Temporally Coherent Stylization of Animations:

Texture Fractalization and Perceptual Evaluation

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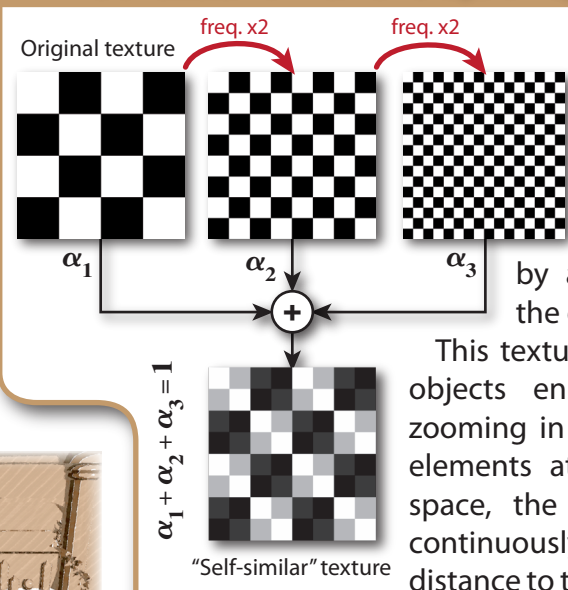
Goal and Motivations

Stylized rendering methods, which aim at depicting 3D scenes with 2D media such as pigments or strokes, are often faced with *temporal coherence* issues when applied to dynamic scenes. This problem arises from the contrary goals of depicting a 3D motion while preserving the 2D characteristics inherent to any style marks.

What we call **texture fractalization** is a common solution to solve this problem. Extending this approach, we propose an object-space infinite zoom mechanism for real-time coherent stylization. This method modifies the patterns of the targeted medium. Therefore, we perceptually evaluate the dissimilarity of the *fractalized* texture to the original.

Fractalization and Object Space Infinite Zoom



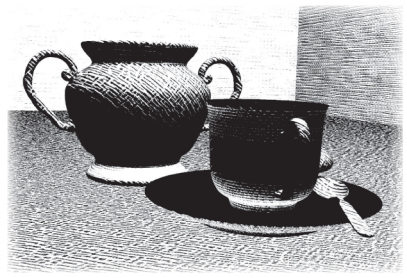
In [BBT09] we propose a new **infinite zoom mechanism** by extending previous screen-space *fractalization* algorithms. The fractalization process consists in creating a "**self-similar**" texture by alpha-blending multiple scales of the original.

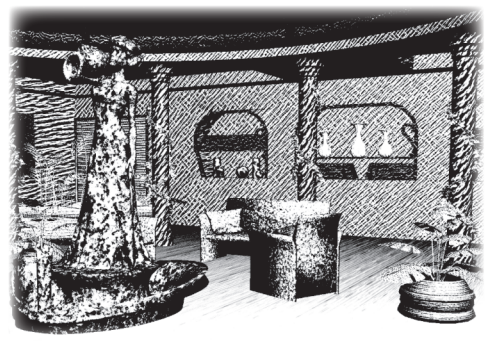
This texture is mapped on the animated 3D objects ensuring a convincing feeling of zooming in and out. But, to keep the texture elements at a quasi-constant size in screen space, the scale and blending-weights are continuously modified according to the objects distance to the camera. Doing so, the **illusion of an infinite zoom** is created with a full temporal coherence.

Watercolor

Collage

real-time applications of our infinite zoom mechanism with three different non-photorealistic styles



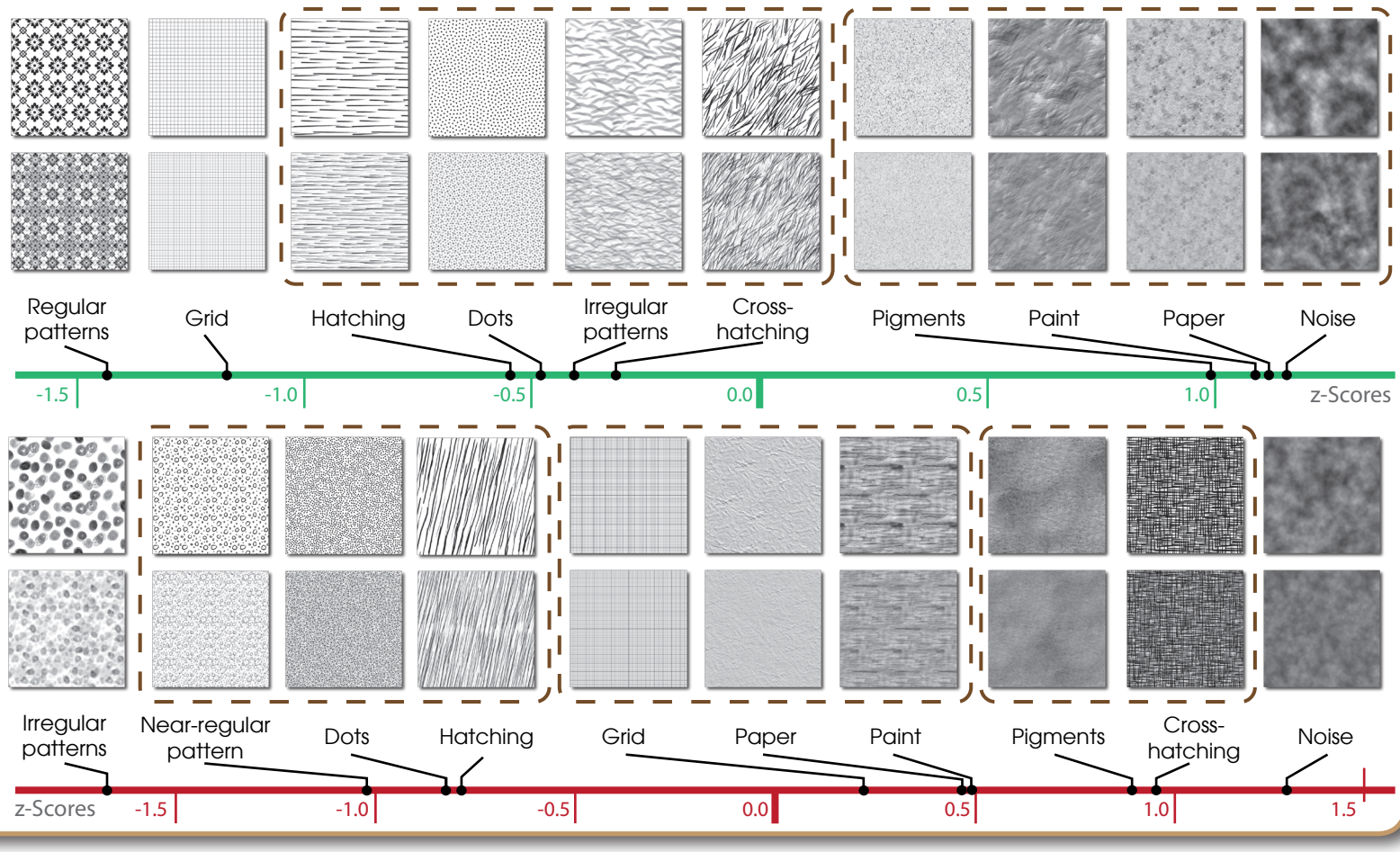


Binary style

Perceptual Evaluation of "Self-similar" Textures

In [BTS09] we present the results of a **perceptual study** evaluating the distortion induced by the fractalization of ten typical textures of medium. We perform a user experiment in which users are asked to **rank pairs of original / transformed textures** from the least distorted pair to the most distorted one.

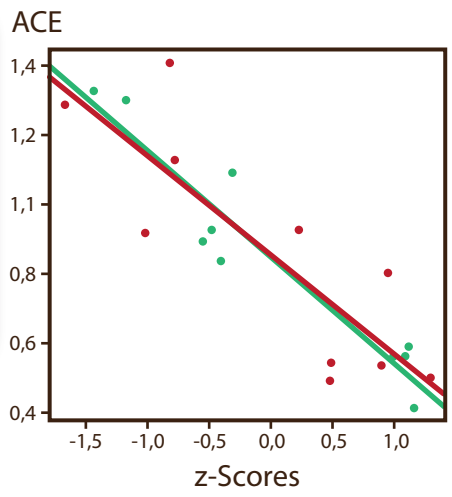
We provide a statistical analysis of the 103 resulting rankings to derive perceived quality scales (z-Scores) and classes of equally distorted media. For both image sets we show that the **unstructured textures** seem to be more robust to the fractalization, contrary to textures exhibiting more distinctive features. Besides, the **overall contrast** of patterns seems to be the most significant criterion for the grouping, whereas feature shapes seem to play a less important role.



Objective Quality Metric

In this last step, we study the correlation of these subjective scales with several objective metrics coming from image quality assessment and texture analysis, and based on global and local image statistics or spectrum analysis. As expected, only **local image statistics** give conclusive results. The other metrics are either unable to handle this amount of distortion, or cannot consider simultaneous variations in terms of contrast, scale and frequency.

We suggest that the **Average Co-occurence Error** (ACE) of Copeland *et al.* [CRT01] is a good predictor of the distortion as it exibits a strong correlation with the perceptual interval scales for both series.



References:

[BBT09] Pierre Bénard, Adrien Bousseau, and Joëlle Thollot, *Dynamic Solid Textures for Real-Time Coherent Stylization*, I3D 09.

[BTS09] Pierre Bénard, Joëlle Thollot, and François Sillion, *Quality Assessment of Fractalized NPR Textures: a Perceptual Objective Metric*, APGV 09.

[CRT01] A.C. Copeland, G. Ravichandran, and M.M. Trivedi, *Texture synthesis using Gray-level Co-occurrence Models, Algorithms, Experimental analysis and Psychophysical support*, Optical Engineering 01.

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