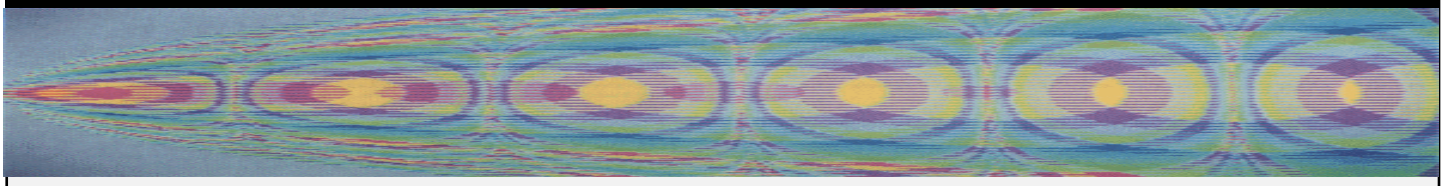
Thesis Project **Color Reduction for Image Segmentation Based on Cellular Automata (CA) and Genetic Algorithms (GA)**

University of Zurich[UZH]



Topic

The color reduction in digital images and documents is a very active research topic and is used in many applications such as image segmentation, analysis, compression and transmission. The objective of color reduction is to cluster the *N* colors of an image into only *c* color clusters, where *c*<<*N*, using several techniques based either on splitting algorithms, which divide the color space in disjoint regions, or on cluster analysis, where vector classifiers are used to find the optimal palette.

Cellular Automata (CA)

CA were initiated in the early 1950s as a general framework for modeling complex structures capable of self-reproduction and self-repair [1]. They have also been applied successfully to several image processing applications, such as in [2].

A CA is a collection of cells (in image processing, pixels) on a grid of predefined shape and it is evolved through a number of discrete time steps according to a set of transition rules. These rules are based on the state of a neighborhood and they are applied iteratively for as many time steps as required. CA can also be designed in a parallel structure, which results in real-time processing speeds.

Assignment

In this project we focus on a new color reduction and segmentation approach based on CA. More specifically, we want to exploit the inherent properties of CA, and using effectively the color and texture information located in a dynamically changed neighborhood, to segment the input image. As a first pre-processing step, a smoothing and denoising CA operation could be applied, emphasizing in maintaining the image fidelity and eliminating the deformation of object boundaries. In the next step, a color reduction algorithm could reduce significantly the number of colors in the pre-processed image and generate a segmented output. The Genetic Algorithm (GA) will be used to search for the best CA rules that can realize the best smoothing and noise filtering, as well as to evolve the CA when global coordination is required. This method should be applicable to any type of color image and it should accommodate any type of color space.

References

[1] J. von Neumann. Theory of Self-reproducing Automata. University of Illinois Press, Urbana, 1966.

[2] P.L. Rosin, Training Cellular Automata for Image Processing, IEEE Transactions on Image Processing, Vol. 15, No. 7, pp. 2076-2087, 2006.

Requirements

Interest in image processing and application development in C++ and Matlab.

Work Load

- 40% theory
- 40% implementation
- 20% testing

Student Project Type

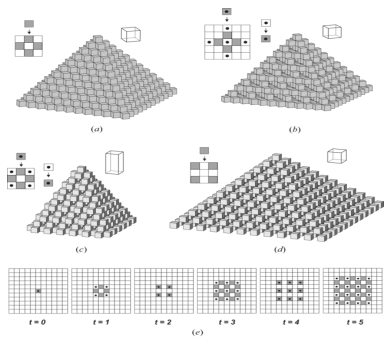
Based on the scope of the topic and optional tasks, this project can be done as Bachelor or Master thesis. Goals are adjusted depending on the project type.

Supervision

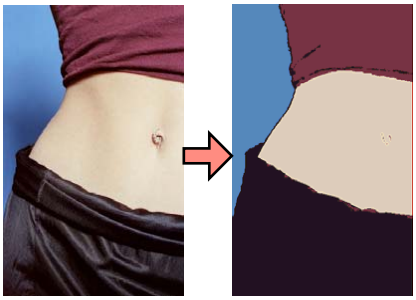
Prof. Dr. Renato Pajarola
Georgios-Tsampikos Michailidis (Assistant)

Contact

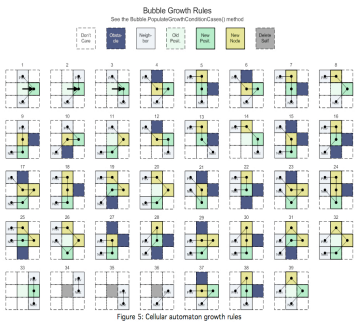
Write an E-Mail to gtmichail@ifi.uzh.ch



3D Cellular Automata.



Color reduction and Segmentation example using Cellular Automata.



Cellular Automata rule set example.

VISUALIZATION AND MULTIMEDIA LAB

Prof. Dr. Renato Pajarola
Visualization and MultiMedia Lab
Department of Informatics
University of Zürich