

1. Introduction and Topic of Interest

The general subject that interests me is **Computer Science**, specifically the sub-discipline of **Game Development**. The specific aspect of this subject that intrigues me is the **comparison of different lighting methods in video games in terms of their performance and visual quality**. I am particularly interested in understanding which methods offer the best balance between these two factors.

2. Current Knowledge

Currently, I understand that lighting in video games is a crucial aspect of game development as it significantly impacts the visual quality and performance of the game. Different lighting methods, such as parametric/bitstream methods, hybrid methods, and reduced-reference (RR) models, have different characteristics and efficiencies. Some methods are more efficient but may not provide the best visual quality, while others may offer superior visual quality but require more computational resources such as real time ray tracing or PTGI (A combination of ray tracing and path tracing).

3. Information Needed

To become better informed about this topic, I need to find out more about the specific methods used for real time lighting and identify the most common ones out of them to help maintain focus within my research. Moreover, I need to consider factors that I would use to analyse performance and visual quality. Factors such as FPS, Avg FPS, 1% Lows, Power Draw, Hardware Utilisation, Texture quality and more. Additionally, I would need to research on the implementation of various lighting methods in different game engines and how that would impact quality or performance metrics. Finally, I would look into how developers balance performance and visual quality.

4. Research Question

How do different lighting methods in video games compare and contrast in terms of their performance and visual quality, and which methods offer the best balance between these two factors?

I have completely revised my topic because my original choice was extremely niche, making it highly challenging to condense all the necessary information within 1000-1500 words. Additionally, my new topic holds greater personal interest for me and is likely to captivate a broader audience.

5. Working Thesis

My current working thesis is that **the balance between performance and visual quality in video game lighting methods is not a one-size-fits-all solution but rather a dynamic equilibrium that varies depending on the specific requirements of a game project**. This balance is influenced by factors such as the game's artistic style, technical constraints, targeted hardware platform, and the intended gaming experience.

More specifically, methods such as static lighting might be preferred in games where performance is the priority (Firewatch and LIMBO for example), as this approach requires less computational power due to pre-computed light maps. Conversely, for games emphasizing high visual fidelity, dynamic lighting methods, though more resource-intensive, might be the optimal choice due to their real-time adaptability and ability to produce more realistic and immersive environments. Moreover, sometimes solo/indie developers may use these methods to reduce development time.

Furthermore, hybrid lighting methods, which combine elements of both static and dynamic lighting, might offer the most balanced approach for games that aim to strike a balance between performance and visual quality.

However, the best method can only be determined by a thorough comparative analysis of the different lighting techniques, taking into account factors such as the computational cost, implementation complexity, artistic control, and the overall impact on the visual aesthetics and gameplay experience.

To add, most well-known games (Counter Strike, VALORANT, Rainbow Six, LoL, COD, The Last of Us, Uncharted and many more) utilise a hybrid model alongside a rendering technique known as deferred rendering which will be explained further in my research paper.

6. Sources of Reliable Information

Akay, Simal. *Degree Project in Architectural Lighting Design Second Cycle 15.0 Hp Lighting for Tension in Video Games*. 14 July 2022. <https://www.diva-portal.org/smash/get/diva2:1683254/FULLTEXT01.pdf>

This was found through a google search "lighting in video games with a mood", I was trying to find something on how lighting systems might change on the basis of a game's tone and mood.

Cristian Lambru, Anca Morar, Florica Moldoveanu, Victor Asavei, Alin Moldoveanu. "Comparative Analysis of Real-Time Global Illumination Techniques in Current Game Engines | IEEE Journals & Magazine | IEEE Xplore." ieeexplore.ieee.org, ieeexplore.ieee.org/document/9527241. Accessed 5 Mar. 2024.

I found this source by using Google Scholar with the keywords: "real time game lighting comparison".

El-Nasr, Magy, and Ian Horswill. "Intelligent Lighting for Game Environments." *Journal of Game Development*, vol. 1, Jan. 2005, pp. 17–50.
https://www.researchgate.net/publication/229139093_Intelligent_Lighting_for_Game_Environments

I found this by searching for "lighting for game environments" on google scholar.

Andrey Iones, Anton Krupkin, Mateu Sbert, Sergey Zhukov. "CSDL | IEEE Computer Society." [Www.computer.org](http://www.computer.org), www.computer.org/csdl/magazine/cg/2003/03/mcg2003030054/13rRUwwslvK. Accessed 6 Mar. 2024.

I was searching for video game lighting through the UVIC Library when I found this.

Magy Seif El-Nasr, Simon Niedenthal, Igor Kenz, Priya Almeida, Joseph Zupko. "Dynamic Lighting for Tension in Games." *Game Studies Journal*, vol. 7, no. 1, 2006, summit.sfu.ca/item/13.

This was also found through a google search "lighting in video games with a mood".

Tomas Akenine-Möller, Eric Haines, Naty Hoffman, Angelo Pesce, Michał Iwanicki, and Sébastien Hillaire. *Real-Time Rendering*. Boca Raton, Crc Press, Taylor & Francis Group, 2018.

This source was found through the UVIC Library website and search terms "Real Time Rendering".

Wang, Brandon. "VALORANT Shaders and Gameplay Clarity." [Technology.riotgames.com](http://technology.riotgames.com), Riot Games, 30 June 2020, technology.riotgames.com/news/valorant-shaders-and-gameplay-clarity.

I found this source via a google search with the terms "Valorant Lighting". My intent with this search was to gauge an understanding of how lighting works in performance oriented games such as VALORANT since it falls under the e-sports category and not the AAA titles category.

7. Source Annotation

Cristian Lambru, Anca Morar, Florica Moldoveanu, Victor Asavei, Alin Moldoveanu. "Comparative Analysis of Real-Time Global Illumination Techniques in Current Game Engines | IEEE Journals & Magazine | IEEE Xplore." [ieeexplore.ieee.org](https://ieeexplore.ieee.org/document/9527241), ieeexplore.ieee.org/document/9527241. Accessed 5 Mar. 2024.

Annotation:

This article by Cristian Lambru, Anca Morar, Florica Moldoveanu, Victor Asavei, Alin Moldoveanu. offers a detailed comparison of real-time global illumination techniques in current game engines. Authored by experts in game development and computer graphics, the paper targets fellow researchers and game developers. The unique comparative analysis provides practical insights into different illumination techniques in various game engines. This source could be illuminating for research on real-time global illumination in game development.

8. Excitement and Worries

One thing that excites me about working on this topic is the opportunity to delve deeper into the intricacies of game development, particularly the technical and artistic decisions that go into creating diverse and immersive gaming experiences. The study of lighting techniques in video games offers a fascinating intersection of art and technology, and it's thrilling to think that the insights gained from this research could potentially contribute to the creation of more visually stunning and well-optimized games in the future.

On the other hand, one thing that worries me about working on this topic is the complexity of balancing visual quality with performance. Understanding the technical aspects of different lighting methods and their impact on a game's performance can be quite challenging. Additionally, evaluating the visual quality of different lighting techniques is a subjective process, which can be influenced by personal preference and the specific artistic style of the game. Therefore, providing an objective comparison and identifying the best balance between these two factors poses a significant challenge.

9. Proposed Topic Summary

My proposed research topic revolves around the comparative analysis of different lighting methods utilized in video games, specifically evaluating their performance and visual quality. I posit that the optimal balance between these two factors is not a universal solution, but rather a dynamic equilibrium that is contingent on the specific requirements of a game project.

This hypothesis is supported by several scholars in the field. For instance, Akenine-Möller et al., in their book "Real-Time Rendering," discuss how various lighting techniques can dramatically affect the visual perception and performance of a game. Similarly, Watt and Policarpo's book "The Computer Image" delves into the technical aspects of different lighting methods and their impacts on computational cost and visual fidelity.

Through my research, I aim to critically evaluate these lighting methods in the context of different gaming scenarios. My goal is to identify the best practices for achieving an effective balance between performance and visual quality, taking into account factors such as the game's artistic style, technical constraints, targeted hardware platform, and the intended gaming experience. I am hopeful that my research will contribute to the existing body of knowledge in game development and potentially lead to more efficient and visually impressive games in the future.