

An Initial Exploration of Digital Ink Texture Construction Methods Based on Blender Material Nodes^{*}

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This study examines the development of painting techniques of Chinese ink wash landscape paintings, pays attention to its unique brush and ink language and features of the representation of elements, and deeply analyzes the artistic characteristics of digital ink wash texture materials. The research focuses on key aspects such as the ink brushstrokes with the combination of emptiness and reality, the profound and serene ink wash space, and the extremely ingenious position layout. It proposes a construction path of digital ink wash texture materials based on the Blender material node system. This method makes use of the flexibility of the Blender material node system to successfully simulate highly realistic digital ink wash textures. It can not only construct static ink wash textures but also realize the dynamic transformation of static ink wash works through animation nodes and procedural control, thereby enhancing the artistic expression of digital ink wash works. The proposal and implementation of this method expand the application scope of the Blender material node system, help deeply explore the potential of digital ink wash art, and open up a brand new research path for constructing digital ink wash textures.

Keywords: Blender, material node, digital ink, ink textures

At the end of the 20th century, artists combined traditional Chinese ink wash art with modern digital technology, breaking through the limitations of two-dimensional planes to obtain three-dimensional or even multi-dimensional fluid ink wash art effects with unique Chinese characteristics (Liu & Li, 2024). Notably, this three-dimensional creative approach involves not only computer graphics and physical simulation but also incorporates artistic design. Various methods for constructing digital ink textures have emerged, such as adjusting and setting different ink wash rendering effects by using the light and dark attributes of the Ramp shader material in the 3D software Maya (Miao & Kong, 2024), or controlling the display range of digital ink wash texture colors through grayscale images in Unreal Engine, and then using normal maps or displacement maps to control the texture undulation effect on the model's surface.

Digital ink wash experimental animation works such as *Early Spring in Guanzhong* (Liu, 2022), *Covering One's Ears While Stealing a Bell* (Li, 2021), and *Autumn Harvest* (Xu, 2024) created by students all use UV mapping technology to map texture maps onto 3D models. Moreover, Professor He Yun from Beijing Institute of Graphic Communication developed a specialized brush used for drawing ink wash styles in Adobe Photoshop software (Ma, 2023), further advancing digital ink art.

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Some film projects, such as *Deep Sea* (2023) found that the edge of the lines in traditional ink wash paintings is full of a granular feeling, so they utilized particles systems to simulate the dynamic texture effect of ink wash (Li, 2023). In constructing three-dimensional ink wash material textures, program algorithms have also been widely adopted. One is generated by computer operations through a standard XYZ coordinate system to endow complex models with correct digital ink wash textures and improve work efficiency (Liu, 2022). Another method, developed by Professor Li Xunxiang's team, is the rendering and synthesis method of freehand ink wash mountain stone textures (Li, Hou, & Deng, 2023). This covers a complete subject conception and drawing content, providing examples or templates for digital ink wash landscape paintings. In conclusion, using material spheres in 3D software to construct digital ink wash textures is difficult to simulate delicate ink marks and brushstrokes, lacking the naturalness and randomness of traditional ink wash paintings. Also, texture mapping and particle rendering methods prolong the production cycle of works and require high-performance equipment. Although algorithm-based construction of digital ink textures is not limited by resolution and pixels and can effectively save computer hardware resources, it has high requirements for technicians and involves a high degree of technical difficulty. This paper proposes a method of constructing digital ink wash textures using Blender's material node system, offering advantages such as high efficiency, repeatability, dynamic control, and resource conservation. This approach greatly improves the efficiency of digital ink wash texture construction and expands its range of applications.

Artistic Characteristics of Techniques of Chinese Ink Wash Landscape Paintings

In ink wash landscape paintings, painters present the distance and depth of landscape levels, the emptiness and reality of depth of field, the brightness, darkness, and obscurity of the sky, and the misty clouds by controlling factors such as the intensity and dryness of ink. Brushwork is used to depict the texture of mountains and rocks, the gurgling of water, and the withered and flourishing branches, enhancing the three-dimensionality and layering of the picture. The skillful use of points, lines, and surfaces creates an ink wash space full of tension and charm. In addition, artists often use the technique of leaving blank spaces in painting, further enhancing the fluidity and artistic conception of the picture and providing viewers with rich space for imagination. These brush and ink techniques, combined with their unique artistic characteristics, jointly shape the charm of ink wash landscape paintings.

The Brush and Ink Language Composed of Brushwork, Texturing Methods, and Ink Application Methods

The brush and ink language is composed of brushwork, texturing methods, and ink application methods. As Huang Binhong once said,

If there is only an outline but no texturing method, it is called having no brushwork; if there is texturing method but without distinguishing between light and heavy, front and back, brightness and darkness, it is called having no ink. (Zhu, 2019. Source: The economy of Guangdong)

In ink wash paintings, brushwork involves variations in lightness, heaviness, speed, and thickness, creating very different visual effects and expressing the painter's different understanding of form and spirit, thus adding vividness and rhythm to ink wash works. Ink application method refers to the skills of using ink and emphasize the principle of "using ink can achieve five colors", meaning that different ink application methods can show the layers and texture of objects in ink wash paintings. Texturing method uses a brush for smearing, rubbing, and gradation, emphasizing texture and pattern to achieve the purpose of having a harmonious balance between form and spirit. Together, these three elements complement each other, forming the unique artistic language and expressive power of ink painting.

Mountains, Rocks, Water Flows, Trees, Clouds and Mists, Pavilions, Towers and Terraces, and Figures Constitute the Elements of Ink Wash Landscape Paintings

Mountains and rocks are the main (central) elements for constructing the pattern of ink wash paintings, shaping the atmosphere, and presenting the aesthetic pursuit of painters. Water, as a dynamic element, brings a sense of fluidity into the picture. Through meticulous line drawing and the interweaving of ink shades, artists vividly depict the meandering rivers and the graceful flow of water. As mentioned in *The Complete Collection of Pure Landscapes* (by Han Zhuo in the Northern Song Dynasty), “Trees are like the clothes of mountains. Without clothes, mountains lack a majestic appearance” (Chen, 2015, Source: Beauty and Times (Middle)). As an embellishing element in ink wash paintings, trees add a visual sense of layering to the overall composition. Painters use gradations of ink or the technique of leaving blank spaces to represent clouds and mists, cleverly creating a layered and three-dimensional atmosphere. When evaluating ink paintings, viewers propose that ink wash paintings are considered excellent when they are “visitable and livable”, which is why architectural elements such as towers, temples, gardens, and pavilions are incorporated into ink wash paintings. In addition, figures, as one of the most indispensable and important elements of ink wash paintings, are often sketched with just a few strokes, serving as a finishing touch that enhances the liveliness of the picture. These rich image elements with unique artistic characteristics jointly construct traditional Chinese ink wash paintings, rich in cultural connotations and possessing great artistic value.

The Ink Brushstrokes With the Combination of Emptiness and Reality, the Profound and Serene Ink Wash Space, and the Extremely Ingenious Position Layout

The start and end of ink brushstrokes play an important role in shaping the momentum of mountains and rocks, the forms of grass and trees, and the flow of clouds and water. Jing Hao (in the Five Dynasties); in his *Notes on Brushwork*, proposed that “There are four postures of a brush, namely sinew, flesh, bone, and spirit” (Zhang, 2015, Source: Research on Art Education), which emphasizes the vivid charm of ink brushwork. Besides, in the stage of making ink wash element models, designers must consider the layout of brushstrokes in ink wash works to ensure the accurate presentation of the painter’s unique brushwork techniques. Ink wash paintings, through its formal language, constructs mountains that seem approachable, grass and trees with texture, and water vapor connecting heaven and earth, full of a profound and serene sense of space. In practical applications, with the aid of virtual reality technology, viewers can place immerse themselves in the virtual ink wash space and reconstruct their senses to more intuitively perceive the expression of ink wash space pursued by painters. Xie He (in the Southern Qi and Liang Dynasties) pointed out “six principles of painting” in *An Appraisal of Ancient Paintings*, with the fifth principle being “composition and placement”. This principle covers the careful layout of spatial elements, the ingenious arrangement of structures, and the accurate reconciliation of environmental elements. In digital ink wash works, this principle is reflected through the arrangement of models, the handling of perspective relationships, and the production of materials, all of which help to create a profound sense of space, allowing the audience to experience “being in a painting and touring”.

Establishment of Three-Dimensional Models of Ink Wash Elements and Construction of Their Ink Wash Material Textures

In the process of building three-dimensional models of ink wash object elements, designers need to carefully consider the line direction of the artist’s brushwork to ensure the accuracy of the model structure and capture the

delicate characteristics of the artist's painting. Based on the structural characteristics of each element, designers can use the "UV Toolkit" in Maya to accurately handle the UV information distribution of the model and the overall outline construction of the model. Additionally, Zbrush software provides the model with a Fresnel material effect. By observing the changes in the structure of different positions before and after the model, designers can perform topological optimization and detail carving on the three-dimensional model. This paper uses the "rasterization" algorithm and proposes a construction method of digital ink wash material textures based on the principle of the Eevee rendering engine in Blender. This method offers efficient feedback and fast rendering, thereby accurately constructing more realistic and artistic digital ink wash textures.

Establishment of Three-Dimensional Model of Mountain and Rock Elements and Construction of Their Ink Wash Material Textures

The Painting of Liang in the Five Dynasties is a masterpiece of Jing Hao, a painter in the Five Dynasties. In the painting, the mountains and rocks are piled up in layers and have a thick and solid form. The designers first use Maya to create a low-poly model of the mountains and rocks to show their overall outline and volume. Subsequently, Zbrush is used for detailed sculpting to refine the overall shape and proportions of the mountain forms and rocks. In this painting, Jing Hao widely uses texturing and gradation to show the shadows, fronts and backs, and three-dimensional outlines of the mountains and rocks. The designers can adjust the details, roughness, and scaling and other parameters of the "noise texture" material node in Blender to effectively record the black-and-white information of the texture of the mountain and rock model. This process successfully constructs the texture that reflects Jing Hao's technique of using short, repetitive strokes to show the heft of the mountains. Then the "mapping" node is introduced to regulate the distribution law of ink wash texture on the structure of the mountain and rock model, so as to realize the dynamic matching of brushwork details and model structure. Additionally, the "layer weight" node can adjust the reflection effect of light on the surface of the mountain and rock model and make the texture details focus on the structural edges, thus constructing the brushstroke texture of the mountain and rock outline.

Establishment of Three-Dimensional Model of Forest Elements and Construction of Their Ink Wash Material Textures

The painter Li Cheng (in the Five Dynasties and early Song Dynasty) had extremely expressive brush and ink techniques for depicting trees. In his work *Reading the Stele and Nesting Stones*, crab-claw trees and pine and cypress trees are depicted with realistic techniques. After the designer builds the low-poly model of trees using Maya, the clay brush in Zbrush is used to finely carve the "crab-claw" shape of tree branches to show the concave-convex texture of withered trees and highlight their growth characteristics. In the painting, the use of ink employs a technique of heavy ink outlining complemented by lighter ink washes for the internal textures. Heavy ink is used for outlining, and the internal texture is gradated with light ink. First, you should add a "layer weight" node to the forest model in Blender to adjust the reflection characteristics of light on the model surface to construct the outlined texture of trees. Next, a "color gradient" node is introduced as the gray channel of the "layer weight" node, by allowing for fine-tuning of the stroke thickness in the tree's outline texture by adjusting its value. Secondly, you should endow the model with a "noise texture" node to regulate its attributes such as scaling, details, and roughness, which can construct the ink wash texturing texture on the surface of trees. Finally, you should connect the above nodes in a mixed way to the "color mix" node to complete the construction of the digital ink wash material texture of forest elements.

Establishment of Three-Dimensional Model of Tower, Temple, and Other Architectural Elements and Construction of Their Ink Wash Material Textures

When commenting on the sense of space in Guo Zhongshu's delineation paintings in *The Appraisal of Paintings From Deyu Studio* (by Li Zhi in the Northern Song Dynasty), it is said that it can make viewers achieve a visual effect of "looking into the emptiness as if one can step on it" (Huang, 2014, Source: Literary Life (Art China)). In his painting *The Emperor Minghuang Taking a Summer Retreat*, the majestic and magnificent as well as exquisitely crafted architecture is all shown. Taking the architectural corridor in the painting as the object of digital ink wash practice, the designer first uses Maya to build the geometric structure model of palace architecture, and then combines Zbrush to delicately depict the decorative patterns and detailed textures of the architecture to avoid the surface of the building walls and columns being too flat and lacking in details. When constructing the digital ink wash texture of towers, temples, and other architectural elements, it is necessary to highlight its painting characteristics of simple form, smooth lines, and elegant colors. You should add a "solidify" modifier to the long corridor column model in Blender to offset the material on the model surface and construct the outlined texture on the edge of the model. Combined with the "displacement" modifier, using procedural textures, displacement along vertex normals, local axes or vectors, you should add cloud-like textures to the outlined texture of the long column model to simulate the handmade characteristics of the corridor columns and avoid a stiff effect. This method is also applicable to constructing the outlined texture of tiles. To further enhance the model's detail, the designer connects the "noise texture" node to the "mapping" node and the "coordinate texture" node. Adjusting the node values can construct the texturing texture on the surface of tiles and make the texture distribution position consistent with the tile structure.

Establishment of Three-Dimensional Model of Cloud and Mist Elements and Construction of Their Ink Wash Material Textures

The ever-changing forms of clouds and mist in ink wash paintings are unpredictable and complement each other, enhancing the charm and elegance of landscape paintings. Clouds and mist are mostly depicted by using light ink and thick water, light ink and wet painting, and the technique of leaving blank spaces, emphasizing the artistic conception expression of the picture rather than detailed depiction. Therefore, designers can use the cloud and mist system in Blender to build three-dimensional models of clouds and mist. The Mi family is known for the distinctive "falling eggplant dot" technique, which often depicts clouds surrounding mountains, characterized by clear brushstrokes. Adding a "noise texture" node to the cloud and mist model in Blender and adjusting its scaling value can construct the corresponding brushstroke texture of the Mi family's cloud and mist dot texturing. At the same time, changing the connection method of "texture coordinates" to "object" can make the cloud and mist texture randomly distributed around the mountain. Once the construction of the digital ink wash texture of clouds and mist is completed, designers can adjust the "mapping" parameters of the "noise texture" node to animate the clouds, resulting in a natural and dynamic representation.

Establishment of Three-Dimensional Model of Water Flow Elements and Construction of Their Ink Wash Material Textures

In the Southern Song Dynasty, Li Tang was especially good at painting water, and his work *Wanhe Songfeng Tu* depicts four or five flying springs. Moving from a distance closer, there are two waterfalls hanging down from between the main peaks in the middle. The spring water passes through the rocky foot of the mountain and is connected like pearls, and the water flows surging (Li, 2015). In the painting, the texture of the waterfall is clearly

visible, and the ripples and eddies between the springs are turbulent, making it an excellent choice for digital copying. Considering the mountain structure and posture comprehensively, the designer uses Maya to establish a waterfall-shaped patch model. The water flow texture of the waterfall is constructed through “mapping” and “texture coordinates” in the “noise texture” node. The “mapping” node adjusts the density and length of the waterfall texture to simulate the brushstroke direction when the painter is painting. Endowing the “mapping” node with UV texture coordinates can control the waterfall texture lines to adjust autonomously following its shape.

Establishment of Three-Dimensional Model of Figure Elements and Construction of Their Ink Wash Material Textures

Tang Dynasty painters tried to depict the contours and expressions of figures with concise lines and ink colors, and deeply explored the inner world and spiritual outlook of figures. The collaborative work *Paintings of Tang Palace Ladies* by Tang Dynasty painters Zhang Xuan and Zhou Fang showcases the images of beautiful women in the Tang Dynasty with “a smile that enchants all who see it” (N.A., 2009, Source: Chinese place names). In the early stage of establishing the figure model, designers need to analyze the appearance, personality and behavioral characteristics of the figure from multiple angles, and accurately adjust the body proportions and the distribution of points, lines, and surfaces of the figure model in Maya to ensure the reasonable topological structure of the model. Meanwhile, Zbrush is used for high-poly carving of accessory details and clothing wrinkles. In Blender, the “texture painting” function is often used to build the overall ink wash material texture of the figure. Digital ink wash textures are given to the hair buns, sideburns, eyeballs, and eyelashes of the figure by using the transparency mapping method. For the ink-colored texture at the edge of the figure model, the outline helper plugin in Blender software is used. The plugin has a non-destructive outlining function, which can enhance the contour clarity and artistic expression of the figure model.

Conclusion

Chinese ink wash paintings carry the rich and profound traditional culture of the Chinese nation for thousands of years. During its continuation and development, traditional two-dimensional ink wash animations, as a unique art form, have produced many excellent ink wash animation works since the end of the 1950s, such as *The Cowherd*, *Little Tadpoles Looking for Their Mother*, *Feeling From Mountain and Water*, etc. However, the production technology of domestic ink wash animations is relatively demanding, the production process is relatively complex, and the investment of time and manpower is also very large. Consequently, detached from commercial factors, ink wash animations are facing an embarrassing situation of being unable to continue (Li, 2014). At the same time, with the rise of the digital age, three-dimensional ink wash animations, while inheriting the essence of traditional ink wash animations, integrate the advanced applications of digital technology, prompting traditional Chinese ink wash animations to usher in new development in the digital age. This paper proposes a customized and refined construction path of ink wash textures based on the Blender material node system. In addition, Blender’s real-time preview function enables artists to instantly view and adjust the digital ink wash texture effects, thereby significantly improving work efficiency. As a cross-platform open-source software, Blender can run on multiple operating systems, providing sharing and communication opportunities for users on different platforms, further promoting the promotion and application of digital ink wash texture construction.

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