Approaches for Obtaining Texture Images for Computer Vision Purposes

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Abstract - **In this paper is proposed an algorithm for generating synthetic texture with desired appearance and size and an algorithm for synthesizing texture from a photo. Also, is proposed a proper visualization process for using the received texture to obtain a realistic appearance of 3D surfaces which can by applied in geographic maps, for mapping of a vegetation and other special features onto terrains, to correct failings of a photo, video and satellite images.**

Keywords - **texture synthesis, texture generation, texture visualization.**

1. Introduction

The computer's generated images with textured surfaces are interesting and realistic. The texture mapping is a technique for adding details to the external appearance of the surface by wrapping or projecting the textured image onto the surface. The first step in working with textures is creating them. Often the source of textures is a photo or video image or a hand drawn picture and the resulting texture piece usually hasn't the desired shape and size. To cover a large object with the texture we must repeat it but that will produce unacceptable defects such like visible boundaries, visible repetitions or the both. To escape that defects there is necessity of synthesizing texture with desired size from a texture piece. There is no general approach for decision of this problem[1],[4],[6],[9].

Other alternative way is creating synthetic texture by algorithmic (procedural) manner that gives a possibility to receive many and various samples with different sizes. Such texture samples can be used for applications from decoration to creating complex 3D structures and motion.

Texture is related to qualitative properties of surfaces, but due to its complexity and great variety, there exists neither a unique definition of texture nor an accepted computational representation of it. One of the widely accepted definitions of texture is given by Pickett[10]. He states that a texture is an optical pattern that contains a large number of elements (spatial variations in intensity or wavelength), each visible to some degree, and, on the whole, densely and evenly arrayed over the field of view.

One of the many applications of textures consists in synthesizing realistic images of terrains. Such images pose a number of problems. The challenge stems from the visual complexity and diversity of the modelled scenes[7],[8]. They include natural ecosystems such as forests or grasslands, human-made environment, for instance parks and gardens, intermediate environments, such as lands recolonized by vegetation after forest fires or logging, visualization of models of ecosystems for research and educational purposes, and synthesis of scenes for computer animations, games, and computer art.

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2. Definition of the problem

There is necessity of new ways and means to obtain surfaces with texture appearance with the aim of generating natural scenes in systems for visualization of spatial data. The texture sample must have a needed size to cover the surface without repetitions, a desired appearance and must be obtained quickly. The texture visualization system must be flexible and must allow the user quick changes of the appearance of the terrain (its texture) as well as of its shape.

3. Solution of the problem

The task assigned for texture visualizing is solved by means of a computer-generated texture and a synthesized texture

-computer generated texture

The advantage of generated textures in comparison with the synthesized ones consists in the rapid obtaining of image with previously given size and the avoiding the necessity of analyses when synthesizing textured image from a photo. The generated texture looks like vegetation with adequate color arrangement.

-synthesizing texture from a photo

The goal of texture synthesis can be stated as follows: to generate a new image from an example texture, such that the new image is sufficiently different from the original yet still appears as though it was generated by the same underlying stochastic process as was the original texture. If successful, the new image will differ from the original, yet have perceptually identical texture characteristics. This can be measured psychophysically in texture discrimination tests. To satisfy both criteria, a synthesized image should differ from the original in the same way as the original differs from itself.

Proposed solution of the defined problem is a system composed of a part for generation/synthesis the texture**,** a part for specification the terrain and a part for texture visualization of spatial data describing the terrain and the texture.

3.1 Generation of 2D texture sample

3.1.1. Algorithm

In this paper is proposed following algorithm for generation of texture images that is next map onto the terrain:

1. Input data: size of generated image determined by the coordinates of upper left and lower right corner **(x1, y1, x2, y2),** a scaling variable **scale**, a colour palette **pal**.
2. Output data: a computer-generated texture image possessing given size, scale and colour appearance.
3. Method: the proposed algorithm generates a texture image by determining the intensity of pixels in a small area and propagates it in its neighbourhood**.** The process starts with the given size of the image and decrease that size to reach the level of one pixel surrounded by eight neighbours. The initial setting of the intensity of the four pixels marking the four corners of the image is randomly. From the primary randomly assigning is determined pixels intensity, marked the corners of four new equal rectangles consist of the initial one.

The process continues recursively with determining the intensity of the following five pixels dividing the corresponding rectangle into four new pieces etc. until the level of one pixel is achieved. After that the algorithm continues by scanning the areas in reversed order until a complete image size is achieved. Scanning the pixels in generated image in the depicted manner is done in procedure divide. The function adjust determines the pixel's intensity.

1.1.1Experimental results and analyses

The proposed algorithm is tested with various colour palettes, scales and image sizes (fig 1.,2). By assigning the colour palette **pal** in the registers and interrupting of the monitor is achieved different and interesting colour arrangement. Figure 1a illustrates obtaining different colour combinations. The changes of the scaling variable **scale** lead to images in different scales independent of the image size. Figure 1b shows this scaling. The image size is 240 X 240 pixels. The algorithm generates an image with given size (the necessity of various size of texture piece follows from the various size and shape of the terrain). When the texture is little in size it must resized or repeated to cover the terrain. In both cases this results in undesirable defects. Receiving an image with arbitrary size eliminates this inconvenience. On the figure 2 is shown an image with size 480 X 640 pixels. The image size has no crucial effects in comparison with the algorithms for texture synthesis from a given texture sample where the size of piece is of great importance for the synthesis velocity [2].

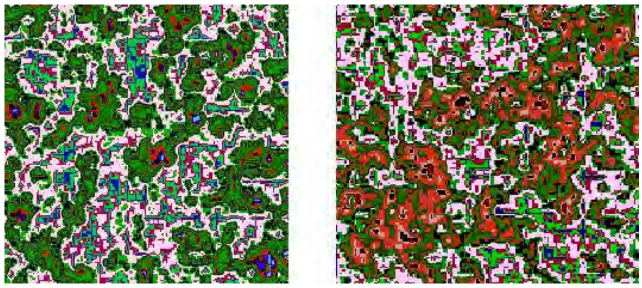

Fig. 1 (a) Texture images obtained with a various values of the color palette

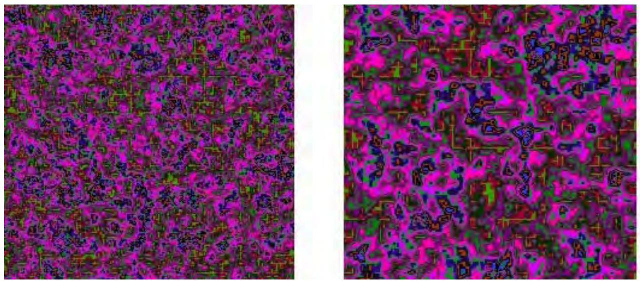

Fig. 1 (b) Texture images obtained with a various values of the scaling variable

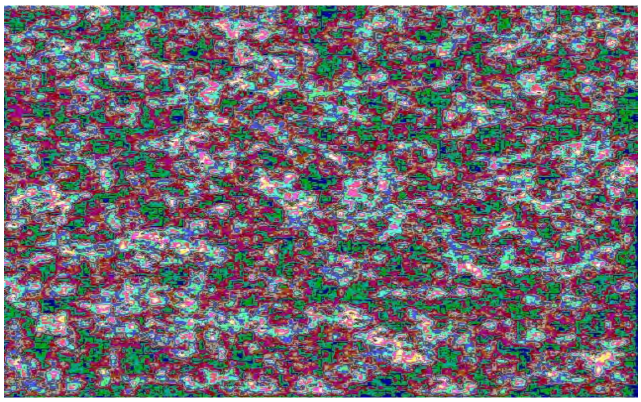

Fig. 2. Texture image obtained with given size- 480 x 640 pixels.

3.2 2D texture synthesis

3.2.1 Pyramidal methods for image analysis

The image pyramid data structure was originally developed for image coding. In this data structure an image is represented hierarchically, with each level corresponding to a reduced resolution approximation.

Wavelets have become a tool of choice in analyzing single and multidimensional signals, especially if the signal has information both at different scales and localizations [3]. A wavelet representation is a multiscale decomposition of the signal and can be viewed as a complete tree, where each level stores the projections of the signal, with the wavelet basis function of a certain resolution. A wavelet representation can be transformed back into the original signal using a fast hierarchical inverse transform. The computations proceeds from the root of the tree down to the leafs, using filters that are complementary to those used in wavelet transform.

3.2.2 Algorithm

1.Input data: texture sample (scanned photo image)

2.Output data: texture with given size and perceptually identical with the original.

3. Method The texture sample is a tree representing the wavelet based multiresolution analysis. From the point of view of the synthesis algorithm the image is a collection of pats from the root of the tree toward the leaves.

The task of the algorithm is to generate a tree whose pats are typical sequences generated by the most likely mutual source of the input tree. From the resulting tree a new image is reconstructed by applying an inverse wavelet transform. A measure of similarity is threshold. Two pats from nodes x and y are considered similar when the differences between their corresponding values are below a certain threshold. If two pats are similar we can continue one with values from the other, while still preserving the fact that they emerged from the same stochastic process. A level-dependent similarity criteria for tree pats is used. Lower resolution levels of the tree have looser similarity criteria than higher resolution levels and therefore a larger threshold is used at lower levels. This adaptive measure is chosen because the human visual system is more sensitive to high frequency information [5].

3.2.3. Experimental results and analyses

On the fig.3 are shown the results of the algorithm with various values of the threshold. The output image (synthesized texture) is four times larger than the input ones. The selection of the threshold has a big impact on the outcome of the algorithm. Selecting a larger threshold causes the outcome to differ more strongly from the input. On the other hand, a small threshold can cause the outcome to be a copy of the input. Thus, by leaving the threshold selection to the user, the user is supplied with a powerfull tool to achieve the desired outcome.

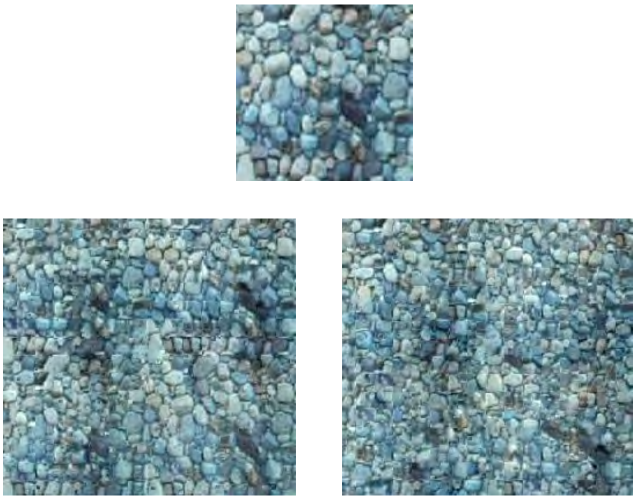

Fig. 3. Texture synthesis from a texture sample obtaining from a photo.

3.3 Terrain specification

The aim of this step is to determine shape and local orientation of the terrain. The surface representing a terrain covered with vegetation is generated by any equation of two variables or may be known in advance.

The generated surface can be edited for introducing new additional elements and for increasing the realism of the scene. The synthesizing algorithm gives a possibility of additional editing which increases the realism of the terrain. In the future it can be expanded with parameters controlling the roughness of the terrain, the rate of its changes, the expletive possibility of adding streams, roads and others.

4. Use of the proposed approach for computer visualization purposes.

The technique of texture mapping is based on mapping the synthesized image onto a surface. There are many works on the problem in the computer graphics literature. In our work we use a technique for standard texture mapping: the initial image (texture) is mapped onto the surface in a 3D object space (terrain) by mapping function and the surface is mapped onto the image space (display) by projection.

Extras like illumination, reflection and point of view are not subject of this work.

On a fig.4 is shown the visualization system and its components.

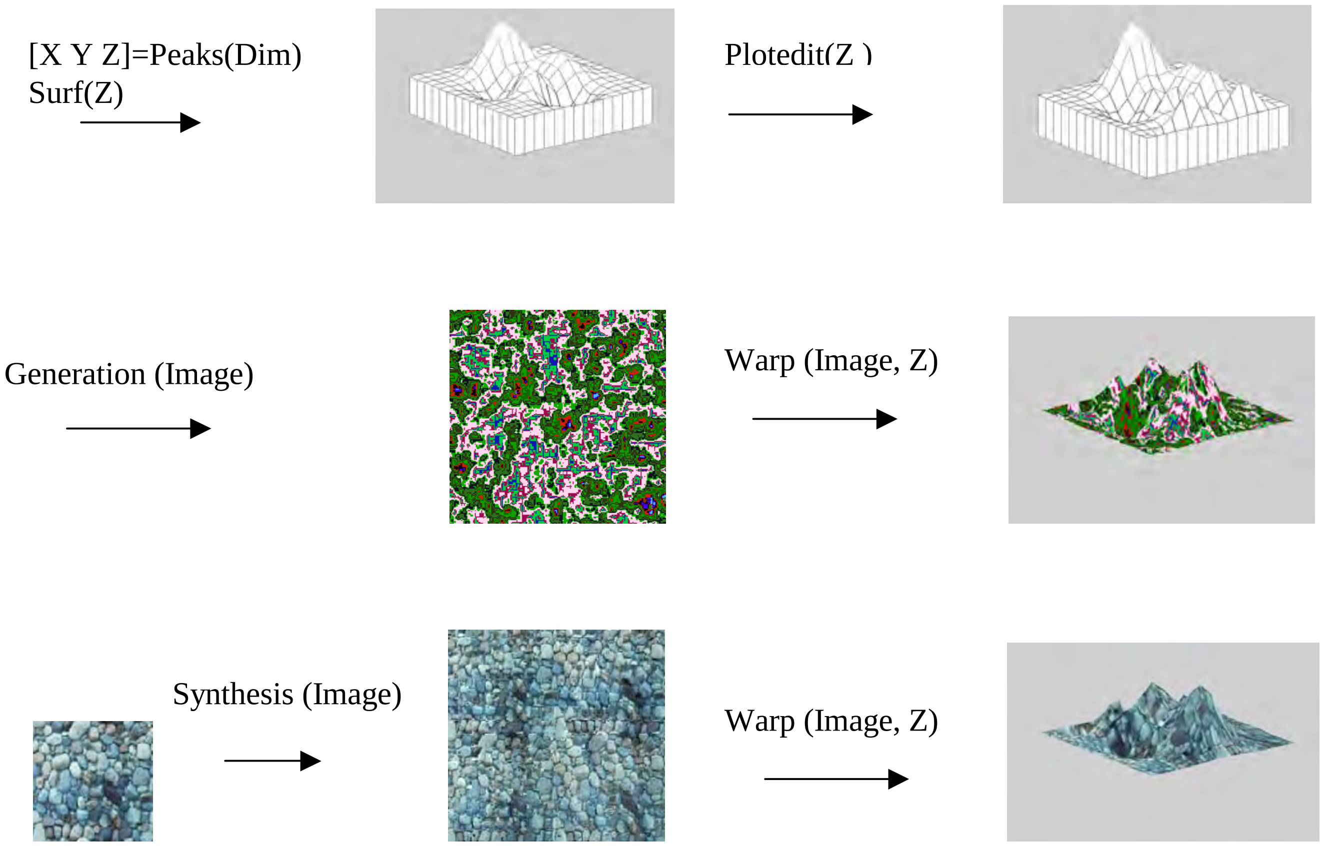

Fig. 4. System for texture visualization

5. Conclusions and future work

In this paper we show how computer generated/synthesized image (texture) can be used for mapping onto computer generated and hand edited surface (terrain) to receive a synthesized scene of terrain. Such scenes gives interesting possibilities for spatial data visualization. The texture image could be obtained from scanned photos or could be generated.

Increasing of realism of the scene could be obtained by introducing illumination and reflection.

By additional analyses the proposed approach can find an application in image correction by introducing a changes in the image so these changes remain invisible for the viewer. This is usually applied in the tasks for reconstructing damaged images and also for elimination of unneeded elements of the scene.

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