Automatic Parallelization of Sequential Codes

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APPENTRA SOLUTIONS

Startup, spin-off of University of Coruña
THE PROBLEM

Theory & Experimentation & Computation
THE PROBLEM

HPC is a pervasive technology
HPC is a competitive business advantage
HPC is crucial to address grand scientific challenges

HPC is a key enabling technology
THE PROBLEM

Programs **underutilize the parallelism** of the powerful modern computers.
THE PROBLEM

Adapt programs to the changing market
Goal: Parallelization of simulation codes with OpenMP

<table>
<thead>
<tr>
<th>TRL</th>
<th>BENCHMARK</th>
<th>DISCIPLINE</th>
<th>SIZE</th>
<th>OPTIMAL PARALLELIZATION</th>
<th>COST-EFFECTIVE PARALLELIZATION</th>
<th>INCORRECT PARALLELIZATION</th>
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</thead>
<tbody>
<tr>
<td>TRL-5</td>
<td>PI</td>
<td>Integration method</td>
<td>18</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lab environment</td>
<td>Mandelbrot</td>
<td>Fractals</td>
<td>103</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laplace2D</td>
<td>Digital signal processing</td>
<td>67</td>
<td>5%</td>
<td>47%</td>
<td>48%</td>
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</table>

- Developers with degree in computer science and experience in parallel programming.
- Additional expertise in OpenMP (studying master in HPC).
- Time constraints for each lab: PI (2h), Mandelbrot (2h), Laplace2D (4h)

CSE/HPC is challenging even with expertise
THE SOLUTION

You don't need to be an expert in parallel programming. Just focus on your business.

New software tool for automatic parallelization
Decouple application from parallel hardware
PARALLWARE 1.0

Automatic parallelization of sequential codes

- Simplicity
- Correctness
- Portability
- Performance
- Reduce time-to-market
PARALLWARE 1.0

Sequential simulation source code in C

PARALLWARE Automatic parallelization

Parallel simulation source code in C/OpenMP

OpenMP Compiler

Executable on multi-core computer

Source-to-source parallelizing compiler
# PARALLWARE 1.0

<table>
<thead>
<tr>
<th>TRL</th>
<th>BENCHMARK</th>
<th>DISCIPLINE</th>
<th>SIZE</th>
<th>SPEEDUP</th>
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<tr>
<td>TRL-5</td>
<td><strong>PI</strong></td>
<td>Integration method</td>
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<td>5.39</td>
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<td>Lab environment</td>
<td><strong>Coulomb</strong></td>
<td>Physics</td>
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<td>5.64</td>
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<td></td>
<td><strong>Matrix multiplication 2D</strong></td>
<td>Dense&amp;Sparse linear algebra</td>
<td>19</td>
<td>3.85</td>
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<td><strong>Mandelbrot</strong></td>
<td>Fractals</td>
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<td>6.34</td>
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<td><strong>Heat diffusion</strong></td>
<td>Heat diffusion</td>
<td>29</td>
<td>1.52</td>
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<td><strong>Laplace2D</strong></td>
<td>Digital signal processing (DSP)</td>
<td>67</td>
<td>4.52</td>
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<td>TRL-6</td>
<td><strong>Simulation based on the method of moments (MoM)</strong></td>
<td>Computational Electromagnetism (CEM)</td>
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<td>Real environment</td>
<td><strong>Simulation based on the method FDTD</strong></td>
<td>Computational Electromagnetism (CEM)</td>
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<td><strong>Simulation based on the method MLFMA</strong></td>
<td>Computational Electromagnetism (CEM)</td>
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</tbody>
</table>

Benchmarking platform: Intel(R) Core(TM) i7-4700MQ CPU @ 2.40GHz (8 threads with hyperthreading); RAM 8GB
WHY USING PARALLWARE?

+10 years I+D
Proven with real codes
World-wide exclusiveness
Coarse-grain parallelism

New technology for extraction of parallelism
“We were pretty impressed by the tool, because parallelism extractions is not a simple problem to solve.”

“I do not see automatic parallelization of the outer loop in the MOM matrix fill as a trivial task. Thus, for a compiler to do this automatically is quite impressive.”
WHY USING PARALLWARE?

- Computational Electromagnetics (CEM)
- Oil & Gas
- Computational Hydraulics

Dense & Sparse programs across many CSE fields
WHY USING PARALLWARE?

Sequential simulation source code in C

PARALLWARE
Automatic parallelization

Parallel simulation source code in C/OpenMP

OpenMP Compiler

Executable on multi-core computer

Straightforward tool-chain integration
WHAT’S IN OUR ROADMAP?

Open standard OpenMP for multi-cores
WHAT'S IN OUR ROADMAP?

Open standards OpenMP/OpenACC for many-cores
WHAT’S IN OUR ROADMAP?

Open standard MPI for clusters??!!
HOW TO TRY PARALLWARE?

Request free trial
www.appentra.com/products/free-trial/

Request full-version
www.appentra.com/contact/
THANKS!

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