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Application of Parallel Computing Technologies for Numerical Simulation of Air Transport in the Human Nasal Cavity

Alibek Issakhov and Aizhan Abylkassymova

Abstract The use of parallel computing technologies for numerical simulation of air transport in the human nasal cavity was considered in this paper. Investigation of air flow in the human nasal cavity is of considerable interest, since breathing is done mainly through the nose. A two-dimensional numerical simulation of air transport in the model cross-sections of the nasal cavity to normal human nose based on the Navier-Stokes equations, the equations for temperature and equation for relative humidity were conducted in this study. The projection method is used for the numerical solution of this system of equations. This numerical algorithm was fully parallelized using different geometric decompositions (1D, 2D, and 3D). A preliminary theoretical analysis of the speed-up and effectiveness of various methods of decomposition of the computational domain and the real numerical experiments for this problem were made in this work. Moreover the best domain decomposition method has been determined. The obtained data transfer numerical modelling air human nasal cavity was verified with known numerical results in the form of velocity and temperature profiles.

Keywords Decomposition methods · Theoretical analysis of efficiency Speed-up · Alveolar state · Heat transfer in the nasal cavity · Projection method Finite volume method

1 Introduction

The current trend in the development of high-performance computers opens up new opportunities for developing highly effective methods for modelling complex problems using multi-level decomposition and hierarchical parallelization of computations. For most real physical processes with a large computational grid this approach

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