Intelligent Lighting for a Better Gaming Experience

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ABSTRACT
Lighting assumes many aesthetic and communicative functions in game environments that affect attention, immersion, visibility, and emotions. Game environments are dynamic and highly unpredictable; lighting such experiences to achieve desired visual goals is a very challenging problem. Current lighting methods rely on *static manual* techniques, which require designers to anticipate and account for all possible situations and user actions. Alternatively, we have developed ELE (Expressive Lighting Engine) – an intelligent lighting system that automatically sets and adjusts scene lighting in real-time to achieve desired aesthetic and communicative goals. In this paper, we discuss ELE and its utility in dynamically manipulating the lighting in a scene to direct attention, stimulate tension, and maintain visual continuity. ELE has been integrated within *Unreal Tournament 2003*. The videos shown at [14] shows a demonstration of a first person shooter game developed using the *Unreal* 2.0 engine, where ELE was configured to dynamically stimulate tension, while maintaining other visual goals.

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INTRODUCTION
Visual composition, including light placement, angles, and colors, camera angle, field of view, and movement, and textures, have an important impact on how game environments are perceived by players. Scene designers have recognized the role that visual composition plays and its impact on scene communication and perception [1-3, 5, 10, 12]. At GDC (Game developers Conference), Will Wright, the creator of the *Sims*, identified several functions that visual composition assumes in game environments, including directing player's focus to important elements in a game by balancing saturation, brightness, and hue of objects in a level [17]. This is important to identify and acknowledge, because it is a design element that affects game play and emotional engagement [10, 12]. In this paper, I will focus on lighting.

Lighting designers have identified several visual design goals for lighting, including establishing visibility for important areas in the scene, directing viewer's attention to important areas (visual focus), establishing depth, and evoking moods, as well as providing information, such as the time of day and environment setting [1, 3-9, 11]. These are important goals that affect game play at different levels. Setting the right mood and atmosphere, for example, is important to create emotional engagement [9, 10]. Due to the advancements of graphics, game environments are becoming increasingly complex and harder to decipher. In these cases, directing users' attention to important scene elements becomes crucial for achieving the quick responses required to survive in most action, adventure, and horror games.

LIGHTING DESIGN METHODS FOR GAMES
Recognizing the importance of lighting, game designers devote much time to lighting. They manually predefine light positions, angles, and colors for each light and level in a game to achieve the desired visual goals, including setting atmosphere and providing necessary visibility. This procedure is problematic, because lighting design depends on design parameters, such as character locations, object locations, and tension, which change unpredictably during interaction. Therefore, static manual lighting designs can result in several problems, including distracting colors and insufficiently lit scenes.

Directing player's attention to significant objects or characters is important, especially for fast paced games with complex elaborate environments, where players need to decipher the visual environment quickly. Lighting plays an important role in directing attention. According to previous experimental results [15], due to poor lighting conditions many players failed to spot enemies quickly enough to respond in *Unreal Tournament 2003* (UT2003),

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which has caused much frustration and quitting. While dynamic lighting is desirable in this situation, very clever and careful static lighting designs may work for linear game architectures (i.e. games where level of importance and locations of objects can be determined at design time).

In addition, good dramatic lighting design often involves continuous modulation depending on the situation; this necessitates a dynamic lighting approach, as opposed to the static manual approach, that is flexible and sensitive to the player's situation and goals. To illustrate this point with a concrete example, consider horror or adventure games; designers of such games often use low-key lighting (very shadowy lighting) to evoke the necessary mood (e.g., *the Suffering*, *Blade of Darkness*). This kind of lighting hinders visibility, which can be crucial to game play, e.g. when attacking an enemy. In such games an intelligent lighting system is required to adequately balance the lighting design.

ELE

We have developed a dynamic intelligent lighting system called ELE (Expressive Lighting Engine) [15, 16]. ELE is developed based on cinematic theory [1, 5, 9, 13]. It uses constraint-based optimization to automatically, in real-time, select best lighting configuration that satisfies the desired perceptual goals, including establishing necessary visibility, directing player's attention to important scene elements, and evoking moods. The use of a dynamic automatic system allows for continuous modulation of lighting to accommodate the situation, thus alleviating the problems described above.

RESULTS OF USING ELE IN *UNREAL*

ELE has been interfaced with the *Unreal 2* Engine. Videos are available at [14]. ELE continuously selects a lighting configuration that addresses the desired visual design goals in real-time given the current situation. This continuous modulation of lighting provides a dynamic method for directing players to important areas in the game, which improves the gaming experience. We preformed a study to compare enemy spotting time with and without ELE. With ELE, users were able to spot the enemy faster, and thus weren't easily frustrated [15].

ELE also balances and accommodates several lighting design goals, including visibility, depth, tension, and atmosphere, while maintaining visual continuity. These goals, as discussed above, have great implication on game play and engagement. The videos in [14] show several examples where ELE was configured to stimulate tension through color patterns while establishing necessary visibility and maintaining visual continuity. One video shows a game where tension was defined to be a measure of danger calculated from user's perspective. To clearly see the utility of ELE, we also posted videos showing same scenes without ELE.

CONCLUSION

In summary, we have emphasized the importance of lighting design in creating a fulfilling and engaging game experience. Alternative to current *static* lighting design methods, we discussed ELE (Expressive Lighting Engine), a *dynamic* lighting system that *automatically* adjusts scene lighting in real-time to accommodate the dynamic situation. We have discussed the utility of this dynamic approach to lighting design in game environments. ELE has a great potential in enhancing gaming experiences by integrating a cinematic, expressive, automatic, and intelligent dynamic lighting design approach.

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