Funded thesis offer

ENSA Nantes (AAU, UMR CNRS 1563)

Perception of architectural lighting ambiances in immersive digital devices

Keywords

Immersion; virtual reality; image processing; lighting ambiances; visual perception; high dynamic range; architecture.

General information

The PhD student will be hired as part of the PERCILUM project, a pioneering research project that explores **the perception of architectural lighting ambiances in virtual environments. It aims to develop new immersive visualization tools for lighting ambiances from a pedagogical standpoint.** These tools will allow to improve the understanding of lighting ambiances to help decision-making for actors involved in lighting.

PERCILUM is funded by the Agence Nationale de la Recherche (ANR) as part of the 2019 generic call for projects. It is carried out by a pluridisciplinary team of researchers from four laboratories: the Ambiances, Architectures, Urbanités laboratory (AAU, UMR 1563); the Laboratoire des Sciences du Numérique of Nantes (LS2N, UMR 6004); the Génie Civil et Bâtiment laboratory (LGCB), and the Environnement Ville Société Laboratory (EVS, UMR 5600).

The thesis subject is part of the third task of the Percilum project: *"Analysis and characterisation of the situated perception of in-situ lighting ambiances and in immersive free-viewpoint devices."*

Thesis subject

Nowadays, the immersive multimedia devices that are available on the market (also known as "virtual reality headsets") enable the perception of spatiality, which is really useful to explore architecture virtually. However, exploring is limited as the perception of lighting ambiances with such tools does not mirror reality in a satisfactory way.

The thesis aims primarily to evaluate and characterise the perception of lighting ambiances considering the architectural and lighting characteristics of the scene, the rendering device features (virtual reality headset, immersive screens…) and the image processing applied. The results should allow to propose recommendations regarding the rendering of architectural images in immersive digital devices offerings different types of lighting ambiances.

Indeed, beyond the quantitative command of the luminous flux to save energy in buildings, light carries essential, affective and cultural values that participate in our quality of life indoors [Hobday, 2006; Boubekri, 2008] and in the conception of profitable spaces for people [Andersen, 2015; Mardaljevic, 2005]. Many architects use it to create ambiances, reveal volumes, pace a journey and create emotions [Zumthor, 2006; Holl, 2011; Pallasmaa, 2012]. The training offered to actors in the building industry thus requires tools that include the qualitative dimension of light in order to make conception choices. However, while the state of the art indicates that the use of image reproduction tools for the visualization of lighting ambiances is an active research theme [Murdoch et al., 2015], no works have led to a faithful rendition of lighting ambiances on any type of scene and regarding associated perceptual dimensions [Zhao et al., 2015; Schielke, 2016].

The PhD work will thus focus on the use of high dynamic range (HDR) technologies and virtual reality to render a lighting ambiance as faithfully as possible. Nowadays, HDR technologies allow to capture and recreate a large array of contrasts. The point will be to evaluate the visual perception of omnidirectional HDR images (360) with virtual reality headsets according to different dimensions regarding the study of ambiances (faithfulness to reality, comfort, affective and aesthetic dimension, etc.). To this end, the metric and perception models developed for the study of the Quality of Experience (QoE) of HDR systems [Cadik et al., 2008; Krasula et al., 2014; Yeganeh et al., 2013; Vigier et al., 2016; Perrin et al. 2017] should be broadened and adapted to the study of architectural lighting ambiances and to the project study cases.

The systems targeted here are in free viewpoint. They give the use the possibility to move their head and into the image with three degrees of freedom. This mobility allows in particular to focus on lighting transitions and on the user's visual adaptation during these transitions. Yet, it requires to adapt the representation methods for HDR content by proposing tone mapping and high luminance rendering algorithms adapted to the viewing window selected by the user and to the systems' latency, while maintaining a spatio-temporal coherence of the lighting and the contrasts [Cutchin and Li, 2016]. The staging of reproduction, especially the possibility to move within the scene, will be subjected to studies, to examine the similarities of the sensitive experiences between a real and a reproduced scene.

Experiments to evaluate the perception of lighting ambiances in immersive digital systems will be carried out as part of this thesis. As part of an interdisciplinary approach, the experiments should rely on protocols integrating both subjective (interviews, questionnaires) and objectives (behavioural measures, eye tracking) measures to characterise precisely the sensitive perception of these ambiances. In particular, the study of the perceptual fidelity of lighting ambiances from the measure of visual attention and its comparison in real and rendered scenes, will also be studied in this project [Narwaria et al., 2012 ; Ellahi et al. 2020].

Work context

The selected candidate will be recruited under doctoral contract and jointly integrated to the AAU-CRENAU and LS2N laboratories. They will register to the Engineering Sciences (SPI) doctoral school, hosted by the Ecole Centrale de Nantes.

The thesis will be supervised by Daniel Siret, Director of the UMR AAU, researcher specialized in insolation in architecture. The supervision will be completed by Toinon Vigier, lecturer in computer science at the University of Nantes, researcher in the Image Perception Interaction team at LS2N, and Céline Drozd, researcher at CRENAU and specialised in lighting in architecture et in the pedagogy of ambiances.

Expected date of beginning: January 2021
Proportion of work: 100%.
Duration: 36 months
Workplace: Nantes (ENSA Nantes, Université de Nantes)
Monthly gross remuneration according to the CNRS framework.
Employer: CNRS.

Profile

Training

Considering the interdisciplinary element of the research, the selected candidate can have an education in several education fields:

- Master 2 or computer engineering degree (IHM, virtual reality, image processing) with a strong interest for humanities.
- Master 2 in architecture or design with a strong interest for digital sciences (virtual reality, images).
- Master 2 in cognitive sciences with a strong interest for digital sciences (virtual reality, images).

Required skills
- Ability to work independently, organizational ability.
- Interest and competence in experimental work (methodological rigour, implementation of experiments, collection and analysis of data).
- Spoken and written communication skills: dissertation, article, scientific report.
- Good command of spoken and written English (presentations, interviews and publications).

Application

In accordance with the CNRS commitment to the European Human Resources Strategy for Researchers (HRS4R), the candidates must apply on the application platform of the Portail Emploi of CNRS (https://bit.ly/2Ho8qk7), to the exclusion of all other procedures. The application should include:

- A cover letter (between 5,000 and 7,000 characters) highlighting the relevance of the candidate's profile with the thesis subject,
- A short personal CV (1 page maximum),

Closing date for the receipt of applications: 30 November 2020
The pre-selected candidates will be invited for an in-person or remote interview.

Contacts
Toinon Vigier toinon.vigier@univ-nantes.fr
Daniel Siret daniel.siret@aau.archi.fr