Accepted Manuscript

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Author: S. Alowayyed G. Závodszky V. Azizi A.G. Hoekstra

PII: S1877-7503(17)30278-8
DOI: https://doi.org/doi:10.1016/j.jocs.2017.11.008
Reference: JOCS 799

To appear in:

Received date: 8-3-2017
Revised date: 10-7-2017
Accepted date: 11-11-2017

Please cite this article as: S. Alowayyed, G. Závodszky, V. Azizi, A.G. Hoekstra, Load balancing of parallel cell-based blood flow simulations, *<![CDATA[Journal of Computational Science]]>* (2017), https://doi.org/10.1016/j.jocs.2017.11.008

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Load Balancing of Parallel Cell-based Blood Flow Simulations

S. Alowayyed[a,b,*], G. Závodszky[a,c], V. Azizi[a], A.G. Hoekstra[a,d]

[a] *Computational Science Lab, Institute for Informatics, Faculty of Science, University of Amsterdam, The Netherlands*
[b] *King Abdulaziz City for Science and Technology (KACST), Riyadh, Saudi Arabia*
[c] *Department of Hydrodynamic Systems, Budapest University of Technology, Hungary*
[d] *ITMO University, Saint-Petersburg, Russian Federation*

Abstract

The non-homogenious distribution of computational costs is often challenging to handle in highly parallel applications. Using a methodology based on fractional overheads, we studied the fractional load imbalance overhead in a high-performance biofluid simulation aiming to accurately resolve blood flow on a cellular level. In general, the concentration of particles in such a suspension flow is not homogeneous. Usually, there is a depletion of cells close to walls, and a higher concentration towards the centre of the flow domain. We perform parallel simulations of such suspension flows. The emerging non-homogeneous cell distributions might lead to strong load imbalance, resulting in deterioration of the parallel performance. We formulate a model for the fractional load imbalance overhead, validate it by measuring this overhead in parallel lattice Boltzmann based cell-based blood flow simulations, and compare the arising load imbalance with other sources of overhead, in particular the communication overhead. We find a good agreement between the measurements and our load imbalance model. We also find that in our test cases, the communication overhead was higher than the load imbalance overhead. However, for larger systems, we expect load imbalance overhead to be dominant. Thus, efficient load balancing strategies should be developed.

*Corresponding author

Email addresses: S.A.Alowayyed@uva.nl (S. Alowayyed), g.zavodszky@uva.nl (G. Závodszky), V.W.AziziTarksalooyeh@uva.nl (V. Azizi), A.G.Hoekstra@uva.nl (A.G. Hoekstra)

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