Lehrstuhl für Rechnerarchitektur und -kommunikation

Marching Pixels

An Organic Computing principiple for smart embedded cameras.

Marching Pixels are a novel approach for high-speed image processing in future smart CMOS cameras. Due to ongoing developments, such vision systems will comprise millions of simple processing elements within a few years. Sophisticated constraints like hard realtime requirements or robustness are not achievable with centrally organised architectures in such massively-parallel environments. In the *Marching Pixels* project, new strategies are searched, where lifelike agents crawl around a pixelfield realised on chip level. They exploit emergence in order to collaboratively traverse objects and retrieve the objects' attributes'.

Achieved so far:

- Marching Pixels algorithm toolbox; a set of object traversing strategies which differ in capabilities and costs:
 - 1. Edge Running
 - 2. Reduction Lines
 - 3. Flooding
 - 4. Opposite Flooding
 - 5. Perl Chains (cooperation with the group of S. Fekete)
- Implementation of hardware in VHDL and SystemC
- Test and simulation on **FPGAs** showed the feasability of the approach
- Development of a micro-programmable massively-parallel hardware based on cellular automata and arithmetic logical units for easy testing and realisation of arbitrary emergent algorithms

Current Projects

- Extending the Marching Pixels algorithm toolbox
- Introduction of self-healing to the micro-programmable architecture (in cooperation with ASoC project of W. Rosenstiel/A. Herkersdorf)
- Manual development of new algorithms using Evolutionary Algorithms and Genetic Programming
- Building a framework for automatically generated emergent parallel programs based on evolving cellular automata and genetic programming



above: Evolved single-agent edge exploration algorithm

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above: Ideas of algorithms Edge Running, Reduction Lines, Flooding, and a simulation of Perl Chains (which is a cooperation with the group of S. Fekete)



• above: Sample application: Retrieval of number and size of blood and liver cells



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