2018-00544 - [PhD Campaign] - Light transport operators simplification using neural networks - Inria Grenoble research center

Niveau de diplôme exigé: Bac + 5 ou équivalent  
Fonction: Doctorant

A propos du centre ou de la direction fonctionnelle

Grenoble Rhône-Alpes Research Center groups together a few less than 800 people in 35 research teams and 9 research support departments.

Staff is localized on 5 campuses in Grenoble and Lyon, in close collaboration with labs, research and higher education institutions in Grenoble and Lyon, but also with the economic players in these areas.

Present in the fields of software, high-performance computing, Internet of things, image and data, but also simulation in oceanography and biology, it participates at the best level of international scientific achievements and collaborations in both Europe and the rest of the world.

Contexte et atouts du poste

Computer-generated pictures are frequently used nowadays, both for entertainment (video games, special effects in motion pictures) and for more serious applications, such as virtual prototyping. All these applications rely on photorealistic rendering: creating an image of the virtual scene that looks as close as possible to a photograph. Photorealistic rendering involves simulating light transport throughout the entire scene: following light as it is emitted from the light source, bounces on objects in the scene, until it reaches the virtual camera.

The connection between the light emitted by the light sources and the environment and the light that reaches the camera can be expressed as a light transport operator. The complexity of the light transport operator depend on the scene complexity and on the physical phenomena being modelled. Specular surfaces result in high-frequency changes that are easier to model, while diffuse surfaces result in low-frequency variations, which require integrating over a large set of directions. A lot of past research has focused on finding compact and accurate representations for the light transport operator.

We often encounter the following paradox: some effects (soft shadows, diffuse surfaces, indirect global illumination) result in very smooth variations but require integrating over a large domain. The smoother the effect, the larger the integration domain, requiring a large number of samples to reach convergence. In short, the less an effect is visible, the more expensive it can be to compute.

Recent research used neural networks for denoising images computed using Monte-Carlo simulation; the result is an image that is identical to the converged version (using thousands of samples per pixel) with as little as one sample per pixel. Neural networks are efficient in this context because of the problem characteristics: clear input, clear metric for success. It focused on the last bounce of illumination, just before it reaches the virtual camera.

Mission confiée

The goal for this thesis is to use neural networks for simplification of the light transport operator, higher up in the transport chain.

Principales activités

We will begin with indirect diffuse illumination, which is both very expensive to compute and very simple in its structure. Our aim is to have a compact representation for the indirect light transport operator using neural networks, and to apply this knowledge to produce fast global illumination simulation. The neural network approach has two different outcomes: fast offline simulation and, with a different network, interactive global illumination, useful for real-time rendering of complex scenes.

After this first step, we will apply the approach to other global illumination phenomena that are both expensive to compute and simple (but not obvious) in their results. The most challenging issue currently in photorealistic rendering is accurate simplification and filtering of complex geometry, such as fur or tree leaves, when a single pixel can covers thousands of small details. We need to replace the complex geometry defining the object by a simple representation that can still be used...
for computations and rendering with sufficient accuracy. Again, this is an area where neural networks are expected to excel.

Bibliography:
- Mots-clés : Global Illumination, Illumination simulation, photorealistic rendering, neural networks

Compétences
Candidates are expected to have a good knowledge of Computer Graphics techniques, especially global illumination algorithms, along with a good knowledge of neural networks.

Avantages sociaux
- Restaurant on site
- Financial participation for public transport
- Social security
- Social and sporting activities
- Arranging working time
- French courses

Rémunération
Monthly salary after taxes: around 1596,05€ for 1st and 2nd year. 1678,99€ for 3rd year. (medical insurance included).