Visual Cues to Restore Student Attention based on Eye Gaze Drift, and Application to an Offshore Training System

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ABSTRACT

Drifting student attention is a common problem in educational environments. We demonstrate 8 attention-restoring visual cues for display when eye tracking detects that student attention shifts away from critical objects. These cues include novel aspects and variations of standard cues that performed well in prior work on visual guidance. Our cues are integrated into an offshore training system on an oil rig. While students participate in training on the oil rig, we can compare our various cues in terms of performance and student preference, while also observing the impact of eye tracking. We demonstrate experiment software with which users can compare various cues and tune selected parameters for visual quality and effectiveness.

CCS CONCEPTS

• **Human-centered computing → Virtual reality**.

KEYWORDS

Educational VR; Attention; Eye Tracking; Visual Cues

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1 INTRODUCTION

We are presenting 8 attention-restoring visual cues to encourage students to return visual focus to the correct object when their attention shifts elsewhere. As a simple example, we measure inattention by using the *gaze angle* between the student's eye gaze vector and the vector from the student to the target object. Cues are activated once the gaze angle surpasses a threshold. We have described a more general inattention score elsewhere [4]. Our cues are specifically being used to "restore attention" after it is lost. We believe this will result in a more subtle and effective use of the cues, when compared to previous works [7] in which visual cues are used to "guide attention" from the start. In addition to adapting some of the best-performing cues from prior work, we include a few of our own cue variations for future assessment.

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Each one of our cues has been integrated into an offshore training system on a virtual oil rig (Fig. 1k) in order to gather data about cue performance (time and head/eye movements necessary to restore student attention) and the benefits of eye tracking. Students will be tasked with learning about various features of the oil rig. Our cues will be used to assist the student when inattention is detected.

Once our cues have been compared and optimized, they will be integrated with a pedagogical agent that presents content in a VR field trip [4]. This will promote student attention and provide a more engaging learning environment in educational VR.

2 ATTENTION-RESTORING CUES

2.1 Preliminary Details

Audience members will be able to cycle through cues and toggle eye-tracking on and off. They will also be able to manipulate multiple parameters, which allow control over features of the cues.

Each cue shares two common parameters: *transparency/fade strength* and *cue size*.

Some cues have a special *placement* parameter that determines whether they are placed along an arc on a head centered sphere with radius being the distance between the head and the target or along a cubic Hermite curve like the one described by Biocca et al. [1].

In order to handle objects in the VR scene occluding our cues, select cues are rendered such that they appear through other objects.

2.2 Cue Descriptions

The *standard arrow* (Fig. 1a) is a single 3D arrow. It is placed along the arc above and is oriented to point towards the target. A positioning parameter allows for the arrow to be offset some percentage towards the target.

The *trail of arrows* (Fig. 1b/1c) places multiple arrows along the arc or curve between the student's gaze and the target object. This is expected to provide a stronger cue than a single arrow.

The *navigation sphere* (Fig. 1d) is a novel cue that is a field of arrows on a head-centered sphere. Arrow placement does not depend on any gaze tracking, so arrows appear static rather than moving. The arrows appear at vertices of an (invisible) icosphere and are oriented to point along an arc towards the target, as for the standard arrow. A parameter varies the number of arrows, corresponding to different icospheres with different levels of detail.

The *attention funnel* (Fig. 1e) is based on the one created by Biocca et al., which was created by placing multiple rings along a cubic curve between the student and the target [1]. A rendering parameter changes the rendering style (ring or goalpost).