

Research Article

Analysis of Digital Image Quality Between Conventional Design Outputs and Generative Artificial Intelligence Images Using Digital Image Processing Methods

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Abstract: Recent developments in Artificial Intelligence (AI) have introduced innovative approaches to digital image production, enabling automated image generation from text-based instructions. The increasing adoption of AI image generation tools has created a need for objective methods to evaluate the quality of their outputs in comparison with images produced through conventional design techniques. This research investigates the visual quality differences between AI-generated images and images created using traditional graphic design software. An experimental quantitative method was applied by analyzing image pairs that shared identical resolutions and file formats. Image quality evaluation was performed using the Mean Squared Error (MSE) metric, which quantifies pixel-level discrepancies between two images. The experimental results demonstrate that MSE can effectively identify variations in image characteristics and similarity. Lower MSE values indicate a closer correspondence between compared images, whereas higher values reflect more substantial deviations in pixel composition. The findings highlight the applicability of MSE as a quantitative tool for image quality assessment and provide additional insight into the performance of AI-based image generation technologies within digital image processing applications.

Keywords: Artificial Intelligence; Digital Image Processing; Generative AI; Image Quality Evaluation; Mean Squared Error.

1. Introduction

The growing adoption of Artificial Intelligence (AI) has reshaped the way digital visual content is created and distributed. Among its most notable applications is the development of generative image systems capable of transforming textual instructions into visual representations. Advances in deep learning architectures and large-scale training datasets have enabled AI platforms to generate images with increasing levels of detail, realism, and creativity, making them attractive tools for various design and multimedia applications.

Despite these technological developments, conventional graphic design software such as CorelDRAW and Adobe Photoshop continues to play an essential role in professional design workflows. These applications allow users to directly manipulate visual elements and maintain full control over composition, color adjustment, and object placement. As a result, images produced through conventional design processes often reflect deliberate artistic decisions and structured editing techniques.

The rapid expansion of AI-generated imagery has raised questions regarding the visual characteristics and quality of machine-generated outputs when compared with traditionally designed images. Evaluating these differences requires a quantitative approach capable of examining image characteristics beyond subjective human perception. Digital image processing provides several techniques for assessing image quality through numerical analysis of pixel information.

Among the available evaluation methods, Mean Squared Error (MSE) is frequently employed to quantify differences between two images by measuring pixel-level deviations. The metric offers a straightforward means of determining image similarity, where smaller values indicate greater correspondence and larger values signify more pronounced differences. Therefore, this study applies the MSE method to investigate and compare the

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quality of images produced by conventional design software and AI-based image generation systems.

2. Research Methodology

This study employed a quantitative experimental approach to compare the quality of digital images produced by conventional design software and AI-based image generators. The image dataset consisted of digital images standardized to the same format and resolution to ensure consistent evaluation. Image quality was assessed using the Mean Squared Error (MSE) method, which measures the average squared difference between corresponding pixel values of two images. Lower MSE values indicate higher similarity, while higher values represent greater differences in image quality [6].

Research Approach

This study uses a quantitative experimental approach. The quantitative approach is applied because the research data consists of numerical values obtained from digital image pixel calculations. The experimental method is used to compare image quality generated by two different image creation techniques.

Research Objects

The research objects consist of two groups of digital images:

- Images produced using conventional graphic design software, specifically CorelDRAW.
- Images generated using AI image generation tools such as DALL·E, Midjourney, and Stable Diffusion.

All images are stored in PNG or JPG format with identical resolution to ensure accurate comparison results.

Data Collection Technique

The data collection process is carried out through the following steps:

- Creating digital images using conventional graphic design software.
- Generating images using AI image generators based on the same prompt.
- Standardizing image size and resolution.
- Saving all images in identical image formats.

Mean Squared Error (MSE) Method

The Mean Squared Error (MSE) method is used to calculate the average squared difference between two digital images based on RGB pixel values [2]. The MSE formula is expressed as follows:

$$MSE = \frac{1}{m \times n} \sum_{i=1}^m \sum_{j=1}^n (I(i, j) - K(i, j))^2$$

Where:

- $m \times n$ = image dimensions (width \times height)
- $I(i, j)$ = pixel value of the first image
- $K(i, j)$ = pixel value of the second image

A smaller MSE value indicates a higher level of similarity between the two images, while a larger MSE value indicates greater differences in pixel values and lower similarity.

Data Analysis Technique

The data analysis process in this study consists of the following steps:

- Extracting RGB pixel values from each image.
- Calculating the differences between pixel values of the compared images.
- Computing the Mean Squared Error (MSE) value based on the pixel differences.
- Analyzing the level of image similarity based on the resulting MSE values.

3. Results and Discussion

The results indicate that lighting conditions and object characteristics influence the MSE values. The lowest MSE values were obtained under lighting levels of 500–600 lux, indicating a high degree of image similarity. In contrast, higher MSE values reflected more significant visual differences between conventionally designed images and AI-generated images.

Image Testing Results

The testing was conducted by comparing images generated using conventional design methods and AI image generation tools based on the Mean Squared Error (MSE) parameter [2] [7]. The evaluation was performed under various lighting conditions and object detail variations.

Table 1. MSE Testing Results.

No	MSE Value	Lighting (lux)	Result
1	0.0148	500	Very Similar
2	0.0234	200	Fairly Good
3	0.0456	800	Needs Improvement
4	0.0567	500	Not Similar
5	0.0198	600	Very Similar



Figure 1. Comparison of Template and AI Results.

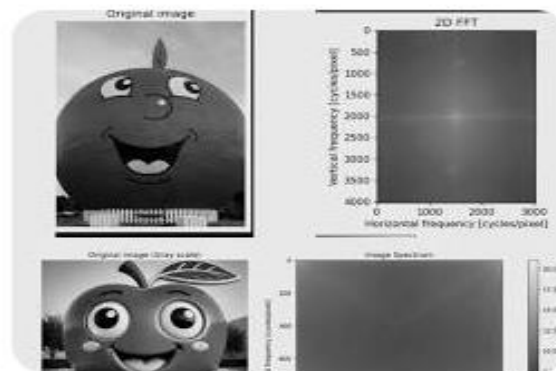


Figure 2. Comparison of Template and AI Results.

Based on the results, lighting conditions significantly affect the similarity level of digital images. The lowest MSE values were obtained at lighting levels between 500–600 lux, indicating higher similarity between images. In contrast, higher MSE values occurred under overly bright or low lighting conditions, which reduced image similarity.

Image Quality Analysis

The results of this study indicate that the Mean Squared Error (MSE) method is capable of objectively identifying differences in digital image quality [1] [2]. Images produced using conventional design methods exhibit more stable pixel structures because they are directly controlled by the designer.

Meanwhile, images generated using AI image generation tools show more complex visual variations, which result in higher pixel value differences in several tests. This condition leads to increased MSE values when compared to conventionally designed images. In addition, the MSE method is effective for measuring overall (global) similarity between images [6]. However, this method has limitations, as it cannot indicate the specific location of visual differences within an image.

Image Processing Implementation

The MSE calculation process is implemented by comparing the RGB values of each pixel in the images (Hasan, 2025; Iskandar, 2023).

An example of the implementation code is as follows:

```
val r1 = (pixels1[i] shr 16) and 0xFF
val g1 = (pixels1[i] shr 8) and 0xFF
val b1 = pixels1[i] and 0xFF
```

```

val r2 = (pixels2[i] shr 16) and 0xFF
val g2 = (pixels2[i] shr 8) and 0xFF
val b2 = pixels2[i] and 0xFF
    
```

```

sum += (r1 - r2) * (r1 - r2) +
      (g1 - g2) * (g1 - g2) +
      (b1 - b2) * (b1 - b2)
    
```

The code above is used to calculate the differences in the red, green, and blue color channels for each pixel in the images. The squared differences are then accumulated to compute the overall Mean Squared Error (MSE) value between the two images.



Figure 3. RGB 100.

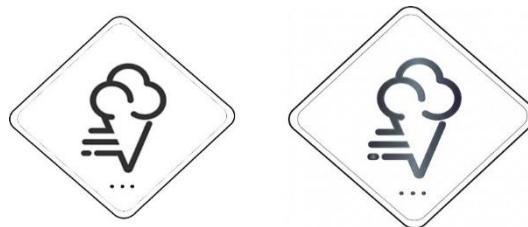


Figure 4. RGB 50.



Figure 5. RGB 200.



Figure 6. RGB 180.



Figure 7. RGB 160.



Figure 8. RGB 198.

4. Conclusion

The MSE method proved effective in objectively measuring the similarity of digital images. The results indicate that conventionally designed images exhibit more stable pixel structures, while AI-generated images tend to show greater visual variation. Future studies are recommended to incorporate additional metrics, such as Structural Similarity Index (SSIM) and Peak Signal-to-Noise Ratio (PSNR), to provide a more comprehensive evaluation of image qual.

The results show that the MSE method is able to provide an objective measurement of the similarity and differences in digital image quality based on pixel values. A lower MSE value indicates a higher level of image similarity, while a higher value indicates greater differences in image structure.

This research contributes to the development of digital image processing and the evaluation of image quality in the context of Artificial Intelligence [2] [6]. For future research, it is recommended to incorporate additional evaluation methods such as the Structural Similarity Index (SSIM) and Peak Signal to Noise Ratio (PSNR) to achieve a more comprehensive analysis of image quality.

Author Contributions: Danang Prisma Ramawan¹ contributed to the comparative analysis of digital image quality between conventional design application images and generative artificial intelligence images based on digital image processing. Akhmad Fadjeri² supervised the research process, developed the research methodology, and conducted technical validation and evaluation of the system.

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