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Parallel Implementation of Cellular Automatons

Abstract

Cellular automatons are discreet systems, which divide the space into cells, forming a lattice structure. This is a framework that can be efficiently parallelised and its characteristics include general behaviour. The variation or changing of the model can be easily illustrated by its three-dimensional visualisation. Due to the generality of the system, it has several other domains that can be used in. One of the problems that can be studied in this system is the morphological thinning in image processing.

Morphological thinning is at the core of several digital image processing algorithms, like object/shape/pattern recognition etc. The skeleton of an object is a maximally thinned version of its shape, which is equidistant to the boundaries of the object and retains its topological relations. Standard skeletonization algorithms process binary images by applying morphological operators in a fixed, well-defined manner. The project studies the task of morphological thinning in the more general, albeit still easily parallelizable framework of cellular automatons, which allows the use of richer, even non-deterministic models. By using this framework the obtained results are twofold:

i. **Quantitative**: with a parallelised implementation on GPU we achieved a 10-12 speedup on 5 vectorised images with 6 different resolution (min: 0.06 megapixel, max: 67.1 megapixel)
ii. **Qualitative**: by allowing different degrees of stochasticity in the cellular automaton models we obtained random branches on the skeletons of the thinned image and by combining 100 of these not only the skeletons but the shape characteristics are visible, too.

Future work will consider applying genetic algorithms to develop specific rules for the cellular automata model.

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2015