



Procedural texture graphs for ray-tracing rendering

Proposal for a PhD in Computer Science at the University of Strasbourg, France.

Graphes de textures procédurales pour le rendu par lancer de rayons

Proposition de thèse de doctorat en informatique à l'Université de Strasbourg.

Procedural texturing for digital worlds. The huge size of virtual worlds in graphics applications is a challenge for the management (i.e. creation, editing, storage, transfer, processing and rendering) of large amounts of 3D data. Textures are a key ingredient when it comes to increase the visual complexity. Procedural texturing is a content generative approach, which drastically reduces the pre-processing and storage needs by computing the data on demand. This project is concerned with both the modeling and the rendering of procedural textures.

Procedural texturing consists in traversing a directed acyclic graph, the Procedural Texture Graph (PTG). Source nodes are mathematical functions, among which we are particularly interested in procedural noises [GSVDG14, GLM17, HN18]. Sink nodes are final outputs. Inner nodes are pixel processing operations, including linear operators (e.g. derivatives and convolutions), arithmetic combinations, and non-linear intensity filters (e.g. thresholding and color tables) [HNPN13].

A new workflow for rendering procedural textures. The standard workflow consists in 3 consecutive stages. (a) The graph is designed by artists using specific softwares. (b) The output texture is computed by traversing the PTG in topological order, and it is stored. (c) The 3D scene is rendered using the stored texture. This workflow is efficient in terms of computation and it is convenient for anti-aliasing at rendering stage because standard techniques can be applied to the pre-computed textures. However, due to the memory cost, it is complex to use with high-resolution textures on large areas of the scene. So as to overcome this limitation, we propose a new workflow which avoids pre-computation and storage. The graph is evaluated on demand, and controlled by the output rendering requests. The rendering technique is ray tracing, so the core question is: how do the virtual light rays interact with the texture graph?

PhD project. The PhD candidate will work on enriching the texture graph with metadata that allow for an actual computation of the ray propagation when combined with ray data and light

propagation rules. He/she will then design and implement novel algorithms to produce the procedural texture graph with metadata from an input example.

This work is part of the project “Rendering procedural textures for huge digital worlds” (ReProcTex), an ANR-DFG joint project between the University of Strasbourg (France) and the Karlsruhe Institute of Technology (Germany). The candidate will be hosted at the University of Strasbourg, in the Computer Graphics team of the ICube lab. He/she will be co-advised by Basile Sauvage and Jean-Michel Dischler. He/she will spent several periods in Karlsruhe, collaborating with Johannes Schudeiske and Carsten Dachsbacher, from the Computer Graphics team at Karlsruhe Institute of Technology.

Related papers

[GSVDG14] Gilet, G.; Sauvage, B.; Vanhoey, K.; Dischler, J.-M. & Ghazanfarpour, D.
Local Random-Phase Noise for Procedural Texturing.
ACM Transactions on Graphics, ACM Press, 2014, 33.

[GLM17] Galerne, B.; Leclaire, A. & Moisan, L.
Texton Noise
Computer Graphics Forum, 2017, 36 (8), 205-2018

[HN18] Heitz, E. & Neyret, F.
High-Performance Procedural Noise using a Histogram-Preserving Blending Operator.
Proceedings of High-Performance Graphics, 2018.

[HNPN14] Heitz, E.; Nowrouzezahrai, D.; Poulin, P. & Neyret, F.,
Filtering Non-Linear Transfer Functions on Surfaces.
IEEE Transactions on Visualization and Computer Graphics, 2014, 20(7), 996-1008.

Links

- CG team at the ICube lab http://icube-igg.unistra.fr/en/index.php/Main_Page
- ReProcTex project <http://igg.unistra.fr/People/reproctex/>
- Basile Sauvage http://icube-igg.unistra.fr/fr/index.php/Basile_Sauvage
- Jean-Michel Dischler http://icube-igg.unistra.fr/fr/index.php/Jean-Michel_Dischler
- CG team at KIT <https://cg.ivd.kit.edu/english/>

Funding

ANR-DFG project ReProcTex.

Who should apply

- Master degree in Computer Science, or equivalent.
- Strong background in computer graphics, mathematics, and programming.
- Additional skills in some of the following topics would be appreciated: texture synthesis, procedural textures, rendering, ray tracing, GPU programming.
- Fluent french or english speaking.

How to apply

Send a CV and an application letter before June 19th, 2020
to sauvage@unistra.fr, dischler@unistra.fr