A flexible approach to non-homogeneous texture generation

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ABSTRACT

Due to the numerous applications, textures reserve significant interest in many scientific fields. Several recent works concentrate in the analysis and synthesis of textures, and they still are a very active and actual area of research in Computer Graphics. In this work, we propose a pixel-based technique, which allows the production of smooth textures and a precise patterns' visualization. Textures' patterns may move or vary along given directions or may progressively change their appearance. We implemented our algorithm incorporating much functionality in a general framework; this framework offers the possibility to generate non-homogeneous textures in a flexible and interactive way. Integrating artistic effects and performing a frames' animation is also possible, allowing the production of a variety of effects in an easy and general way.

Keywords

Texture synthesis, Non-homogeneous textures, Artistic effects, Image generation.

1. INTRODUCTION AND MOTIVATION

Textures reserve much attention and interest in Computer Graphics. Although in the last years many works concentrate in optimizing synthesis algorithms, the production of *ad hoc* generated outputs still remains challenging: recent research in this field recognizes the lack of local control in the synthesis process and there is a need for flexible user intervention [Ash01], [Her01]. The complex nature of real objects requires many attributes in order to be visualized in a realistic and credible way, textures often seems to be generated by a few underlying processes, and they are the result of several appearances that need to be appropriately combined together. For this purpose, we propose a novel idea, which introduces the required flexibility in textures generation. With respect to our previous work, we generalize here the texture synthesis method, proposing a much broader and complete methodology, still offering the user a simple and intuitive interface.

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2. THE ALGORITHM

Our algorithm proceeds as follows. It is based on a *per-pixel* synthesis (refer to [Wei00] for details about the basics), but instead of just using an input sample, we facilitate of a set of inputs, using in addition a collection of filters and operators, which produce a heterogeneous matrix of samples in order to produce *ad hoc* generated output images. Moreover, in order to improve quality and time costs, we performed a multi-pass algorithm using *Image Pyramids* [Hee95].

3. SYSTEM

We built a comprehensive system that incorporates several settings and functionalities. This framework allows the user to flexibly design his output and to interact with the texture generation process: the user can select options, defining variable parameters to generate personalized textures. One or more samples (a *sample set*) may be used as source seed for the synthesis. Additionally, further operators we named *Vector Field, Filters* and *User controls* also may contribute in generating or modifying the output.

In the framework, the samples' set is constituted by an input *matrix* (Fig.1), whose dimensions belong to the range $[1, W*H]$, being W and H, respectively, the specified width and height of the output texture.

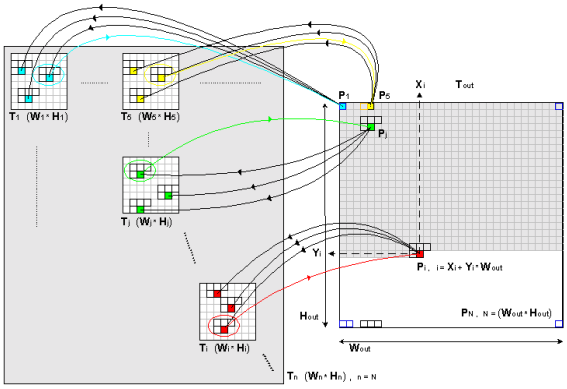

Figure 1. Matrix of input samples.

Some of the most common case studies and possible fields of application are:

- Filtered Texture Synthesis: *Image Processing Filters* may be used [Tap04] to vary characteristics in the sample or to modify and highlight some regions of interests in the output, as well as to augment a texture with artistic effects (Figure 2a).
- Texture Bending: superimposing a direction field may strongly influence a texture appearance,adding possible 3d effects and forcing the input patterns to follow specified directions (see Figure 2b).

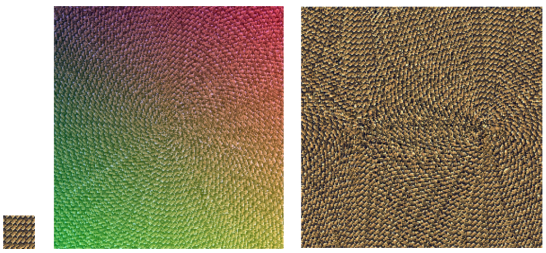

Figure 2. Gradually filtering the texture sample (a) and moving a given pattern along specified directions (b).

- Texture Synthesis for Vector Fields Visualization: using samples characterized by having a major direction (*directional textures*) leads to the interesting application of vector fields' visualization. Emphasizing ROIs, critical points (Figure 3) and singularities is possible (details about the procedure in [Tap03]).
- Texture Mixture and Texture Metamorphosis: objects often comprise more than one uniform look: they may present many appearances from different materials. Composing together dissimilar aspects is an important task for texturing natural 3d objects. Applying our method, this task can be achieved without the need of blending functions. Morphing, as well as changing textures aspect depending on surrounding circumstances or lighting effects is another interesting point to investigate in.
- Texture Animation: textures may evolve or change in time and space; a particular feature may appear, vary, move or disappear, similarly as for vector fields that describe complex physical phenomena.

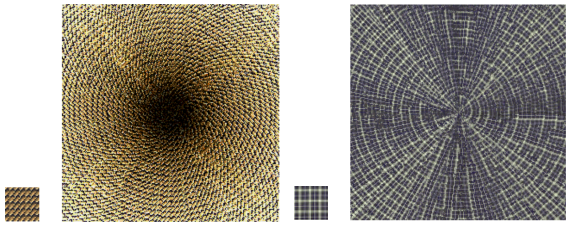

Figure 3. Enhancing center position with brightness (a) and just visualizing a given pattern along circular field.

4. CONCLUSIONS

We propose a system for flexible non-homogeneous texture synthesis. This novel approach aims at producing varying textures and patterns. With the described framework, we provide a complete tool for texture synthesis manipulation, which permits to generate a variety of outputs and effects, both for scientific and artistic tasks. Therefore, one of the main contribution of this work is having added various degrees of freedom to the generation of textures. We think this may be important in Computer Graphics as useful instrument, which contributes promising applications in several fields and also keeping the road open for further research. The extension to frames' animation still requires further investigation and it is part of our ongoing work.

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