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# IMAGE-BASED PULMONARY AIRFLOW SIMULATION USING CARTESIAN ADAPTIVE MESH REFINEMENT METHOD

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## ABSTRACT

Advancement of computed tomography (CT) technology enables us to develop a complete patient-specific geometric model of pulmonary airways. Computational fluid dynamics (CFD) analysis using the patient-specific model should become an essential tool in the future diagnosis. One of the difficulties in pulmonary airflow simulation is that pulmonary airways are multi-scale branched channels[1]. The complex nature of the airway geometry requires time consuming mesh generation process of unstructured meshes. Moreover, mesh size control should depend on local flow scales; micro-scale meshes should be used for peripheral airways, whereas those are unnecessary for trachea. To solve this discrepancy, an Adaptive Mesh Refinement (AMR) method is applied to an airway model. Mesh sizes are locally determined by diameter of an airway branch and by distance from the wall at each airway branch. As CT data consists of cube called voxel, Cartesian mesh is adopted for computational mesh to ease mesh generation. We apply a high-order AMR method[2], based on the Interpolated Differential Operator scheme with Stable Coupling[3] (IDO-SC), for the discretization of fluid equations. We have validated our method by using two different kinds of CT image-based airway models: One is AMR model which number of nodes was 270827 and another is the finest uniform mesh model which number of nodes was 398221. As a result, the number of nodes decreased by 32% while the average differences between the two models was 1.1% for velocity and 0.8% for pressure.

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