Design of Metal Forming Production Processes and Cycles by using Heterogeneous Hardware Architectures

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ABSTRACT

Design of production processes and cycles is usually based on computationally intensive multi-iterative connection of two numerical procedures, i.e. modelling of processes and optimization [1]. Additionally, this approach can be preceded by sensitivity analysis (SA), which allows to reduce computational complexity of both procedures, however SA itself can be also very demanding dependently on dimensionality of analysed models [2]. Currently, several different approaches, dedicated to increase computational efficiency of manufacturing process design, are developed e.g. simplification of computational domain, application of faster and more accurate methods, parallelization and distribution. Two latter approaches can be obtained by using modern High Performance Computing (HPC) infrastructures, which in most cases are composed of many computing nodes connected to each other by high bandwidth network. Each of such nodes contains conventional multicore CPUs and additional computing devices in form of graphic cards (e.g. Nvidia, AMD) or coprocessors (e.g. Intel Xeon Phi). This type of architecture is called heterogeneous because of different internal organization of computing and memory units. The list of the fastest computers in the world with detailed description of their nodes and devices is presented on TOP500 list (www.top500.org) published twice a year.

This paper presents the way of manufacturing processes and cycles design by using HPC infrastructures. Two main computing scenarios are determined and described in details. The first one is focused on singular usage of computing infrastructure for one use case of numerical simulation of industrial process or cycle. The second scenario considers many iterations of numerical simulations on HPC side. This scenario is divided into two sub-scenarios of SA and optimization performance. The main difference between these cases is the way a set of input data is generated. Input data of SA depends on dimensionality of model and ranges of particular model parameters, while in the case of optimization, input data are generated dynamically after each evaluation of objective function. This difference influences preparation of computing jobs as well as implementation of both procedures.

This paper presents in details all applied numerical procedures and scenarios of HPC usage. Scalarm software (www.scalarm.com), which is used as a middleware for preparation of computing jobs, queuing and monitoring of progress, is also described in the paper. Examples of obtained results and discussion on increase of computational efficiency are presented as well.

Acknowledgements

Financial support of the Statute Research of the Faculty of Metals Engineering and Industrial Computer Science AGH is acknowledged, grant no. 11.11.110.300.

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