Offer #2025-08622

Doctorant F/H Lighting estimation from images for seamless integration of virtual objects into real scenes

The offer description below is in French

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

Le centre Inria de l'Université de Rennes est l'un des huit centres d'Inria et compte plus d'une trentaine d'équipes de recherche. Le centre Inria est un acteur majeur et reconnu dans le domaine des sciences numériques. Il est au cœur d'un riche écosystème de R&D et d'innovation : PME fortement innovantes, grands groupes industriels, pôles de compétitivité, acteurs de la recherche et de l'enseignement supérieur, laboratoires d'excellence, institut de recherche technologique

Context

All visual effects used on feature films have a process where virtual objects, whether creatures or set extensions, require to have a perfect synthetic lighting matching the real on-set lighting. If they fail to capture or reproduce the real lighting, the human eye is trained enough to instantly detect issues and classify the result as being not realistic. Even today on most recent super-productions, that lighting seems wrong for some situations. This is mostly due the inherent technique used -the HDRI chrome and diffuse balls- that fails to capture the local lighting changes. These are just a coarse approximation of the real lighting and they do not take into account occlusions and interreflections. To correct this, some VFX companies will have

artists to manually correct the lighting which may induce additional flaws in the visual integration of virtual objects.

Past year, a preliminary work has been achieved using single images as input. It allowed us to estimate the global illumination of a real scene. The first step computed an HDR panorama from a single image [2], whilst an approximation of the 3D model of the scene was obtained using AnyDepth [3]. By reprojecting the estimated HDR panorama onto the 3D model, we generate a first approximation of the global illumination and thus insert virtual objects into real scenes in a photorealistic and visually plausible way, using Unreal Engine [1].

Assignment

The objective of this thesis is to work on new techniques for estimating the position, orientation and intensity of light sources from videos, to seamlessly integrate virtual objects into real scenes.

We propose here to build on this work by first improving the current limitations and then generalizing the approach. The first step is to be able to work from videos where the lighting is dynamic. Indeed, the current approach only allows static lighting as we use a single image to compute the lighting. The key challenge lays in the ability to generate temporally stable light estimations over the sequence. A second step is to design a validation framework to assess the preciseness of the light reconstruction and the quality of the generated results, typically by using the ground truth generated by a game engine such as Unreal Engine (UE). More precisely, we would use a photo realistic scene and use not only the real video created by UE but also the 3D model and the HDR representation of the scene to compare our results to the same simulation in UE. Additional extensions would include the possibility to have a multi-pass rendering approach where the synthetic objects illumination also impacts the real scenes (consider for example the color bleeding of a virtual red sphere over a real white wall).

In addition to the previous research directions, to improve the generalization capacity the thesis will also focus on exploring techniques using radiance scene representations such as 3D Gaussian Splatting to model more precise light behaviors than emissive meshes [5] and also explore how diffusion-based techniques could be adapted to handle light sources estimation, in the way ray diffusion is used to perform camera pose estimation [6].

The application of the results to real scenes will be then investigated, either from single images or 360 videos provided by VFX companies and movie productions.

[1] https://www.unrealengine.com/

[2] Wang, Jionghao & Chen, Ziyu & Ling, Jun & Xie, Rong & Song, Li. (2023). 360-Degree Panorama Generation from Few Unregistered NFoV Images. 10.48550/arXiv.2308.14686.

[3] Yang, Lihe & Kang, Bingyi & Huang, Zilong & Zhao, Zhen & Xu, Xiaogang & Feng, Jiashi & Zhao, Hengshuang. (2024). Depth Anything V2. 10.48550/arXiv.2406.09414.

[4] https://www.ncam-tech.com/

[5] Bernhard Kerbl and Georgios Kopanas and Thomas Leimkühler and George Drettakis. 3D Gaussian Splatting for Real-Time Radiance Field Rendering. ACM Transactions on Graphics, volume 42(4), July 2023

[6] Zhang, Jason Y and Lin, Amy and Kumar, Moneish and Yang, Tzu-Hsuan and Ramanan, Deva and Tulsiani, Shubham . Cameras as Rays: Pose Estimation via Ray Diffusion. International Conference on Learning Representations (ICLR), 2024.

Main activities

- analyse existing contributions in the field
- design research prototypes that improve over existing work (video/light estimation)
- publish the work in selective venues

Benefits package

- Restauration subventionnée
- Transports publics remboursés partiellement
- Congés: 7 semaines de congés annuels + 10 jours de RTT (base temps plein) + possibilité d'autorisations d'absence exceptionnelle (ex : enfants malades, déménagement)
- Possibilité de télétravail (après 6 mois d'ancienneté) et aménagement du temps de travail
- Équipements professionnels à disposition (visioconférence, prêts de matériels informatiques, etc.)
- Prestations sociales, culturelles et sportives (Association de gestion des œuvres sociales d'Inria)
- Accès à la formation professionnelle
- Sécurité sociale

General Information

- **Theme/Domain :** Interaction and visualization
  Scientific computing (BAP E)
- **Town/city :** Rennes
- **Inria Center :** Centre Inria de l'Université de Rennes
- **Starting date :** 2025-10-01
- **Duration of contract :** 3 years

- **Deadline to apply :** 2025-04-04

Contacts

- **Inria Team :** VIRTUS
- **PhD Supervisor :**
  Christie Marc / Marc.Christie@irisa.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

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Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.