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The Role of Artificial Intelligence in Enhancing Realistic Image Quality

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Article

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The Role of Artificial Intelligence in Enhancing Realistic Image Quality-RMSE

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Abstract

The rapid advancement of artificial intelligence (AI) has significantly impacted the fields of digital and realistic imaging, enhancing image quality through techniques such as resolution enhancement, noise reduction, and color correction. Despite these developments, the application of AI in improving real-world image quality remains relatively limited. This study explores various AI-based websites and platforms specialized in enhancing realistic images, with a focus on images of the Neom Stadium in Saudi Arabia, the venue for the 2034 FIFA World Cup. Through qualitative analysis including expert interviews and thematic exploration, the study identifies strengths, weaknesses, and opportunities in current AI-driven image enhancement tools. The findings offer valuable insights into how AI technologies are shaping the future of image design and quality improvement in real-world contexts.

Keywords

Artificial Intelligence, Image Enhancement, Realistic Imaging, Neom Stadium , AI Tools, Image Quality, Digital Imaging.

1. Introduction

The image plays a vital role in human visual communication, serving as a key tool to convey information, evoke emotions, and capture the viewer's attention. Image quality depends on factors such as resolution, sharpness, color accuracy, and composition. Clear and detailed images communicate messages more effectively.

Thanks to advancements in artificial intelligence, image quality has improved significantly, with AI helping to increase resolution, reduce noise, and correct color and focus issues. This has made images more realistic and engaging, which is important in fields such as advertising, education, healthcare, and design. Meeting high-quality standards is essential for an image to have the desired impact and connect effectively with its audience. Experimental results validate that the implemented objective image quality metrics quantitatively assess the lightness fidelity and color constancy robustness of the evaluated images (1).

2. Realistic Image QualityRMSE

According to prior research, objective image quality metrics such as RMSE, PSNR, and the universal Q metric can effectively evaluate lightness and color constancy, provided that images captured under standardized lighting conditions (e.g., D65) are used as references [1]. The objective of Image Sharpness Assessment (ISA) is to quantify the degree of blurriness that degrades perceived image quality [2]. To ensure an optimal Quality of Experience (QoE) for end users, image quality must be assessed in a manner that is both efficient and reliable [3]. In this context, it is essential for analysts to distinguish between zoomed-in images and those blurred through Gaussian filtering, as the former often exhibit excessive sharpness and undesirable artifacts [4]. The development and calibration of denoising algorithms are generally based on standard test images that have been artificially degraded with additive white Gaussian noise (AWGN) to simulate real-world noise conditions [5]. Figure 1 illustrates the distinct visual characteristics between zoomed-in images and those subjected to Gaussian blurring. The zoomed-in image (left) reveals pronounced pixelation and exaggerated edge sharpness, which introduce visible artifacts and compromise the integrity of fine details. In contrast, the Gaussian-blurred image (right) demonstrates smooth tonal transitions and a reduction in high-frequency content, resulting in softened edges and effective noise suppression. This distinction is critical in image quality assessment, as each type of degradation impacts perceptual sharpness and artifact presence differently, necessitating tailored evaluation approaches "Image source: Generated using ChatGPT’s AI-based image synthesis tool".



Figure1.image was generated using an AI-based image synthesis tool

Image quality is a pivotal factor in medical image analysis, directly influencing the accuracy of diagnostic outcomes. High-resolution, sharp images provide the necessary detail for precise diagnosis; however, obtaining such images frequently requires advanced and expensive imaging technologies[6]. Amidst the swift evolution of digital imaging technologies and the soaring popularity of high-resolution displays, there emerges an ever-growing demand for blind image quality assessment (BIQA) models tailored to high-definition images. Yet, despite these advances, challenges persist[7].. Figure 2 illustrates the difference in visual quality between high-resolution (1920 × 1080 pixels) and low-resolution (640 × 480 pixels) images of a European robin (Erithacus rubecula).The high-resolution image on the left reveals fine feather details and sharp facial features, while the low-resolution image on the right shows significant pixelation and loss of detail. This comparison emphasizes the importance of image resolution in capturing and analyzing avian morphology "Images generated using artificial intelligence".



Figure 2. Comparison between high-resolution and low-resolution images

Enhancing contrast is an essential image processing method used to increase the clarity and distinguishability of histopathology images, which play a vital role in medical diagnosis [8] .These images often contain complex tissue structures and subtle variations in staining that can make it difficult to identify pathological features. By applying contrast enhancement techniques, important cellular details such as nuclei, cytoplasm, and tissue boundaries become more pronounced, improving both visual assessment by pathologists and the accuracy of automated diagnostic systems. As demonstrated in Figure 3, contrast enhancement significantly improves the differentiation of tissue components, thereby facilitating more reliable and precise diagnosis.

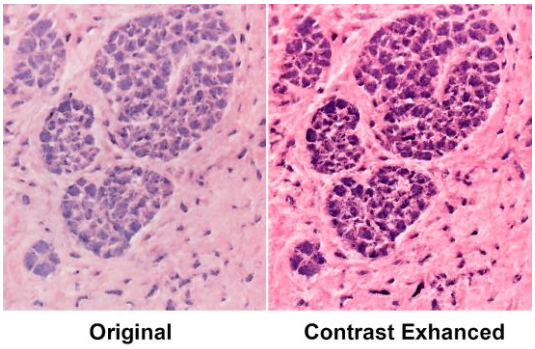


Figure 3. Image generated using artificial intelligence-based image synthesis tools.

Color accuracy is the extent to which a reproduced color resembles the original or intended color, as seen by the human eye or verified through standardized measurement methods. Color accuracy plays a crucial role in many industries, such as biomedical science, cosmetics, and multimedia production[9]. Pixel brightness in images indicates

the level of light intensity, serving as a crucial element that impacts the sharpness of the image and the precision of later data analysis [10]. Figure 4 clearly demonstrates the effect of brightness by splitting the scene into two halves. The right side represents daylight with high brightness, resulting in vivid colors and sharp details of the building, road, and trees. In contrast, the left side depicts nighttime with significantly lower brightness, causing darker colors and less visible details due to reduced lighting. This contrast highlights the crucial role of brightness in determining visual clarity and image quality. Figure 5 displays noise, which refers to random and irregular variations in pixel values that introduce unwanted distortions, making the image appear grainy, speckled, or blurred.

The overall brightness is often measured as the mean (average) of all pixel values in the grayscale image:

$$\text{Brightness} = \frac{1}{N}\sum_{i=1}^{N} I_i \quad (1)$$



Figure4. brightness

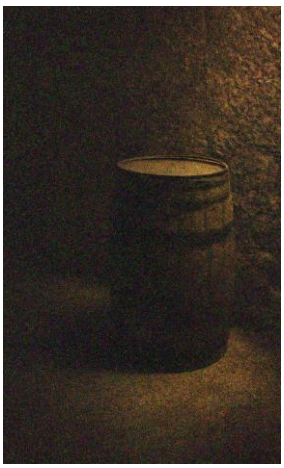


Figure 5. Image Noise

Focus is the process by which an optical system adjusts to make certain parts of a scene appear sharp and clear in an image. When focus is directed at an object in the foreground, elements located in the background tend to lose sharpness and appear blurred. Conversely, focusing on background objects causes the foreground to become indistinct [11]. This inverse relationship

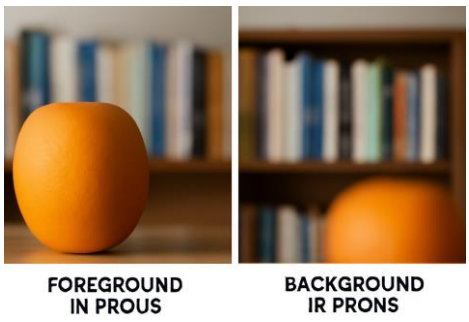


Figure 6. Focus

between the clarity of foreground and background arises from how lenses manage light and focus points. Photographers and visual artists

often use this effect deliberately to draw attention to a subject or to provide a perception of depth. Similarly, in scientific fields like microscopy, controlling focus is essential to isolate and examine specific layers or structures within a specimen (Figure 6). The role of image composition in classifying image aesthetics is investigated, Low-level features based on traditional photography principles, such as simplicity and the golden mean, are proposed to build a classifier, When tested on a baseline dataset, near state-of-the-art accuracy is achieved, highlighting the importance of composition in aesthetic assessment[12]. Digital image processing can be challenging due to the wide variety of image file formats available. Each format has its own features, advantages, and limitations, which can complicate tasks such as storage, retrieval, analysis, and sharing across different platforms[13]. Therefore, a solid understanding of these formats is essential for effective image management and accurate interpretation across diverse applications.

Table 1. image quality standards

Standard	Description
Resolution	Number of pixels (width × height). Higher resolution means clearer, more detailed images.
Sharpness	Clarity and definition of details; sharp images have distinct edges and minimal blur.
Contrast	Difference between light and dark areas; good contrast makes images vivid and highlights details.
Color Accuracy	How true and natural the colors appear; colors should be balanced, not washed out or oversaturated. Color accuracy is the extent to which a reproduced color resembles the original or intended color, as seen by the human eye or verified through standardized measurement methods.
Brightness	Amount of light in the image; proper brightness reveals details without being too dark or bright.
Noise	Unwanted grain or speckles, often in low light; high-quality images have minimal noise.
Focus	The main subject is in clear focus, standing out sharply from the background.
Composition	Arrangement of elements to achieve visual balance and appeal.
File Size & Format	File size affects quality during storage or transfer; PNG retains quality, JPEG compresses and may reduce it.

3. Popular AI Design Software: Enhancing Creativity and Efficiency

The rapid advancement of Artificial Intelligence (AI) has significantly influenced various creative fields, particularly design. AI integration within design software tools has revolutionized how designers work by streamlining repetitive processes, boosting creative potential, and increasing overall efficiency. This paper reviews some of the leading AI-based design applications that are currently shaping the landscape of graphic and multimedia design.

Adobe Sensei

Adobe Sensei serves as the AI backbone for Adobe's Creative Cloud products. It enhances creative workflows by automating time-consuming tasks such as image editing, tagging, and content analysis. By intelligently handling technical details, it allows designers to dedicate more time to artistic innovation.

Canva with AI Features

Canva is a popular online platform designed for users of all skill levels to create visual content. Its AI functionalities include smart layout recommendations,

background removal tools, and text suggestions, all aimed at simplifying the design process while maintaining high-quality outputs.

Runway ML
Runway ML provides artists and creators access to a suite of machine learning models tailored for creative projects. Users can experiment with image synthesis, style transfers, and even live video manipulation, enabling new forms of artistic expression fueled by AI.

DALL·E by OpenAI
DALL·E is a generative AI system that transforms written descriptions into original images. This tool empowers users to create imaginative visuals by simply inputting descriptive text, thereby expanding the creative possibilities beyond traditional methods.

DeepArt
DeepArt employs AI algorithms to convert regular photos into artwork inspired by famous painters' styles. This platform leverages style transfer technology to blend photography with classical art aesthetics, offering users a unique artistic transformation.

Fotor (AI Image Generator)
Fotor utilizes AI to assist users in editing and generating images efficiently. Features like automatic enhancement, retouching, and creative filters make it a valuable resource for both novices and professionals seeking quick and effective image improvements.

Artbreeder
Artbreeder allows the fusion of multiple images using AI, creating novel and often unexpected results. By adjusting specific image parameters, users can explore a wide range of creative variations, making it a powerful tool for innovation and artistic exploration.

Let's Enhance
Let's Enhance focuses on improving image resolution and quality through AI algorithms. It is especially useful for upscaling images while preserving fine details, addressing a frequent challenge faced by digital designers.

4. Impact and Future Prospects

AI design tools have transformed creative workflows by offloading technical and repetitive tasks, thus enhancing both productivity and creative freedom. These technologies also enable the generation of complex and unique designs that might be challenging to create manually. Nonetheless, challenges such as ethical considerations, bias in AI models, and the balance between automation and human creativity persist.

Looking ahead, AI design software is expected to become more seamless and personalized, fostering enhanced collaboration between humans and machines.

Innovations may include more intuitive interfaces, real-time AI-assisted design adjustments, and deeper customization options to suit individual artistic needs.

The incorporation of AI in design software represents a significant evolution in creative industries. Tools like Adobe Sensei, DALL·E, and Runway ML illustrate how AI can augment creativity and streamline design processes. As AI continues to mature, it will increasingly influence how designers conceive and realize their work, opening new horizons for artistic innovation.

5. Methodology

This study aims to investigate and evaluate image design using artificial intelligence techniques available through popular specialized websites in this field. An organized methodology was followed to ensure accuracy and comprehensiveness of the results, including the following steps.

Initial Data Collection

A preliminary online search was conducted using search engines and specialized websites for AI-based image design, such as DALL·E, Midjourney, and Stable Diffusion. The tools, features, and operational mechanisms of each site were documented.

Analysis and Comparison of Websites

The websites were evaluated based on specific criteria including Service Type, Strengths ,Weaknesses and Main Uses.

Qualitative Analysis

This study employed a qualitative approach through in-depth, semi-structured interviews with 13 professional graphic designers. The purpose of these interviews was to explore their perspectives, experiences, and insights concerning the use of artificial intelligence tools in image design and enhancement.

The data gathered from the interviews were carefully transcribed and thematically analyzed. This analysis aimed to identify common patterns, challenges faced, and opportunities presented by AI-driven design processes. The findings provide valuable understanding of how AI technologies are influencing modern

graphic design workflows. Table 2 presents a summary of the interviews conducted with the designers, highlighting the key findings from each interview.

Although artificial intelligence has quickly advanced in digital and realistic imaging, its use in enhancing real-world images is still somewhat limited. Table X lists several websites and platforms that specialize in improving images of the Neom Stadium in Saudi Arabia Figure 1, which will host the 2034 FIFA World Cup.



Figure 7. Neom Stadium in Saudi Arabia

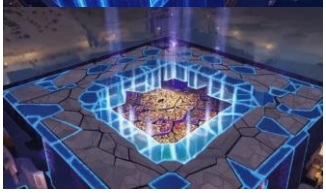
Table 2. summary of the interviews

Company	Service Type	Strengths	Weaknesses	Main Uses
Grok3	AI platform	High capability for deep image understanding and complex visual content analysis and fast	Relatively new platform, may need time for full adoption	Image analysis, image classification, precise information extraction
Adobe Firefly	AI-powered image enhancement and editing	Fully integrated with Adobe products, advanced AI for image editing	requires expertis	Image editing, quality enhancement, defect removal
Canva	Simple design with AI tools	Easy to use, ready-made templates, basic automatic enhancement	Limited AI capabilities compared to professionals	Quick marketing and social content design
RunwayML	Creative open-source AI tools	Wide support for advanced models, video and image editing capabilities	Requires some programming knowledge	
DALL·E (OpenAI)	Text-to-image generation	Creative high-quality image generation from text prompts, highly flexible	Limited precise control, some images unrealistic	Artistic image generation, fast creative content
NVIDIA Canvas	Sketch to realistic image tool	Converts simple sketches into highly realistic images	Requires high-performance hardware	Background and natural scene design
Topaz Labs	Image enhancement (upscaling, denoising)	Excellent image quality improvement while preserving details	Does not create images from scratch	Image upscaling and cleaning
pixlr	Generate editor / graphic design	Limited vector editing	Performance can lag with large files	Quick photo editing and retouching

The original image presents a solid conceptual design, but certain areas lack sharpness and clarity. In contrast, the AI-enhanced images show a noticeable improvement in various aspects, such as detail clarity, color vibrancy, and edge definition. While each AI tool provides slightly different enhancements, the overall outcome is a much sharper and more visually appealing image. Over the last few decades, artificial intelligence (AI) has advanced significantly, driven by key breakthroughs in machine learning and the growing availability of big data and computational power (14). Image captioning is applied in various fields, including automated script generation, medical image tagging, and news reporting. However, producing an accurate description that highlights specific regions of an image is a challenging task when using deep learning techniques (15).Background lighting plays a crucial role in the degradation process, greatly impacting the quality of enhanced

images (16).). Ultimately, The growing ubiquity of generative AI in academia necessitates a comprehensive analysis of student engagement patterns to ensure an ethical and effective transition. (17).

Table 3. Enhancing image quality using A I

Company	After enhancing image quality using A I	AI-Enhanced Images	Original Image	Aspect
chatgpt		Improved resolution and clarity	Moderate resolution, slight blur	Image Quality
grok		Details more distinct and sharper	Some details in the center are unclear	Detail Visibility
runwayml		Colors are brighter and better contrasted	Colors are somewhat muted	Color and Contrast
.firefly.adobe		Edges are cleaner and more defined	Edges appear rough and cracked	Is not related Structural Integrity
pixlr		Enhanced images look professional and refined	The image looks less polished	Overall Impression

6. Recommendations

1. **Enhance Accessibility and User-Friendliness of AI Tools**
   To promote broader adoption among professionals and amateurs alike, AI-based image enhancement platforms should prioritize intuitive user interfaces and streamlined workflows. Simplifying complex AI functions will enable more users to benefit from advanced imaging capabilities without requiring deep technical expertise.
2. **Focus on Real-World Image Enhancement**
   Given the current limited application of AI in enhancing real-world photographs, future research and development should concentrate on algorithms specifically tailored to address natural lighting variations, noise, and texture preservation in realistic settings, such as architectural and environmental photography.
3. **Promote Integration with Existing Design Workflows**
   AI image enhancement tools should be designed to integrate seamlessly with popular graphic design software and creative platforms (e.g., Adobe Creative Cloud, Canva). This integration will help professionals incorporate AI enhancements into their existing workflows, increasing productivity and creative flexibility.
4. **Address Ethical and Quality Control Concerns**
   Developers and users should establish clear guidelines to ensure the ethical use of AI in image processing, including transparency about AI modifications and preventing over-reliance that may compromise image authenticity. Additionally, standardized benchmarks and quality metrics should be adopted to assess AI-generated enhancements objectively.
5. **Encourage Collaborative Research and Cross-Disciplinary Innovation**
   Collaboration between AI developers, graphic designers, photographers, and domain experts (such as medical imaging specialists) can foster the development of more robust, context-aware AI models. Such interdisciplinary efforts can accelerate innovation and ensure AI tools meet the practical needs of diverse applications.
6. **Support Continuous Training and Education**
   To maximize the benefits of AI in image enhancement, educational programs and workshops should be developed to train designers and photographers on effectively utilizing AI tools, understanding their capabilities, and recognizing their limitations.

7. Ethical Compliance and Participant Protection

The methodology employed in this study strictly adheres to the ethical standards for research involving human subjects. We confirm that all methods were carried out in accordance with relevant institutional guidelines and regulations. The experimental protocols and interview procedures were approved by the Research Ethics Committee at the University of Bisha. Furthermore, we confirm that informed consent was obtained from all 13 professional graphic designers prior to their participation in the semi-structured interviews and thematic analysis.

8. Ethical Approval and Participant Consent

The author confirm that all methods were carried out in accordance with relevant guidelines and regulations. All experimental protocols involving human participants in this study were reviewed and approved by the Research Ethics Committee at the University of Bisha. Furthermore, the authors confirm that informed consent was obtained from all subjects (the 13 professional graphic designers) prior to their participation in the semi-structured interviews and qualitative analysis. These protocols were designed to ensure the systematic and ethical collection of data while strictly protecting participant confidentiality and research integrity.

9. Analysis of Current Limitations and Challenges

The integration of Artificial Intelligence (AI) into image enhancement workflows, while transformative, faces multifaceted challenges categorized into technological, methodological, and ethical dimensions.

9.1. Technological and Operational Constraints

- **Limited Real-World Efficacy:** Despite significant progress in digital processing, the deployment of AI for enhancing authentic, real-world photography remains restricted.
- **Environmental Sensitivity:** Current AI models frequently exhibit volatility when processing natural lighting fluctuations, stochastic noise, and the preservation of intricate textures in realistic environments.
- **Infrastructure Barriers:** Advanced synthesis tools often necessitate high-performance computational hardware, creating a digital divide in accessibility.
- **Precision and Control Deficits:** Generative models often lack granular user control, occasionally producing artifacts or outputs that lack physical realism.
- **Interoperability Issues:** The proliferation of diverse image file formats continues to complicate standardized storage, retrieval, and cross-platform analytical consistency.

9.2. Methodological and Human-Centric Factors

- **Scope of Qualitative Data:** The empirical insights of this study are grounded in a specialized cohort of 13 professional designers, which may influence the universality of the thematic findings.
- **Creative Autonomy:** A critical tension persists in maintaining an equilibrium between algorithmic automation and the preservation of human creative agency.
- **Technical Literacy Gaps:** The barrier to entry remains high for many professional-grade platforms, requiring either deep domain expertise or rudimentary programming knowledge.

9.3. Ethical and Systematic Barriers

- **Algorithmic Bias and Ethics:** Significant concerns remain regarding inherent biases in training datasets and the broader ethical implications of automated image synthesis.
- **Authenticity Risks:** The potential for over-reliance on AI-driven enhancement poses a documented threat to the ontological authenticity of the original visual record.
- **Lack of Evaluative Standardization:** The field currently lacks a unified framework of objective benchmarks and standardized quality metrics necessary for the rigorous assessment of AI-mediated improvements

10. Summary

This paper examines the role of artificial intelligence in improving the quality of realistic images, highlighting the progress made in digital image processing techniques such as super-resolution, denoising, and color accuracy. It addresses the current limitations of AI applications in real-world image enhancement and reviews several specialized online platforms that provide these services. The Neom Stadium in Saudi Arabia, scheduled to host the 2034 FIFA World Cup, serves as a case study to demonstrate practical applications of AI-enhanced imaging. The study incorporates qualitative data from interviews with professional graphic designers to assess how AI tools influence contemporary design workflows and identifies the potential for further innovation and adoption in this field.

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Disclosure statement

No potential conflict of interest was reported by the author.

Availability of data and material

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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