the point set fusion feature map lies in its comprehensiveness and inclusiveness. Compared to feature maps based on single features, the fused feature map not only contains multidimensional information but also more accurately conveys the design intent and internal structural relationships of the sketch. In teaching, this method provides students with tools for multidimensional analysis of hand-drawn works, helping them to understand and master hand-drawing skills more comprehensively. At the same time, this feature map provides sufficient and precise data for AI to further understand the sketch, enabling it to generate design results in creative applications that better meet the actual needs and aesthetic requirements of landscape design.

4. APPLICATION MODELS OF AI IN HAND-DRAWING TEACHING FOR LANDSCAPE DESIGN

4.1 AI-based Hand-Drawing Teaching Process Design

In the AI-based hand-drawing teaching process, first, students complete sketch drawing according to the design theme or actual needs using hand-drawing tools, and then transform the sketch into an electronic image through a scanner or graphics tablet, inputting it into the AI teaching system. Next, the AI conducts a detailed analysis and feature extraction of the hand-drawn sketch, employing pixel modality and point set modality analysis methods to extract pixel features such as color and texture, as well as structural information from the sketch, thereby generating preliminary feature maps. These feature maps provide the foundation for subsequent design analysis. During the feature map acquisition stage, the fusion network module further aggregates feature maps from different modalities, using advanced algorithms and techniques such as attention-based feature fusion algorithms to effectively integrate color information and structural information, generating a more comprehensive feature representation. This process enables students to more clearly understand the structural relationships of the design and the interactions between elements, and provides precise feature support for AI's subsequent creative applications.

4.1.1 Hand-Drawing Sketch Creation and Input

In the initial stage of hand-drawing teaching in landscape design, students use hand-drawing tools to create sketches based on the assigned design theme or actual project requirements. During this process, teachers encourage students to exercise their imagination and creativity, transforming design concepts into sketches that display landscape layout, element shapes, and spatial hierarchy. For example, “Figure 1” shows a rest area with a wooden roof and dark blue pillars, surrounded by various plants, including tall trees and low flowers. On the right is a decorative bamboo curtain and a pottery jar, with a plant bearing red flowers nearby, conveying an atmosphere of tranquility and harmony. “Figure 2” depicts a peaceful residential area landscape, with a winding stream in the center, flanked by lush trees with full canopies. On one side of the stream stands a modern white multi-story building, with people walking, talking, and playing in front, against a backdrop of blue sky and distant mountains, giving an overall impression of peace and pleasantness.

After completing the hand-drawn sketch, students need to transform it into an electronic image through digital devices such as a scanner or graphics tablet, and input it into the AI teaching system. The quality and clarity of the sketch at this stage are crucial for subsequent AI analysis and processing. If the sketch is not drawn clearly or the details are vague, it may lead to deviations in AI's feature extraction and analysis, preventing it from accurately grasping the student's design intent and thereby affecting the effectiveness and precision of subsequent teaching.

Figure 1 Hand-drawn Sketch 1.

Figure 2 Hand-drawn Sketch 2.

4.1.2 AI Analysis and Feature Extraction of Hand-Drawn Sketches

Once the sketch is input into the system, the AI automatically initiates the analysis program, conducting an in-depth analysis from the dimensions of pixel modality and point set modality, accurately extracting various feature information and generating corresponding feature maps.

In pixel modality analysis, the AI identifies features such as color and texture in different regions of the sketch, segmenting the sketch into various landscape element areas, such as vegetation areas, water bodies, and buildings, and extracting pixel feature maps that reflect the color distribution and texture variations in these areas. For example, when analyzing vegetation areas, the AI captures the distribution of green-toned pixels and the fine lines of leaf textures; in water body analysis, the AI focuses on the variations in blue tones and water surface textures, especially the shimmering effects. Through these analyses, the AI provides precise design suggestions regarding color usage and texture representation, helping students better master hand-drawing techniques.

Point set modality analysis focuses on extracting structural information from the sketch. The AI analyzes the coordinate positions and connection relationships of points to determine the contours and shape features of various landscape elements, generating point set fusion feature maps that encompass point features, stroke features, and global features. For example, when analyzing building contours, the AI accurately identifies the points that form the building's shape and their connections, determining the building type (such as the symmetrical structure of European architecture or the flying eaves and bracket sets of Chinese architecture). Additionally, the AI can comprehensively grasp the compositional balance and density distribution of the sketch's overall features. Through these analyses, the AI provides guidance on the rationality and overall structure of the design, helping students identify the strengths and weaknesses in their designs, and enabling targeted improvements and optimizations.

4.1.3 Fusion Network Module for Feature Map Aggregation

The fusion network module plays a crucial role throughout the teaching process. It is responsible for aggregating the various feature maps extracted by AI from pixel modality and point set modality analyses. By comprehensively integrating the effective information from these feature maps, it generates a comprehensive feature representation that provides students with more valuable design references.

During the fusion process, the fusion network module employs advanced algorithms and techniques, such as attention-based feature fusion algorithms. These algorithms can automatically identify and highlight key information in different feature maps, enabling students to more intuitively understand the intrinsic connections and interactions between various landscape elements. For example, by integrating the color information from the pixel feature map with the structural information from the point set fusion feature map, students can clearly see the distribution of different colored landscape elements within the overall structure and understand how they interact to create specific spatial atmospheres and visual effects.

Through the aggregated feature maps, students can obtain more comprehensive and in-depth design information, thereby better grasping the design direction and improving the quality and feasibility of their design proposals. This process also enhances design efficiency by reducing the time spent on repeated modifications and adjustments, making the entire design process smoother and more efficient.

4.2 AI-assisted Drawing Recreation

In hand-drawing teaching for landscape design, AI-assisted drawing recreation plays a significant role. Students provide AI with materials through hand-drawing, and AI then uses advanced technologies to recreate these materials, offering innovative and diverse design perspectives. Hand-drawn materials can be input into AI through descriptive text or image vectorization, providing a rich basis for creation. By analyzing these materials, AI employs techniques such as Generative Adversarial Networks (GANS) to generate new works, optimizing the style, color, and element combinations in the design. AI's recreation not only provides students with references and inspiration but also helps them understand the integration and transformation of different design elements, thereby enhancing their design capabilities and promoting the development of innovative thinking.

4.2.1 Providing Materials for AI through Hand-Drawing

Students' hand-drawn works can be provided to artificial intelligence (AI) through various means to stimulate AI's creative potential and offer innovative design inspiration for teaching. First, one method is to transform hand-drawn sketches into descriptive language for AI drawing models to understand and process. Specifically, students can describe the landscape design elements in their sketches in words, such as style (e.g., modern minimalism, European classicism, Chinese garden, etc.), main landscape elements (e.g., trees, paths, streams, pavilions, etc.), color combinations (e.g., warm-toned gardens at sunset, tranquil water features, etc.), and overall atmosphere (e.g., bustling squares, quiet courtyards, etc.). These textual descriptions provide AI with a clear design intent and help it generate design works that better meet students' expectations during the creation process.

Second, another way is to input hand-drawn sketches into the AI system after image vectorization. By using graphic processing software, hand-drawn sketches are converted into precise vector graphics, preserving key information such as lines, shapes, and colors in the image. AI can directly read these vector graphic data, combining its powerful image generation algorithms with a vast repository of landscape design cases and aesthetic knowledge, to refine and expand the sketches, creating diverse and high-quality design works. This process not only offers students possibilities in different design directions but also helps broaden their design thinking and horizons, promoting continuous iteration and innovation of design ideas.

4.2.2 Methods for AI Recreation Based on Hand-Drawn Materials

After obtaining hand-drawn materials, AI employs advanced technologies and algorithms for recreation, adding creative elements and diverse design perspectives to hand-drawing teaching in landscape design. The Generative Adversarial Network (GAN) is one of the key technologies for AI drawing recreation. A GAN consists of a generator and a discriminator, which compete with each other and continuously optimize their performance. The generator, based on the input hand-drawn materials (such as descriptive language or vector graphics), attempts to create new drawing works. The discriminator, on the other hand, is responsible for judging the similarity and quality between the generated works and real landscape design works. During the training process, the generator continuously adjusts its output to make the works as close to real landscape designs as possible, thereby gradually learning to generate more realistic and creative design works.

Figure 3 AI recreation of hand-drawn Sketch 1.

Figure 4 AI recreation of hand-drawn Sketch 2.

For instance, when AI uses GAN technology to recreate hand - drawn sketches, it can not only optimize the style, element combinations, and color matching but also create works with unique innovation, stimulating students' creative thinking. “Figure 3” shows AI's recreation of hand-drawn sketch 1, presenting an outdoor leisure space design. The design features a wooden roof supported by stone pillars, covering a spacious terrace area. The roof design is simple and complements the surrounding green environment. The terrace is furnished with yellow lounge chairs and small tables, providing a comfortable resting space. Green plants surround the area, adding a natural and harmonious atmosphere, and the light - blue sky in the background enhances the sense of openness of the space. AI uses delicate brushstrokes and watercolor effects in the work to fully express the changes in light and shadow and the texture of materials, giving the entire picture more layers and visual impact.

“Figure 4” shows AI's recreation of hand - drawn sketch 2, reflecting the integration of high - rise buildings and the natural environment. On the left side of the picture are several thick-trunked trees, next to which are grass and brick landscapes. In the lower right corner are brightly - colored flower clusters. A river runs through the picture, with a boat moored on it. There are pedestrians on the shore, shaded by green trees, and the scenery on both banks forms a beautiful natural landscape. In the distance are several modern high - rise buildings, with glass facades reflecting sunlight, showing the modernity of the city. The whole painting presents a perfect combination of nature and urban life, reflecting the concept of harmonious coexistence between humans and nature.

Through this process of recreation, AI can generate more exquisite paintings based on the original sketches, optimize color matching and light and shadow effects, and make the entire picture more vivid and artistically appealing. Such recreated works not only provide students with visual effects of different design element combinations but also inspire their thinking on design innovation. This helps them try new elements and styles in future design processes, enhancing the uniqueness and innovation of their works.

5. CONCLUSION

This study has thoroughly investigated the application of artificial intelligence in hand - drawn landscape design teaching and successfully established an innovative AI - based teaching model. By employing hand - drawn sketch segmentation and feature map acquisition techniques, the study has achieved precise analysis and feature extraction of hand - drawn sketches. This has enabled the provision of targeted feedback and guidance to students, thereby significantly enhancing their modeling abilities. Meanwhile, the AI - assisted painting recreation function has not only stimulated students' creative thinking but also provided them with a wealth of creative materials and diverse design ideas, assisting them in creating more innovative and unique landscape works.

In terms of curriculum design and practice, the integration of AI painting and art design has significantly improved teaching effectiveness. Through clear curriculum objectives and meticulously designed teaching content, combined with the application of practical teaching cases, students have made comprehensive progress in artistic cultivation, creative ability, and team collaboration. Compared with traditional teaching models, the new model is better able to meet students' individual learning needs, improve teaching efficiency and quality, and provide a new direction for the development of hand - drawn landscape design teaching.

In summary, the application of artificial intelligence in hand - drawn landscape design teaching demonstrates broad prospects and potential. Although there are still some challenges and issues at present, it is anticipated that through continuous research and exploration, more efficient and higher - quality teaching outcomes will be achieved in the future, further promoting the innovative development of landscape design education.

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