

数理・情報のフロンティア
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計算機による伝統木工支援 / Computer-Assisted Wood Craft

研究成果の概要

During FY2022, this project focused on modeling this unique and heterogenous annua ring pattern of wood. Previous work in the field of computer graphics proposed a highly efficient technique to synthetically generate various patterns: procedural texturing. With this technique, the points of interest (the visible pixels on the surface of the object being rendered) are calculated based on a series of mathematical operations on demand (during rendering) without storing all pixel colors as a raster image in the texture memory. However, we previous procedural methods do not handle knots. Knots are a common wood feature caused by branches growing out from the stem of the tree, and they cause intricate distortions to the annual ring pattern.

Therefore, we developed a procedural framework for modeling wood with knots. The input to the method is a grafted internal skeleton of a tree log. We calculate the scalar fields of time (distance divided by the local speed of growth) around each strand of the skeleton. The time fields are then merged using established functions for creating a smooth union between multiple fields. We suggest further techniques for fine-tuning the balance of smoothness and for handling dead knots, which include smoothness inversion and so-called butterfly distortions. To produce the final output image, we convert the time field values into pixel colors by mapping it to a one-dimensional raster image of wood colors. We present a variety of rendered solid wood textures aimed at recreating patterns observed in reference images. Further, we reproduce the appearance of engineered wood, specifically plywood and cross-laminated timber. Future work may explore interactive design and fabrication systems based on the proposed texturing framework.

This project was a part of my doctoral thesis [1]. It was also published in the top international journal for computer graphics [2], while a Japanese version was published at a domestic conference [3].

【代表的な原著論文情報】

- 1) Maria Larsson. *Computational Carpentry: Material- and Fabrication-aware Design Systems* (Japanese title: 計算木工: 素材および製作プロセスを考慮したデザインシステム). PhD Thesis. The University of Tokyo, 2023.
- 2) Maria Larsson, Takashi Ijiri, Hironori Yoshida, Johannes A. J. Huber, Magnus Fredriksson, Olof Broman, and Takeo Igarashi. 2022. Procedural texturing of solid wood with knots. *ACM Trans. Graph.* 41, 4, Article 45 (July 2022), 10 pages.
- 3) Maria Larsson, Takashi Ijiri, Hironori Yoshida, Johannes Huber, Magnus Fredriksson, Olof Broman, and Takeo Igarashi. 節目を持つ木材の手続き型 3 次元テクスチャ. VC '22: Visual Computing. Kyoto, Japan. October 2022 (short paper Japanese version of item 2)