International Journal of Internet, Broadcasting and Communication Vol.16 No.2 75-80 (2024)
http://dx.doi.org/10.7236/IJIBC.2024.16.2.75

IJIBC 24-2-9

A Study on Unreal Engine Lumen Lighting System for Visual Storytelling in Games

Chenghao Wang, Jeanhun Chung*

Doctor's Course, Dept. of Multimedia, Graduate School of Digital Image and Contents
Dongguk University, Korea
**Professor, Dept. of Multimedia, Graduate School of Digital Image and Contents*
Dongguk University, Korea
*how9951@gmail.com, * evengates@gmail.com*

Abstract

Research on the visual narrative impact of Unreal Engine's Lumen lighting system in games aims to delve into how Lumen's lighting technology plays a crucial role in game design and gameplay experience, thereby enhancing the visual storytelling of games. Lumen, Unreal Engine's dynamic global illumination solution, calculates lighting and shadows in real-time during gameplay, creating a more realistic and immersive environment. Analysis indicates that Lumen technology not only provides visually realistic and dynamic lighting effects but also significantly enriches the expressiveness and immersion of the game narrative through its changes in light and shadow.

Keywords: *Unreal Engine, Game Visual, Lumen Lighting, Color, Storytelling*

1. Introduction

1.1 Research Background

Digital gaming technology has propelled video games to the forefront of entertainment, offering complex interactive experiences. Visual storytelling, a crucial aspect of game design, combines narrative expression with advanced lighting techniques like the Lumen system in Unreal Engine. Despite its technical prowess, the full impact of Lumen on game design and storytelling remains unexplored. This study seeks to analyze Lumen's influence on visual storytelling in games, aiming to advance both technological and narrative aspects of game development.

1.2 Research Objectives

This study aims to delve into the impact of the Lumen lighting system in Unreal Engine on game visual narratives. Initially, it analyzes how Lumen's lighting technology creates more dynamic and realistic lighting

Manuscript Received: March. 16, 2024 / Revised: March. 22, 2024 / Accepted: March. 28, 2024
Corresponding Author: evengates@gmail.com (Jeanhun Chung)
Tel: +82-2-2260-3, Fax: +82-2-2260-3766
Professor, Dept. of Multimedia, Graduate School of Digital Image and Contents, Dongguk University, Korea

effects in real-time rendering environments, as well as its advantages and limitations compared to static and dynamic lighting. It then explores how the Lumen lighting system, by providing more natural and dynamic lighting effects, offers new means of expression for game visual narratives, particularly in creating atmosphere, guiding player attention, and crafting moods.

Through the research objectives outlined above, this paper provides practical guidance for game designers and developers to explore the potential of the Lumen lighting system, thereby enhancing the quality of game narratives and the player experience. Furthermore, this study also aims to offer new insights into the integration of game visual narratives and technology, promoting interdisciplinary research and discussion.

2. Theoretical Background

2.1 Game Visual Narrative

Game visual storytelling refers to the process of conveying storylines and game world backgrounds through visual elements in games, such as images, scenes, and character designs. In comparison to traditional textual storytelling, game visual storytelling is more interactive and diverse because players can influence the development and outcome of the story through interaction within the game. Through the layout of the game world, the design of scenes, and the application of visual effects, game visual storytelling can create immersive story experiences, thereby enhancing player immersion and emotional involvement.

2.2 Static Lighting and Dynamic Lighting

In three-dimensional environments, lighting is used to simulate the illumination effects of light sources on environments and objects, mirroring the real world. It is crucial for creating the atmosphere and visual perception of the game world and is one of the key factors affecting visual effects.

In game development tools such as Unreal Engine, static lighting and dynamic lighting are two commonly used lighting techniques. Static lighting is a pre-calculated lighting solution, typically computed during the map building phase and stored in lightmaps. Dynamic lighting, on the other hand, is calculated in real time and can respond instantly to changes in light sources and objects within the scene. Dynamic lighting is suitable for scenarios requiring real-time lighting effects, such as dynamic light sources and moving scenes. However, the computational cost of dynamic lighting is significant and may impact game performance.

In summary, the choice between static and dynamic lighting depends on the specific needs of the project and the balance between performance, realism, and the dynamic nature of the intended experience. However, with the advancement of hardware and technology, the issue of high performance consumption associated with dynamic lighting can be addressed.

Table 1. Static Lighting and Dynamic Lighting

Feature	Static Lighting	Dynamic Lighting
Definition	Pre-calculated and stored lighting. The lighting effects are computed in advance and applied directly when the game or scene loads.	Real-time calculated lighting. Lighting effects update in real-time as objects and light sources move or change within the game or scene.

Performance	Low. Since the lighting effects are pre-calculated, the runtime requirements for hardware are lower.	High. Requires stronger hardware support due to the need for lighting calculations to be performed in real-time based on changes in the scene.
Flexibility	Low. Once the lighting has been calculated and stored, it cannot change in response to dynamic events within the game.	High. Can dynamically respond to any changes within the game or scene, such as object movements, changes in light sources, etc.
Use Cases	Suitable for games or applications with relatively static environments, such as interior design or some strategy games.	Suitable for games or applications that require high levels of dynamic interaction, such as action games, driving simulators, etc.
Realism	Can be very realistic, but may appear less natural in some situations due to the lack of dynamic changes.	Typically offers higher realism due to the ability to react in real-time to the interaction between light and objects.
Development Complexity	Relatively simple. Once the lighting effects have been pre-calculated, developers do not need to manage changes in lighting in real-time.	Higher. Requires consideration of performance, light source management, and how to optimize algorithms to balance realism and performance.

2.3 Lumen Lighting System

The Lumen lighting system represents a sophisticated global illumination solution designed to facilitate high-quality, dynamic lighting effects for real-time rendering. This technology, by simulating the real-time propagation of light within complex scenes, achieves realistic visual effects in the realms of gaming and film production. The primary advantage of Lumen lies in its ability to deliver highly realistic lighting and shadow effects without compromising performance, thereby significantly enhancing the quality and immersion of visual content.

Lumen was developed based on a comprehensive analysis of the limitations inherent in existing lighting technologies. Traditional lighting systems typically rely on precomputed lightmaps or simplified lighting models, which, while capable of delivering acceptable visual effects to a certain extent, often fall short in terms of effect and performance when dealing with dynamic scenes and complex lighting conditions. Leveraging the capabilities of real-time computation, Lumen technology effectively addresses these issues by allowing lighting effects to update in real-time with changes in the scene, thereby enhancing the quality of rendering. By providing realistic lighting and shadows, it significantly improves the realism and immersion of scenes. For the gaming and film industries, this translates into higher quality visual presentations and a richer sensory experience.

3. The Impact of Visual Narrative lumen lighting on Game

3.1 Creation of Emotional Atmosphere

Lighting is a pivotal element in crafting the emotional atmosphere of movies and games. The design of game

scenes varies widely, ranging from realistic styles to cartoonish stylizations. However, in actual level design, many factors must be considered, among which the most crucial is the role of lighting in creating an emotional ambiance. Different environments, lighting, and colors can evoke distinct feelings in users.

Due to hardware and software limits, past games faced a choice between static and dynamic lighting. While film principles were adapted for static shots, games' interactivity demands adaptable lighting considering narrative and player interaction. Lumen empowers creators to fine-tune lighting for emotional impact in dynamic game environments.

In this study, the dynamic global illumination of Lumen in video games can influence the emotional atmosphere by real-time adjustments of lighting attributes such as brightness and darkness contrast, warm and cool contrast, and the direction of light sources. Through careful design of lighting, the sense of tension, mystery, thrill, and the emotional intensity of narrative climaxes in games can be significantly enhanced. Moreover, the dynamic adjustment of Lumen lighting can change with the evolution of the game's plot, effectively conveying different emotions and atmospheres. This showcases the emotional changes of characters, the transformation of environments, and the development of storylines, thereby strengthening the player's immersion and emotional engagement with the game world. Therefore, Lumen lighting plays a crucial role in game visual narration, with its dynamic adjustments being a key factor in achieving emotional resonance and an immersive experience.

Figure 1. Lumen Lighting Effects

3.2 Immersion in Real Environments

Immersive real-world experiences are typically achieved through a variety of means, including sensory stimulation such as visual, auditory, and tactile inputs, as well as psychological engagement and emotional connection. In game design, creating a high level of real-world immersion is considered key to enhancing user experience and satisfaction.

Lumen, through its advanced global illumination technology, can real-time reflect the interactions between natural and artificial light sources within complex environments, enhancing the realism of scenes. This sense of realism allows viewers to immerse themselves deeper into the narrative, whether they are stepping into vast outdoor environments or narrow indoor spaces. Lumen accurately simulates how light propagates and reflects in these settings, thereby enhancing the credibility of the story. In the aspect of real-time rendering, Lumen achieves real-time global illumination calculations, meaning that lighting effects can be instantly updated based on changes in the environment (such as the passage of time or movement of objects). This dynamic lighting effect is crucial for creating a sense of realism. Moreover, its ray tracing technology

simulates how light bounces between various surfaces in a scene, including how it penetrates transparent or translucent materials, how it's absorbed or scattered by objects, thereby producing complex and lifelike lighting and shadows.

3.3 Expression of Time and Space

The expression of time and space is also a core element in game design and virtual environments, crucial for creating immersive real-world experiences, enriching visual narratives, and enhancing player experiences. By effectively conveying time and space, a virtual world that is both deep and coherent can be constructed, guiding players to experience and explore the unfolding story.

Lumen allows for real-time adjustments of lighting to simulate changes in illumination at different times of the day, such as sunrise, sunset, and the variations of light throughout the day, providing a powerful tool for conveying the passage of time within a story. Moreover, by simulating the lighting effects under different environmental conditions (such as weather conditions), Lumen can also help create scenes with a strong sense of space, visually reinforcing the story's setting. Through the effective expression of time and space by the Lumen lighting system, games and virtual environments can offer a richer and more layered experience, making players feel truly present in that world. The passage of time and changes in space not only enhance the realism of the environment but also provide players with deeper opportunities to explore and experience the game world. Furthermore, the creative use of time and space can serve as narrative tools, helping to tell more compelling stories and evoke emotional resonance in players.

4. Conclusion

This study delves into the impact of the Lumen lighting system in Unreal Engine on game visual storytelling. The analysis indicates that Lumen technology not only provides more realistic and dynamic lighting effects visually, but also significantly enriches the expressiveness and immersion of game narratives through its dramatic changes in light and shadow.

Firstly, the application of the Lumen lighting system represents a significant advancement in lighting technology. Through real-time global illumination and reflection processing, Lumen is able to deliver more dynamic and realistic visual effects without sacrificing performance. This technological innovation provides game designers with a broader creative space, allowing them to narrate stories with more nuanced lighting effects, thus enhancing the visual storytelling capabilities of games. Secondly, the Lumen lighting system adds new dimensions to game narratives through its technical features. Lighting is not only used to shape the aesthetic appeal of scenes, but more importantly, it can guide player emotions, set atmospheres, and even convey story elements silently. Analysis shows that carefully designed lighting effects can significantly enhance player emotional engagement and understanding of the story, immersing players more deeply into the game world.

In summary, the application of the Lumen lighting system not only enhances the visual quality of games but also greatly enhances the depth of game storytelling and player immersion. Despite requiring additional effort in both technology and creativity to achieve these effects, the dual narrative and visual benefits brought by Lumen undoubtedly provide a promising direction for future game development exploration.

References

[1] Huaxin Wei, Jim Bizzocchi, and Tom Calvert. 2010. Time and space in digital game storytelling. Int. J. Comput. Games Technol. 2010, Article 8 (January 2010), 23 pages.
DOI: https://doi.org/10.1155/2010/897217

[2] Andersson, Irma. "The effect of red-light sources on the player experience of a horror game level." (2022).
https://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-476770

[3] Chenghao Wang and Jeanhun Chung. (2023). Researching Visual Immersion Elements in VR Game . The International Journal of Internet, Broadcasting and Communication, 15(2), 181-186.
DOI: https://doi.org/10.7236/IJIBC.2023.15.2.181

[4] Shelton, Maggie, "Lighting Styles and Moods in Unreal Engine" (2023). *Master of Fine Arts in Digital Media Culminating Experience.* Paper 2.
https://dc.etsu.edu/digitalmedia-culminating-experience/2

[5] Knez, I., & Niedenthal, S. (2008). Lighting in digital game worlds: Effects on affect and play performance. *CyberPsychology & Behavior*, *11*(2), 129-137.
DOI:https://doi.org/10.1089/cpb.2007.0006

[6] El-Nasr, M. S., Niedenthal, S., Knez, I., Almeida, P., & Zupko, J. (2007). Dynamic lighting for tension in games. *Game Studies*, *7*(1).
https://gamestudies.org/0701/articles/elnasr_niedenthal_knez_almeida_zupko

[7] QiYi and Jeanhun Chung. (2023). Research on the Correlation Between the Alienation Effect and Immersion of Breaking the Fourth Wall in Games. The International Journal of Advanced Smart Convergence, 12(4), 328-333.
DOI:https://doi.org/10.7236/IJASC.2023.12.4.328

[8] Jiang QianQian and Jeanhun Chung. (2020). Research on the Visual Elements of VR game . Digital convergence research, 18(12), 507-512.
DOI:https://doi.org/10.14400/JDC.2020.18.12.507

[9] Park Sangyong "A study on game narrative and players' experience" Multicultural Content Research 40 pp. 143-168 (2022): 143.
DOI: https://dx.doi.org/10.15400/mccs.2022.06.40.5

[10] Park Yu-jin, Paik Chul-ho "A Study on the time-space expression of narrative-based game background design; Focused on Chronotope." Journal of the Korean Game Association, 22.2 pp. 117-128 (2022): 117.
DOI: http://dx.doi.org/10.7583/JKGS.2022.22.2.117