Title	医療画像から作成したボクセルデータによる血流・血管壁 連成解析システム
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Abstract

The tendencies to use computer simulation approach to daily medical site have been growing in recent years. The computer simulation is used to research of biomechanical studies today. But it difficult to tough to be used as a tool for daily medical site because it requires making complex actual blood vessel meshes. Reentry, Studies of voxel based fluid analysis, which can easily use medical images via a computer tomography (CT) or a magnetic resonance imaging (MRI) as a computational grid is performed. However, it is not performed that the voxel based fluid-structure interaction analysis considering with an interaction between a blood flow and a blood vessel wall. Therefore in this study, to make using the fluid-structure interaction analysis for daily medical site easy, I studied the models about the fluid-structure interactions on voxel and developed such interaction analysis system. And I verified the system.

In this study, as a method of approximating a object shape by the voxel, I employed the luminosity voxel of the medical image. It can be directly created from medical images without the preprocessing like a computing VOF value or an surface extracting. The interaction analyses need computational grid and treatment of deformation. In this study, the computational grid is made from the luminosity voxel by binarization. And I made the model that considers the deformation by advection of luminosity value.

As a blood vessel and blood flow kinetic model, First, I aimed an artery having over 1.0mm in diameter because the limitation of the current medical image resolution. Next I assumed that the blood flow is Newtonian viscid laminar flow. And then I assumed that the blood vessel wall is an isotropic linear elastic medium, it is obeying Hooke's law. A pressure effect is predominant than a viscous effect for the deformation of blood vessel wall. So I employ the pressure as a fluid force to elastic wall and consider an essential force to wall is the pressure difference between internal and external via a thin wall.

As a method of treatment of the fluid-structure interaction, I employ weak-coupling method. This method separately solves the fluid problem and the structure problem. So it doesn't require numerous amount of memory and computation time, and it can be easily improvement. Since I employed the weak-coupling, I studied information exchanging model between structure analysis and fluid analysis.

First as he information to the structure analysis from the fluid analysis, I employed fluid force on wall, that is, pressure difference. Next as the information to the fluid analysis from the structure analysis, I employed shape deformation and wall moving velocity. In this study, fluid region shape deformation is performed the luminosity advection using displacement velocity from structure analysis. For the next time step fluid analysis, computational grid is made from luminosity voxel by binarization. When the wall displacement is very small, it is likely not to be involving the change of shape by such small displacement into next time computational grid. But the luminosity voxel memories such small displacement by advection, therefore in this method, small displacement effect can be involved. this feature is superior than use simple stair-step voxel for expressing shape. And the wall displacement velocity is also transmitting to the fluid analysis of the next time step as a wall boundary condition. By this method, the small displacement effect can be also involving the fluid analysis of the next time step.

In this study, I verified this system reliability for the fluid-structure interaction analysis about the blood vessel by comparing with consumer fluid-structure interaction analysis software FIDAP.