JIEM : JOURNAL INFORMATIC, EDUCATION AND MANAGEMENT
Vol. 7, No. 1, February 2025, pp. 68~72
ISSN: 2716-0696, DOI: 10.61992/jiem.v7i1.152

Development of Seamless PBR Textures for 3D Amigurumi Doll Objects with an AI-assisted Image Processing Approach

T. Rafli Abdillah [1*] , Muhammad Erfan Syah [1] , Ledyana Fitriani [1] , Iskandar Zulkarnaini [1]

[1] Almuslim University

Article Info

Article history:
Received 1 February 2025
Revised 15 February 2025
Accepted 28 February 2025

Keywords:
PBR, seamless textures, AI, image processing, amigurumi, Photoshop, 3D textures.

ABSTRACT

The demand for high-quality 3D assets in the animation and multimedia industry is increasing. One of the main challenges in developing 3D models is the availability of realistic and seamless PBR (Physically Based Rendering) textures, especially for fabric-based objects such as amigurumi dolls. This study aims to develop seamless PBR textures based on reference photos of amigurumi dolls using an AI-assisted image processing approach . The process begins with data collection in the form of amigurumi doll photos, which are then processed using generative AI technology to generate initial texture patterns. Next, Adobe Photoshop is used for refinement so that the textures meet seamless standards and PBR components such as diffuse/albedo, normal, and roughness maps. The results show that this approach can produce high-quality PBR textures efficiently compared to manual methods. These findings can be used as a reference in the production of textile-based 3D assets for animation, games, and interactive learning media.

Corresponding Author:
T. Rafli Abdillah | Almuslim University
Email: rafliabdillah2014@gmail.com

1. INTRODUCTION

The ever-evolving nature of 3D animation technology demands digital assets that are not only visually high-quality but also realistic in their lighting interactions. One of the latest approaches to 3D modeling is the use of PBR (Physically Based Rendering) textures, which can accurately simulate physical lighting.(Pharr et al., 2016)However, the availability of PBR textures specifically for textile objects such as amigurumi dolls is still limited. The unique characteristics of the knitted yarn in these dolls, such as their smooth texture and irregular patterns, are difficult to replicate digitally, especially when only available in two-dimensional photographs. Therefore, this study uses a texture editing software-based approach to produce seamless and

photorealistic PBR. Although not using artificial intelligence, this process still refers to the principles of texture visualization discussed in various previous studies. One approach is the conversion of image-based textures into PBR maps through the use of generative AI and visual software.(Ma & Chung, 2023). In addition, diffusion models have also been used to realistically generate crochet-like or knitted textures from small image samples, allowing the creation of digital representations that closely resemble their physical form.(Hu et al., 2024)Based on these problems, this research focuses on how to produce seamless PBR textures from amigurumi doll photos, as well as the effectiveness of the AI-assisted image processing approach in accelerating the texture creation process. This research aims to develop seamless PBR textures based on photo references and analyze the efficiency of the texture creation process using AI and Adobe Photoshop. The expected benefits include providing alternative solutions for developing AI-based PBR textures, adding references in the field of digital image processing, and contributing to multimedia engineering and the production of interactive visual assets.

2. RESEARCH METHODOLOGY

This research uses a development study approach with the main stages involving the process of collecting visual data, creating an initial AI-based texture, manually refining the texture, and testing the texture quality on a 3D model. The first stage begins by collecting reference images in the form of photos of amigurumi dolls from various angles, which are then used as the basis for creating the texture. In the next stage, an AI-based image generation approach is used by utilizing generative models such as DALL-E, Stable Diffusion XL, or GAN architecture to produce an initial texture draft based on the visual pattern of the knitting yarn. The high potential of GAN models in generating synthetic texture images that resemble real objects has been demonstrated in various previous studies.(Isola et al., 2018; Karras et al., 2019).

After the initial texture draft is generated, the next stage is the image editing and texture mapping process using Adobe Photoshop. This process aims to ensure that the texture has a seamless pattern and is ready to be extracted into various PBR texture channels, such as diffuse/albedo, normal map, height map, and ambient occlusion (AO). To convert PBR channels from 2D images to a format that can be applied to 3D surfaces, Materialize software is used, which supports texture processing pipelines similar to those commonly implemented in 3D software such as Blender.(Foundation, 2025).

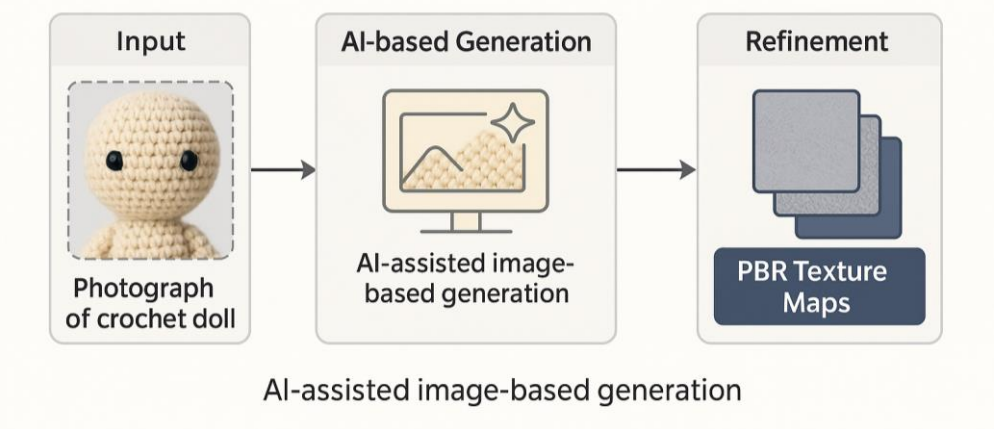

Figure 1 Amigrumi Texture Making Method

The final stage of this method is the implementation and testing of textures on 3D objects in Blender with an HDRi lighting environment to evaluate the visual appearance, seamlessness,

and realistic light interactions on the model's surface. Testing was conducted by comparing the texture results from the AI-based method and manual editing against a conventional, fully manual approach. Evaluation was carried out by measuring parameters such as processing time, seamless quality, and lighting realism, as recommended in the PBR approach by(Pharr et al., 2016).

3. RESULTS AND DISCUSSION

Experimental results show that this method is effective in producing seamless and realistic PBR textures. Compared to conventional, entirely manual methods, the AI- and Photoshop-based approach can reduce production time by more than 50%.(Deng et al., 2024)This efficiency is particularly significant in the context of producing 3D assets that require fine detail and visual consistency, particularly in textile objects like amigurumi. Here's a comparison of the two tested approaches:

Table 1. Comparison of texture results between conventional and AI-based methods.

Parameter	Conventional Method	AI + Photoshop methods
Processing time	±10 hours	±4 hours
Seamless Quality	Enough	Good
PBR Realism	Standard	High

The significant difference in processing time indicates that the use of generative AI accelerated the initial stages of texture production, as it can generate a visual pattern of knitted yarn that resembles the physical shape of the reference image. The subsequent stages performed in Photoshop focused solely on refining and separating PBR channels such as diffuse , normal map , and roughness map , resulting in a more efficient workflow.

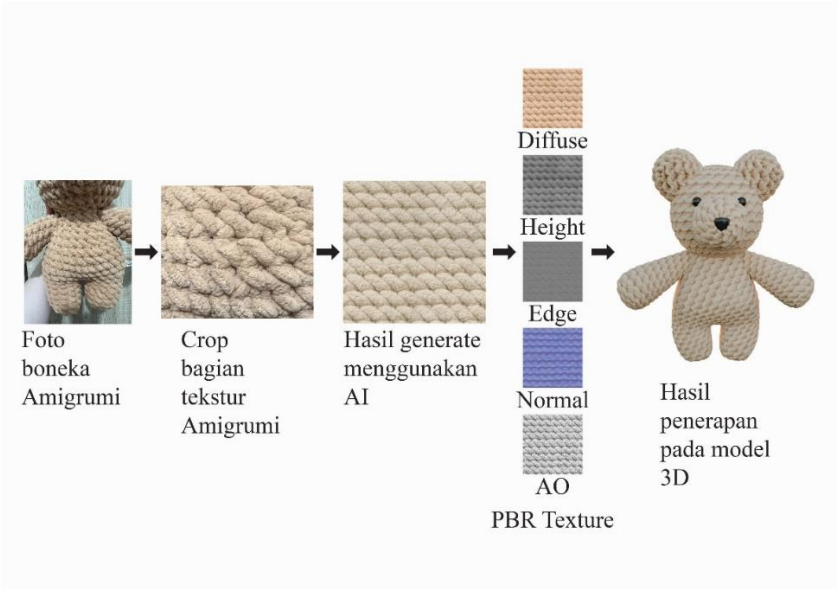

Figure 2 Amigrumi texture creation process

Figure 2 illustrates the actual stages of the research, starting with taking a photo of an amigurumi doll as the primary visual reference. The yarn texture was then manually cropped and used as input in an AI-based image generation process using the ChatGPT Text-to-Image platform. The resulting AI-generated synthetic texture was then processed in the Materialize application to extract various PBR texture channels, such as diffuse , height , edge , normal , and ambient occlusion (AO) . All these channels were then applied to a 3D doll model in a rendering environment to evaluate texture and lighting quality. This process resulted in a seamless, photorealistic texture that resembles real yarn material and significantly accelerated the digital asset creation pipeline.

In terms of visual quality, the rendering results show that the AI-generated textures have smoother thread pattern transitions and more realistic lighting when tested in an HDRi environment in Blender. This indicates that the resulting PBR maps are better able to capture spatial information and surface specularity.

Furthermore, deep learning-based models such as CycleGAN and EnhanceNet have been shown to improve the resolution and clarity of texture details. This effect is particularly evident in knitting-based texture processing, where the effects of normal maps and roughness maps create the illusion of depth and irregularity in the knitted yarn, consistent with the characteristics of the original material.(Sajjadi et al., 2017; Yan Zhu et al., 2020).
Thus, the AI-based approach and image editing proved to be not only time-efficient, but also superior in representing the visual quality of 3D textile textures photorealistically.

4. CONCLUSION

This research demonstrates that an AI-based approach and image editing software like Photoshop can significantly improve the efficiency and quality of PBR texture creation for textile objects like amigurumi dolls. The process, from collecting reference images to mapping textures onto 3D objects, demonstrates that the resulting textures not only have more seamless patterns but also a higher level of realism compared to conventional manual methods.

Parameter comparisons show that the AI method can reduce production time by more than 50% while maintaining or even improving the visual quality of textures. This result is further enhanced by the use of texture channels such as normal maps and roughness maps , which enhance the illusion of depth and surface materiality in 3D models.

Thus, the application of AI in the digital texture production pipeline not only provides technical and aesthetic advantages, but also opens up new efficiency opportunities in the development of interactive visual assets, especially in the animation and multimedia industry based on knitted objects.

5. REFERENCES

Deng, W., Ke, W., Deng, Z., & Wang, X. (2024). Virtual design of woven fabrics based on parametric modeling and physically based rendering. Computer-Aided Design, 173, 103717. https://doi.org/https://doi.org/10.1016/j.cad.2024.103717

Foundation, B. (2025). Blender Manual: Working with PBR Textures. Blender Foundation.

Hu, A., Desai, N., Abu Alhaija, H., Kim, S. W., & Shugrina, M. (2024). Diffusion Texture Painting. Special Interest Group on Computer Graphics and Interactive Techniques Conference Conference Papers '24, 1–12. https://doi.org/10.1145/3641519.3657458

Isola, P., Zhu, J.-Y., Zhou, T., & A., A. (2018). Image-to-Image Translation with Conditional Adversarial Networks. Computer Vision and Pattern Recognition, 3.

Karras, T., Laine, S., & Aila, T. (2019). A Style-Based Generator Architecture for Generative Adversarial Networks. Computer Science, 3.

Ma, K., & Chung, J. (2023). A Research on 3D Texture Production Using Artificial Intelligence Softwear. International Journal of Internet, Broadcasting and Communication, 15, 178–184. https://doi.org/10.7236/IJIBC.2023.15.4.178

Pharr, M., Jakob, W., & Humphreys, G. (2016). Physically Based Rendering: From Theory to Implementation (3rd ed.). Morgan Kaufmann Publishers Inc. https://infoscience.epfl.ch/handle/20.500.14299/128083

Sajjadi, M. S. M., Scholkopf, B., & Hirsch, M. (2017). EnhanceNet: Single Image Super-Resolution Through Automated Texture Synthesis. Computer Science, 2.

Yan Zhu, J., Park, T., Isola, P., & Efros, A. A. (2020). Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks. Computer Science, 7.