Research on Digital Pinhole Photography and Its Application in Landscape Photography (Post-print)

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Abstract

In recent years, alongside the back-to-basics trend within the photography community, the retro/vintage aesthetic has become increasingly prevalent. Traditional pinhole photography methods are characterized by operational inconveniences and other limitations; however, the emergence and development of digital cameras have ameliorated these drawbacks, with digital single-lens reflex cameras providing new creative possibilities for the ancient technique of pinhole photography. The integration of pinhole photography with digital cameras constitutes a novel and distinctive approach that has drawn renewed attention to landscape photography. Therefore, this paper, grounded in research on digital pinhole photography, conducts an in-depth analysis of its application in landscape photography, with the aim of encouraging greater participation from photographers in discussion and research, thereby fostering the long-term development of the field of pinhole photography.

Full Text

Preamble

In recent years, a wave of retro photography has swept through the photographic community, reviving pinhole photography—an ancient technique—as a favored approach once again. However, this method demands considerable technical skill and remains relatively cumbersome to use. For ordinary photography enthusiasts to achieve ideal results requires substantial effort. The emergence and development of digital cameras have transformed these limitations, opening new possibilities for the venerable pinhole technique. In practical photographic exploration, applying digital pinhole cameras to landscape photography has yielded astonishing results. As Charlie Waite, founder of the Landscape Photographer of the Year award, observed, "The camera is an important medium that helps

people become newly aware of their surroundings." Undoubtedly, combining pinhole photography with digital cameras represents a novel and distinctive approach that draws attention to landscape photography.

Digital pinhole cameras change how people view the world, eliminating restlessness and avoiding visual clutter to create images with distinctive aesthetic qualities. Without an adjustable aperture, the pinhole camera possesses a unique and singular aperture, requiring particularly long exposure times—especially at night—to produce images. While ISO sensitivity can be adjusted, excessively high ISO settings produce artificial-looking photographs, representing an inherent limitation. Therefore, during daytime shooting, ISO is typically set to 50, while nighttime ISO may be higher but generally does not exceed 400. With the aid of a tripod and cable release, the camera is set to bulb mode for long-exposure photography.

The Museum of Modern Art in New York once collaborated with German artist Michael Wesely to photograph the city using a digital pinhole camera, superimposing 34 months of photographic content into a single breathtaking image. The "blurred" aesthetic of pinhole photography initially troubled some viewers, motivating practitioners to find a balance between "blur" and "clarity" to enhance artistic quality—a driving force for research, application, and modification of digital pinhole cameras.

2.1 Advantages of Digital Pinhole Cameras

2.1.1 Comparison with Traditional Pinhole Cameras

Traditional pinhole cameras cannot display images immediately after exposure, preventing photographers from assessing image quality until film is chemically developed in the darkroom—a complex process that offers no opportunity to correct imperfect shots. Digital pinhole cameras eliminate this problem entirely, enabling photographers to review images instantly and evaluate whether composition, lighting, or exposure duration requires adjustment. This immediate feedback allows for real-time corrections and continued shooting until satisfactory results are achieved—a significant advantage over traditional methods.

2.1.2 Comparison with Digital Cameras

As technological innovation advances, digital landscape photography has gained widespread popularity, with fewer photographers choosing film. However, all technologies should retain connections to their historical origins, which continually inspire and enhance public creativity. Digital images often suffer from overly harsh lines and somewhat rigid impressions. The fusion of digital cameras with pinhole technology creates a subtle bridge between past and present, producing images that convey softness, tranquility, and romance while stimulating imagination and enhancing overall visual impact. This aesthetic quality represents a crucial reason for selecting digital pinhole cameras.

2.2 Testing Digital Pinhole Cameras

2.2.1 Daylight Performance

During shooting, composition and lighting are first determined using a digital camera for framing and positioning—a process requiring a tripod to ensure stability. After capturing a reference image with the digital lens, the lens is removed and replaced with a pinhole attachment for long-exposure photography. In bright daylight conditions, exposures typically require 1–2 seconds.

2.2.2 Nighttime Performance

Although digital cameras can perform long-exposure photography at night, the required exposure times are several times longer than daytime equivalents, and digital noise becomes significantly more pronounced—a major drawback of nighttime long-exposure digital photography. Digital pinhole cameras effectively compensate for this disadvantage, as their inherent characteristics make them less susceptible to noise issues during extended exposures.

2.3 Application of Multi-Hole Photography Lenses

Multi-hole lenses inherit and advance the advantages of pinhole photography. They produce images that are not only soft and unique but also exhibit three-dimensional stereoscopic effects, delivering strong visual impact and approaching perfection in certain respects.

2.3.1 Application Requirements

Multi-hole digital cameras require bodies with removable lenses; fixed-lens cameras cannot be adapted. Therefore, applications must use rangefinder or SLR cameras. The process involves mounting a plastic body cap on the camera and drilling holes at appropriate positions. For effective design, calculations should follow classical formulas based on geometric optics principles. To enhance clarity and stereoscopic imaging, hole diameter should be minimized, though not so small as to cause diffraction phenomena. Optimal multi-hole design must satisfy three conditions: First, aperture size correlates positively with camera focal length (the "focal length" here refers to the distance between the multi-hole array and the imaging plane, typically only a few millimeters). Second, hole edges must be smooth and rounded to ensure optimal light transmission. Third, the area surrounding the holes must be extremely thin; excessive thickness causes light to reflect repeatedly along the transmission path, degrading image quality.

During fabrication and application, sharpness requires careful attention, as image clarity depends on hole-edge smoothness. To pursue optimal image quality, continuous adjustment is necessary, following a workflow of "hole selection—drilling—polishing—testing." Precise calculation and scientific planning precede fabrication, with testing enabling timely modifications to hole position, size,

and other parameters, thereby avoiding resource waste and improving overall multi-hole lens performance.

2.3.2 Fabrication of Multi-Hole Lenses

A series of multi-pinhole lenses were prepared, including configurations with two, three, or more pinholes arranged in triangular or parallel patterns. For instance, dual-pinhole lenses can be arranged parallel, triple-pinhole lenses in triangular formations, and larger arrays in circular configurations. When applied to digital cameras, these lenses enable the creation of incredible three-dimensional effects, while long exposures simultaneously capture both dynamic and static elements within a single frame. Since multi-hole lenses contain multiple pinholes, they simultaneously gather light from various angles, making the halos created by long exposures a distinctive visual feature.

2.3.3 Application of Multi-Hole Lenses

"Stereoscopic photography theory" describes a technique that simulates three-dimensional effects by capturing two images from different viewpoints. Through repeated experimentation, multi-hole photography has demonstrated that arranging pinholes in triangular configurations produces images with three overlapping exposures that merge into triangular formations, imparting a powerful three-dimensional effect. Additionally, multi-hole lenses offer economic advantages, saving photographers considerable expense. While achieving stereoscopic effects traditionally requires costly stereo attachments or dedicated stereo cameras, multi-hole lenses enable photographers to create and use their own three-dimensional imaging systems.

Conclusion

This study examined the application of pinhole imaging, pinhole cameras, digital pinhole cameras, multi-hole lenses, and digital multi-hole lenses in landscape photography. It first elaborated on the history, characteristics, and principles of pinhole cameras; subsequently explored the fabrication requirements, procedures, and applications of digital pinhole cameras to guide interested enthusiasts; and finally discussed applications in landscape photography, hoping to inspire broader participation and research among photographers to ensure the long-term development of pinhole photography.

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Note: Figure translations are in progress. See original paper for figures.