Diegetic Guidance: Yellow Paint as an accessibility tool for players with reduced visibility

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ABSTRACT

The global video game sector, despite its advances toward photorealism, faces the challenge of including players with reduced visibility. These users often struggle to distinguish interactive elements in complex environments, resulting in limited experience and subsequent frustration. We address this issue by developing and evaluating a functional prototype in Unreal Engine 5 that utilizes yellow paint as a diegetic visual aid to optimize accessibility. Furthermore, we empirically validate this technique as a balance between low cost and strong immersive integration, thereby filling a gap in the literature that traditionally focuses on HUD-based or hardware solutions. For the research, the prototype recreates a soft-horror 3D environment where key elements were highlighted using the yellow paint. The methodology focused on rigorous usability tests with participants who presented a combination of myopia, astigmatism, and color blindness. This approach allowed for a precise measurement of the visual guide's effectiveness through predefined test cases, achieving an overall success rate of 65.91% in task completion. Consequently, yellow paint is established as a viable and relevant resource for strengthening accessibility without sacrificing player immersion, and, on a theoretical level, it offers a significant contribution to the design of more inclusive video games.

Keywords: **I**nclusive Game Design, Visual Signage, Assisted User Experience (UX), Visual Impairment in Video Games, Interactive 3D Environments.

Guía Diegética: La Pintura Amarilla como herramienta de accesibilidad para jugadores con visibilidad reducida

Resumen

El sector global de los videojuegos, a pesar de sus avances hacia el fotorrealismo, enfrenta como reto a la inclusión de jugadores con visibilidad reducida, a quienes se les dificulta distinguir elementos interactivos en entornos complejos y experimentan una limitada experiencia y consecuente frustración. Abordamos esta problemática desarrollando y evaluando un prototipo funcional en Unreal Engine 5 que utiliza la pintura amarilla como un soporte visual diegético para optimizar la accesibilidad, además, validamos empíricamente esta técnica como un equilibrio entre el bajo costo y la fuerte integración inmersiva, llenando así un vacío en la literatura que tradicionalmente se enfocó en soluciones basadas en HUD o hardware. Para la investigación, el prototipo recrea un ambiente 3D de terror suave, dónde los elementos clave fueron resaltados con la pintura amarilla. La metodología se centró en pruebas de usabilidad rigurosas con participantes que presentaban una combinación de miopía, astigmatismo y daltonismo. Este enfoque permitió medir con precisión la eficacia de la guía visual mediante casos de prueba preestablecidos, alcanzando una tasa de éxito general del 65.91% en la culminación de tareas, con lo que, la pintura amarilla se establece como un recurso viable y pertinente para fortalecer la accesibilidad sin sacrificar la inmersión del jugador, y, a nivel teórico se brinda un aporte significativo para el diseño de videojuegos más inclusivos.

Palabras clave: Diseño Inclusivo de Juegos, Señalética Visual, Experiencia de Usuario (UX) Asistida, Discapacidad Visual en Videojuegos, Entornos 3D Interactivos.

1. Introduction

Video games have solidified their position as the primary form of entertainment globally, surpassing the combined revenues of the film and music industries. This growth has been notable because it generated approximately $196 billion dollars globally in 2023 and is projected to reach up to $257 billion by 2028 (Hong & Christofferson, 2024). The mobile gaming segment is the fastest-growing and highest-earning, representing nearly half of global revenue ($92.6 billion in 2024), followed by console and PC gaming (Buijsman, 2024).

Regarding Latin America, a notable dynamism has also arisen there; for 2024, a value close to 19.53 billion dollars was estimated, with growth projections of 14.20% (IMARC, 2024). Countries like Ecuador contributed significant figures, reaching approximately 107 million dollars in 2023 (Prom Perú, 2024).

However, such advancements are not proportional in terms of accessibility. The lack of inclusive designs generates a high-impact social exclusion, by limiting the participation of people with diverse disabilities in a medium that has consolidated both as a predominant form of socialization and in its role as a community builder (Gisela, 2023). This problem becomes more relevant when considering that 72% of players recognize that video games foster a sense of belonging (ESA, 2024). Consequently, a structural gap is evident, which the industry has a responsibility to address to ensure effective and sustainable inclusion processes.

Based on the foregoing, the central problem that this research addresses is the visual perception barrier faced by people with reduced visibility, for example, myopia, astigmatism, color blindness, in modern video games. Among other aspects, this is due to the constant evolution of the video game industry towards photorealism of textures and the adoption of subtle chromatic palettes, which increase usability problems, especially making it difficult to distinguish key interactive elements from the environmental decoration and increase the exclusion of players with visual disabilities and their consequent frustration (Kaiutina & Tahir, 2025; Saez de Tejada, 2022).

Frequently, many accessibility initiatives concentrate their resources on adaptive hardware, such as the Xbox Adaptive Controller, or on the implementation of non-diegetic software solutions, such as mission markers and modifications to the Heads-Up Display (HUD) (Molina López & Medina Medina, 2021). Although these contributions (or inputs) yield great practical value, they often disrupt immersion, which is critical because immersion is an

intrinsic component of the playful experience (or gaming experience).

Even though, on a legal and regulatory level, standards such as Section 508 in the U.S. and EN 301 549 in Europe provide the foundation for accessibility in Information and Communication Technology (ICT) products, there is no direct and harmonized application of these frameworks to the dynamic design of video games. Therefore, it can be stated that the sector remains in a preliminary phase of development. This panorama obliges research to seek accessibility solutions that meet the criteria of effectiveness, economy, and diegesis; that is, solutions that achieve a coherent integration within the game's universe (Andersson, 2024; Kuhne, 2024).

In this context, it is recognized that acclaimed titles (such as Resident Evil 4 Remake, God of War, or Final Fantasy VII Remake) employed yellow paint as a diegetic visual guide. However, this implementation was primarily a design decision to optimize pacing. The lack of a formal study that validates its effectiveness as a specific tool for players with reduced visibility (Kaiutina & Tahir, 2025).

Consequently, the lack of empirical evidence demonstrating how the technique specifically impacts the playful experience of this user group is identified. This drives the current use of yellow paint as a diegetic visual mark from the initial phases of the project, on interactive elements and navigation paths in complex 3D environments, without sacrificing the sense of immersion and without being applied at the end as an external patch (Kaiutina & Tahir, 2025).

Based on the two objectives are pursued:

- The creation of an interactive prototype in Unreal Engine 5 whose main function is to integrate yellow signaling as a diegetic resource to improve the clarity and efficiency of interaction within intricate 3D scenarios.
- A preliminary measurement of the system's utility through

controlled user testing. The sample of participants will include individuals with common visual impairments (myopia, astigmatism, and the various forms of color blindness). This testing methodology is designed to obtain concrete metrics that demonstrate the real contribution of this visual guidance strategy.

In a practical sense, the project seeks to provide video game developers with a low-cost, easy-to-implement option for designing more inclusive experiences. This would directly address the challenges of functional accessibility that have arisen with the trend toward photorealism.

On a theoretical level, the aim is to generate empirical evidence that demonstrates the utility of diegetic visual guides as accessibility solutions that are both effective and non-intrusive. In this way, the study will enrich the academic dialogue and could set a precedent for the development of future accessibility standards in the industry.

2. Materials and methods

To validate our hypothesis, an applied research methodological design was adopted, focused on the development of a prototype and its subsequent evaluation through usability tests. The process was structured following an adaptation of the Waterfall model and the video game design guidelines of the NAMCO company, ensuring rigorous conceptualization and structuring (Pincay-Ponce et al., 2016).

2.1. Design and construction of the prototype

A functional prototype was built using the Unreal Engine 5 video game engine. This consisted of a unique interactive 3D environment: a photorealistic two-story house with a basement, set at night in a forest. The theme is mild horror and suspense, selected to increase the visibility challenges given the naturally required dark lighting of the setting. Overall, this scenario features detailed textures that replicate the problematic conditions of many commercial

mild suspense titles.

The structured narrative was minimalist and oriented towards exploration and the resolution of the escape of the player, nicknamed Javier, a family man who has recently acquired a house in a wooded area. Upon returning to the location to continue the move, he progressively faces unexpected situations that gradually form the interactive experience.

The proposal is organized into two differentiated acts. The first focuses on exploration and the progressive recognition of the 3D environment (**See Figure 1**). This involves identifying and securing essential objects, including a flashlight and a key, which allow the player to unlock new areas of the house and its surroundings, consequently increasing the range of interaction.

The second act introduces a sudden and palpable threat: a "Strange Being" that transforms the game's dynamic, constantly pressuring Javier to adopt stealth and escape strategies. This progression allows for the evaluation of the effectiveness of the yellow paint in both calm exploration contexts and high-tension situations.

Figure 1: Partial image of the enabled basement door, which was previously covered in yellow paint marking the wall. (Left) and location of the flashlight with contrasting yellow paint on the handle (Right)

The core accessibility mechanic was implemented using the Decals

technique. Yellow paint materials were created and projected onto the textures of key objects and navigation paths, such as door handles, switches, keys, and hiding spots. This technique allows for coherent visual integration without modifying the base geometry of the objects. The game's logic, interactions, and enemy artificial intelligence were programmed using Unreal Engine's Blueprint visual scripting system.

2.2. Sample and test procedure

A moderate in-person usability test was conducted with a purposive sample of four university students. Participants were selected to present conditions of reduced visibility pertinent to the study, including myopia, astigmatism, and color blindness. The procedure was carried out in a controlled environment to ensure consistency.

Each participant was asked to play the prototype from the beginning with the objective of completing it. The progress was structured into 11 implicit missions, for example, finding the flashlight, activating the exit, which corresponded to 11 specific test cases. A moderator observed the session, recording whether each test case was successfully completed or not, along with qualitative observations on the player's behavior. Transparency of the process was guaranteed, and participant consent was obtained, ensuring research ethics.

2.3. Data analysis

The analysis was primarily quantitative. The prototype's effectiveness was measured by calculating the overall success rate, defined as the total number of passed test cases divided by the total number of executions, which was 11 cases × 4 participants = 44 executions. The results were broken down by participant to identify individual patterns and were supplemented with the analysis of the qualitative observations to contextualize the failures and successes.

3. Results

3.1. Quantitative Analysis and Key Observations

The prototype evaluation was carried out by executing a total of 44 test cases, yielding a balance of 29 passes versus 15 failures. This figure translates to an overall success rate of 65.91% (N=44). This initial result validates the prototype's functionality, indicating that the yellow paint mechanic was, for the most part, effective in guiding players toward achieving the progression objectives.

3.2. Variability in Participant Performance

A detailed presentation of the data by participants (see Table 1) reveals, however, significant variability in performance that deserves analysis:

- Participant EST_U_001 (Myopia/Astigmatism): Approved 8 out of 11 cases. Their difficulties were concentrated on the initial detection of non-explicitly marked elements and the navigation required in sections with greater pressure.
- Participant EST_U_002 (Myopia, Astigmatism, and Color Blindness): This user achieved maximum effectiveness, completing 11 out of 11 approved cases. This result is of capital importance as it establishes that the intensity and contrast of the yellow marker were fully functional for this multiple visual condition, allowing them to execute all tasks without registering difficulties attributable to the diegetic signaling.
- Participant EST_U_003 (Myopia and Astigmatism): Despite registering zero out of eleven completed tasks, the participant's low performance is not attributed to visual limitations. Review of the session demonstrated that the main obstacle was the user's inexperience with video games, which impacted their difficulty in coordinating the movement controls and the camera (which acts as the first-person player role), preventing effective interaction and vitiating the normal development of the test.
- Participant EST_U_004 (Myopia and Astigmatism): This user

demonstrated outstanding performance, with 10 out of 11 cases successfully completed. Their tests evidenced agile navigation and instant identification of the previously demarcated elements.

Table 1. Summary of key results by test case

Test Case	Key Objective	Pass	Fail	Notable Observations
PT_A1_002	Locate marked flashlight	3	1	Key objects with yellow mark was successfully located by the majority.
PT_A1_005	Locate marked key	3	1	Ditto. Signaling was clear for progression.
PT_A1_007	Activate marked switch	3	1	Ditto. High contrast in the dark cellar proved effective.
PT_A2_002	Activate marked crank	3	1	Ditto. The visual guide worked even in the highest tension act.
PT_A1_001	Find first note	2	2	**Less positive outcome:** Initial detection of objects not directly marked with paint (only yellowish color) was less effective.

3.3. Interpretation and contribution

Successes were unequivocally concentrated on the interaction with those objects crucial for progression that had been explicitly demarcated with yellow paint. The high contrast of the color against the dark background of the horror environment was a determining facilitating factor for the localization of these elements. In contraposition to the reviewed literature, which frequently proposes the implementation of extradiegetic solutions (HUD or menus), our preliminary results strongly suggest that an integrated, diegetic visual guide is a viable and effective alternative, maintaining immersion.

4. Discussion

The results of this study support the hypothesis that yellow paint can function as an effective diegetic visual aid to improve accessibility in video games. The overall success rate of 65.91% and the nearly perfect performance

of two out of the four participants with reduced visibility demonstrate the viability of the technique. The main strength of this approach, evidenced in the tests, is its capacity to guide the player's attention toward crucial elements in an intuitive manner without breaking immersion, which is a common problem in other accessibility solutions in various research (Martinez et al., 2024; Oliva-Zamora & Mangiron, 2025).

The results are nuanced. For example, the positive performance of the participant with color blindness (EST_U_002) was significant, indicating that the high contrast inherent in the yellow color can be a valuable alternative for addressing diverse simultaneous visual limitations, beyond the specific correction of myopia. However, the recorded errors also offer valuable lessons, as was the case with participant EST_U_003 which shows a limitation of the proposed approach: isolated visual accessibility may not be enough to overcome usability barriers when there is a lack of basic game control knowledge.

This highlights that accessibility must be understood as a multifactorial phenomenon that requires comprehensive solutions regarding the effectiveness of diegetic visual guidance, and not exclusively unifocal ones.

Furthermore, the difficulties reported by participant EST_U_001 in the initial identification phase and during navigation under conditions of stress indicate that the efficacy of the yellow paint is highly dependent on the ludic context, the level of tension perceived by the player, and the subtlety with which it is integrated into level design.

Therefore, the incorporation of yellow paint decals represents a low-cost technique that is simple to implement in advanced graphics engines like Unreal Engine; moreover, it provides developers with a direct way to “attend” to more players without compromising artistic coherence in video game production. From a theoretical perspective, this study constitutes an empirical validation of a specific diegetic technique, and contributes to the academic debate around

inclusive design capable of balancing the guidance function with player immersion (Oliva-Zamora & Mangiron, 2025; Palmquist et al., 2024).

For future research, the objective would be to increase the robustness and scope of these solutions. For instance, the incorporation of auditory signals (spatialized sound or haptic feedback) could reinforce directional guidance, especially in situations that demand discretion or present a high level of environmental stress.

Additionally, it would be of great value to explore the variation in the morphology and pattern of the yellow markers. This would allow for the differentiation of various types of interaction. For example, a striped pattern could signal a climbable object, while a circular shape could indicate an activatable switch, thereby enriching the diegetic visual communication.

5. Conclusions

Although AAA titles like God of War and Resident Evil 4 Remake have already adopted yellow paint as a design convention, our research is distinguished by subjecting this practice to a systematic and rigorous evaluation. We worked with a user panel that combines myopia, astigmatism, and color blindness, which allows us to offer unique and concrete data. The empirical contribution of this study is, therefore, twofold: it validates the technique in a controlled environment and, simultaneously, addresses a crucial gap in current academic knowledge.

Studying has fundamental empirical value because it addresses a significant gap in existing knowledge. Despite yellow paint being a design convention in games like God of War and Resident Evil 4 Remake, no formal reports were found confirming that this practice had been systematically evaluated. What differentiates this work is the systematic validation of the technique in a controlled environment, using a group of users with specific visual conditions such as myopia, astigmatism, and color blindness. This not

only validates its practical use but also provides concrete, previously unavailable data.

This approach expands the usual focus on adaptive hardware or non-diegetic software adjustments and aligns with the premise that accessibility must be integrated from the conceptual phases of design, demonstrating that inclusion can and should constitute an organic element of the video game industry's world. The practical application of this perspective is low-cost and highly integrated, without compromising immersion, which is an aspect that distinguishes it from alternatives based on HUDs, which are often distant from the diegetic experience.

By moving past the need for options menus, high-contrast visual guides—such as yellow paint—advocate for integrating accessibility into gameplay by default. However, not everything is visual, as the case of inexperienced players like EST_U_003 raises an essential nuance, such as control or motor interaction issues, despite attempts to provide clear visual signaling. This teaches that an accessibility design must be multidimensional, addressing aspects like player dexterity. An additional point is that the success of the technique is tied to the presence of the markers; this eventually complicates navigation in areas of the scenario that are not directly signposted.

Despite the above, it is advisable to delve deeper into the study of combining yellow paint with additional sensory modalities, such as auditory or haptic stimuli, which addresses high-tension video game scenarios and expands the robustness of the proposed approach.

It is also necessary to investigate the use of variable patterns and shapes (arrows, footprints) to transmit different types of interaction, thereby increasing the richness of the diegetic visual "language." Furthermore, the need to conduct studies with a more extensive and heterogeneous user sample to validate these results on a larger scale is unavoidable.

In conclusion, this study affirmatively answers the main objective by

establishing, through the construction and subsequent evaluation of a prototype, that yellow paint stands as a viable and relevant diegetic visual support that enhances accessibility without imposing a cost on player immersion. Despite the limitations identified, the study provides a practical and theoretical contribution to video game design, demonstrating that it is feasible to create more inclusive and equitable experiences through low-cost and highly integrated solutions.

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