Compiling Image Processing Applications for Many-Core Accelerators
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image analysis: detect geometrical structures in an image
mathematical morphology: image analysis theory and technique based on lattice theory

Mathematical Morphology Base Operators
- arithmetic operators
  - unary (pixel @ parameter, 1 input image)
  - binary (pixel @ pixel, 2 input images)
- morphological operators
- reduction operators
- global max/min/sum
- stencils

Implement more complex algorithms: watershed, arrow, labelling, minima, ...

Improve data-parallelism to take better advantage of the current architecture

Threshold, mask, log2, ...

Global max/min/sum

Neighbor selection + min/max/avg

Stencils:
- ×
- ÷
- +

Binary (pixel)

Sigma-C, a Dataflow Programming Language

Example: Licence Plate Extraction

Mathematical Morphology Base Operators

Optimisations
- unrolling of converging loops
- arithmetic operators aggregation
- generation of hardware-specific customizations
- data parallelization for compute-intensive operators

Compilation Chain

Runtime Environment

Accelerator runtime on I/O clusters

Optimisations
- unrolling of converging loops
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Runtime Environment

Optimizer library

Compilation Chain

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Future Work
- Other programming models:
  - Pthreads/OpenMP on compute clusters, communication library between clusters
  - OpenCL via local memory pagination
- Improve data-parallelism to take better advantage of the current architecture
- Implement more complex algorithms: watershed, arrow, labelling, minima, ...

Results: Execution Times and Energy Consumption (MPPA-256 = 1, lower is better)

References

Pierre Guillou, Fabien Coelho, and François Irigoin.
Automatic Streamization of Image Processing Applications.
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