

Referee report on :

"Optimization of a discontinuous finite element solver with OpenCL and StarPU"

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In this paper, authors are interested in the numerical simulation of an electromagnetic wave on hybrid computers made of CPUs and GPUs. They propose an optimized implementation of a discontinuous finite element method using the StarPU runtime system library. The discontinuous Galerkin method used in this framework is first detailed. Then, StarPU and the macrocell approach considered here are presented, as well as the algorithm. Finally, numerical results showing the efficiency of the developed algorithm are given.

The process proposed in this paper leads to an efficient numerical simulation of electromagnetic waves thanks to a well designed hybrid implementation of a discontinuous Galerkin method. Its approach could interest a varied community concerned by high performance computation of multi-dimensional relevant applications in physics. It could thus have a place in IJFV, even if it is not based on Finite Volumes method. However, the writing of the paper could be improved, by clarifying some points and in order to highlight the novelty of the method. For these reasons, I recommend major corrections, listed below, before its publication in the International Journal on Finite Volumes.

Main comments :

1) Abstract.

In its current version, the abstract presents the solver schnaps and StarPU but does not insist on the goal of the paper. It should be rewritten in order to present the aim of the paper and to highlight the key idea. According to me, the presentation of schnaps and StarPU can stay in the abstract, but have to come after the motivation of the paper.

2) Introduction.

2.1. Some references are missing: for OpenCL, for StarPU.

2.2. Even if this paper will particularly interest the community of High Performance Computing, it seems useful to detail the acronyms: GPU, IGP.

2.3. As in the abstract, the aim of this paper has to be highlighted and expanded.

3) Section 2.

3.1. Page 2. You could precise some points: $f^k : ? \rightarrow ?$, $f : ? \rightarrow ?$, " Ω in R^3 made of N_c in N open sets".

3.2. Page 3. You precise N_d at the end of this page but use it at the beginning.

3.3. Page 3. I am lost with the notations (of course we can find them, but you could clarify this). You define $w(x,t)$ in the basis of polynomial functions, coordinates are denoted by $w_{\{L,j\}}(t)$. Then the formulation consist in finding $w_{\{L,j\}}$ respecting (2.1). But in (2.1) only w_L appears, which is not defined...

3.4. Page 5. The sentences between equations (2.8) and (2.9) are not clear. When you have accumulated V and S , you want to multiply this accumulation by $1/(\omega_{\{L,i\}})$, not $d_{tw_{\{L,i\}}}$, did I misunderstand something?

4) Section 3.

4.1. Page 6. I am not convinced that it is necessary to write a paragraph on the MPI version of StarPU, since you do not use this version. Maybe a short sentence, if you are interested in it for a future work, would be enough.

4. 2. Page 6. You introduced a subsection 3.1 but there is no subsection 3.2. Could it be Section 4 (by changing the name of Section 3)?

4.3. Pages 6 and 7. On the one hand, you listed the more important tasks. On the other hand, you present the DG algorithm. Some things are repeated, other are more detailed in the list of tasks. Is it possible to merge the list and the algorithm? Or at least to refer in the algorithm to the numbering (1) to (5) used in the list of task?

5) Section 5.

5.1. Page 8. Could you define " r " in the exact plane wave solution?

5.2. Page 9. Could you introduce the notation n_{CPU} in the second line of subsection 5.1? And detail the acronym NUMA?

6) There are some misprints listed below.

6.1. Introduction, p.2: "the best one" instead of "the best".

6.2. Section 2, p. 2: a comma instead of a dot at the end of equation " $w=(...), m=8$ ".

6.3. Section 2, p. 3: I think "misuse of notation" is better than "abuse of notation".

6.4. Section 2, p. 4: "if a GL point ... quadrature weight on face F_e ", instead of " w_e ".

6.5. Section 5, p. 9: in the line before subsection 5.1, a dot is missing.

6.6. Conclusion: "optimal" instead of "optiaml".

6.7. References: write the firstname of Munz (since you did it for coauthors).