# Visually Directing User's Attention in Interactive 3D Environments

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Lighting is a very important component of 3D environment design. Research efforts in perception, neuroscience, animation, and film have shown the importance of visual design (a term used to denote lighting, camera motion, and staging design) in guiding participant's attention to important elements in a scene [Block 2001, Bollmann et al. 1997, Calahan 1996, Navalpakkam and Itti 2002, and Treisman et al. 1980]. Neuroscience and psychophysics literature identified several visual attention features: contrast, eccentricity, symmetry, and motion [Treisman et al. 1980, Navalpakkam and Itti 2002].

Cinematic and theatric lighting designers continuously modulate scene lighting to accommodate several design goals, including direct audiences' attention towards important areas in a scene, establishing visibility, evoking moods, and setting atmosphere [Block 2001]. A similar method for controlling and modulating lighting is required for interactive 3D environments. Currently most games use static set-based lighting approach, which does not accommodate the dynamic and unpredictable nature of interactive environments.

ELE, Expressive Lighting Engine [Seif El-Nasr and Horswill to appear], is a dynamic automatic lighting engine modeled based on film, animation, neuroscience, and psychophysics theories to modulate lighting within 3D environments in real-time balancing several aesthetic and design goals, including directing audience's attention to important areas in the environment, establishing visibility, setting atmosphere, and evoking emotions. ELE has been interfaced with a graphics engine (WildTangent) and tested in an interactive narrative called *Mirage* (figure 1). In addition, we also interfaced ELE to Unreal 2.0 engine (figure 2).

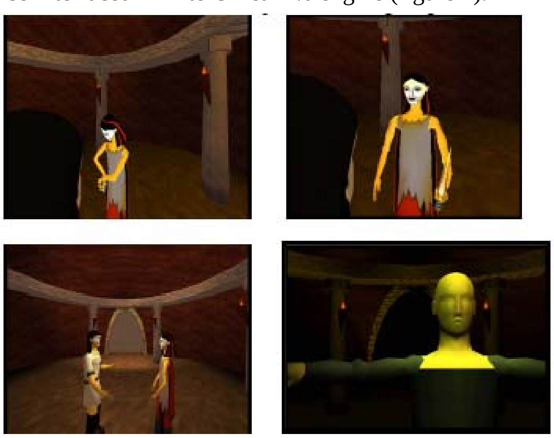

**Figure 1: ELE interfaced with Wildtangent**

We conducted an experiment to demonstrate the merits and utility of ELE over current methods in directing participant's attention to the important characters/objects in the scene. We asked users to play a simple level in Unreal Tournament while wearing an eye tracker mounted on a baseball cap. We observed and measured their eye movements in two versions of the game: one with ELE (figure 2), and the other with a static lighting approach.

Without ELE players were unable to decipher the environment quickly enough to respond to enemy fire, and thus died quickly and were easily frustrated. During the session, when players first enter the level, they begin "scanning" the room for an enemy. According to our observations, players often oscillate around an enemy as if he/she is invisible even though the enemy was in an open environment hidden by no obstacles or shadows. Using the timing data collected by the eye tracker, we identified a significant time lapse between players' eyes passing the character and recognizing the existence of the character. The results for the scene rendered using ELE show a considerable reduction in the players' 'scan' time. Hence, ELE, through careful placement of lights and choices of colors and angles, was able to improve visual attention and guide users to important areas in 3D scenes.

**Figure 2: ELE interfaced with Unreal**

Based on this experiment, we conclude that dynamic automatic real-time lighting modulation is important for ensuring a less frustrating and more fulfilling game experience, especially for naïve players. It is important to note that even though we have argued for modulating lighting in favor of visual attention, we acknowledge that in some situations this goal may be sacrificed for other design goals, example use of shadows to hide a sneaking enemy, as in *Thief I, II and III*. ELE does accommodate these situations by using optimization to select best lighting setup that balances these aesthetic and design goals [Seif El-Nasr and Horswill to appear].

## References

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