PhD Subject proposal

Gaze as a Biomarker of Reality

Evaluation Method for the Realism of 3D Simulations for Training and Education Based on Visual Attention

Laboratory : computer science lab of le Mans University (LIUM)

Team : Technology enhanced learning (IEIAH)

Location : Laval Campus, France (1h20 from Paris by train)

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Project description

Validating 3D simulations is essential to ensure that a simulated object or virtual environment elicits the same reactions as in real life. For example, in virtual reality, it is crucial that a simulation is perceived as close to reality for user behaviors to be translatable to a real situation. The simulation of scenes and objects is very important for learning in simulated conditions, a recurring theme in education [1] and professional training (e.g., in healthcare [2]). Simulation offers us the opportunity to design highly controlled learning situations in conditions that would be difficult to reproduce in reality due to their time and cost, or their associated risks (simulating hazardous situations).

The way we look at scenes or objects can be impacted by disruptive elements, because they are unusual or unexpected. Eye-tracking data is a rich source of information but is very rarely used to evaluate the realism of simulations. The IEIAH team at LIUM has been conducting research in virtual reality for several years (EVAGO and Virtual 3R projects). The geographical context is also very conducive to this research, thanks to possible collaborations and exchanges with researchers within the Laval Virtual Center (ENSAM, Clarté) and the TEEF Master's program.

Project Objectives

The project aims to develop a method for evaluating the realism of simulations, particularly based on eye movements. To achieve this, it is necessary to collect eye-tracking data during the observation of both simulated and real stimuli. The project is divided into two main axes:

1. **Data Acquisition:** Develop a simple and versatile method for acquiring eye-tracking data. This method should be applicable to all types of simulations and allow for the use of crowdsourcing to quickly obtain substantial and diverse datasets.
2. **Modeling and Evaluation:** Create a model for evaluating the realism of stimuli and identifying parts that incorrectly attract attention. This model will use machine learning techniques (AI) to predict what is disturbing in a simulation and calculate a measure of realism.

To achieve these objectives, the project relies on four key steps:

1. **Simplification of the Data Acquisition Process:** Develop simple and versatile experimental protocols for collecting eye-tracking data. This includes using the mouse as a proxy for visual attention and presenting stimuli on a standard computer screen instead of in VR [3].
2. **Validation of Experimental shortcuts:** Compare gaze behaviors obtained in different experimental conditions, particularly between virtual reality and observation on a standard screen. This in order to measure to what extent behaviors observed in virtual reality can be replicated in simpler conditions that enable mass data collection [4, 5].
3. **Identification of Gaze Characteristics:** Identify the gaze characteristics most useful for identifying disruptions of visual attention. This includes analyzing fixations, saccades, pupil responses, and possibly other physiological variables [6].
4. **Modeling and Prediction:** Develop a machine learning model to predict realism. This model will calculate an overall realism value and more detailed outputs will precisely identify which parts of a simulation are problematic. This AI model will integrate into an iterative process for improving simulations.

Expected Profile

The candidate should have:

- A Master's degree in Computer Science or a related field;
- Strong skills in signal processing;
- Proficiency in machine learning (deep learning);
- A good level of English (written and spoken);
- Excellent writing skills.

Recruitment Process

Based on your application documents, then an interview.

Your application should be submitted electronically to
erwan.david@univ-lemans.fr
AND sebastien.iksal@univ-lemans.fr

Your application should include:

- A CV;
- A cover letter;
- Your master's thesis (if available);
- Academic results and rankings for your Master's degree (if available);
- Any other attachments you deem useful (recommendation letters encouraged).

References

[1] Moro, C., Phelps, C., Redmond, P., & Stromberga, Z. (2021). HoloLens and mobile augmented reality in medical and health science education: A randomised controlled trial. *British Journal of Educational Technology*, *52*(2), 680-694. [article]

[2] Tun, J. K., Alinier, G., Tang, J., & Kneebone, R. L. (2015). Redefining simulation fidelity for healthcare education. Simulation & Gaming, 46(2), 159-174. [article]

[3] **David**, E., & Võ, M. L.-H. (March 2023). Mouse movements on-screen are an alternative to gaze in VR. 65th Tagung experimentell arbeitender Psycholog:innen (TeaP; Conference of Experimental Psychologists). Trier, Germany. [abstract, slides]

[4] **David**, E., Beitner, J., & Võ, M. L.-H. (2020). Effects of transient loss of vision on head and eye movements during visual search in a virtual environment. Brain sciences, 10(11), 841. [article]

[5] **David**, E., Lebranchu, P., Perreira Da Silva, M. & Le Callet, P. (2022). What are the visuo-motor tendencies of omnidirectional scene free-viewing in virtual reality?. Journal of Vision, 22(4), 12. [article]

[6] **David**, E., Lebranchu, P., Perreira Da Silva, M. & Le Callet, P. (2019). Predicting artificial visual field losses: a gaze-based inference study. Journal of Vision, 19(14), 22. [article]