Optimization of a GP Application for the Cell Processor

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Outline

• Background
• Optimization for the Cell processor
• Experiments
• Conclusions
Background

• development of digital devices
  – diversification of image processing technology
    • facial recognition
    • fingerprint authentication

designed algorithms in each case
processing objective and object are confined

No general versatility
Background

• Automatic creating image processing filter
  – Genetic Programming (GP)
    • evolutionary computation
    • designing program by changing learning objective

A lot of computation time

Need to speeding up

use Cell processor
Flowchart of GP

start

Generate individual

Fitness calculation

evaluation

selection

crossover

end
Flowchart of GP

Start

- Generate individual

- Fitness calculation

- Evaluation

- Selection

- Crossover

A lot of Computation time

End
Flowchart for Cell processor

start

Generate individual

evaluation

selection
crossover

Fitness calculation

end

PPE SPE

Fitness calculation
Flowchart for Cell processor

start

Generate individual

One individual uses 1 SPE

Fitness calculation

evaluation

selection

crossover

One individual uses 3 SPEs

Fitness calculation

PPE

SPE
Flowchart for Cell processor

1. Generate individual
2. Fitness calculation
3. Send data
4. SPE
5. Fitness calculation
6. SPE
7. SPE
8. SPE
9. SPE
10. Fitness calculation
fitness calculation on the SPEs

Insufficient memory on the SPEs

Necessary information into array structure
fitness calculation on the SPEs

- Send data

\[ T = \frac{W_x \times W_y}{16384} \times N, \]

- Send data

\( T \) : number of transfers, \( N \) : number of images, \( W_x \) : image width, \( W_y \) : image height
fitness calculation on the SPEs

- SIMD

\[
\text{fitness} = 1 - \frac{\sum_{x=1}^{W_x} \sum_{y=1}^{W_y} |O(x, y) - T(x, y)|}{W_x \times W_y \times V_{\text{max}}}.
\]

\(W_x\): image width, \(W_y\): image height, \(V_{\text{max}}\): brightness value
Experiments

• Data
  – 128*128, 256*256, 512*512

• Combinations
  – PPE
  – Multi core
  – Multi core and DMA double buffering
  – Multi core and SIMD
  – Multi core, DMA double buffering, and SIMD
Results

(□) Multi core
(□) Multi core and DMA double buffering
(□) Multi core and SIMD
(□) Multi core, DMA double buffering, and SIMD
Conclusions

• Optimization of a GP for the Cell processor
  – multi core, double buffering, and SIMD

• The most speeded up combination
  – Multi core and SIMD (compared to PPE)
    – 128*128 □ 17 times
    – 256*256 □ 25 times
    – 512*512 □ 36 times
Future works

• Investigate DMA double buffering
  – Why not get effect?
• Speeding up than now
  – SIMD
  – Crossover
Thank you for your attention!