課題名（タイトル）：

The 3D numerical simulation of blood flow in vascular geometries

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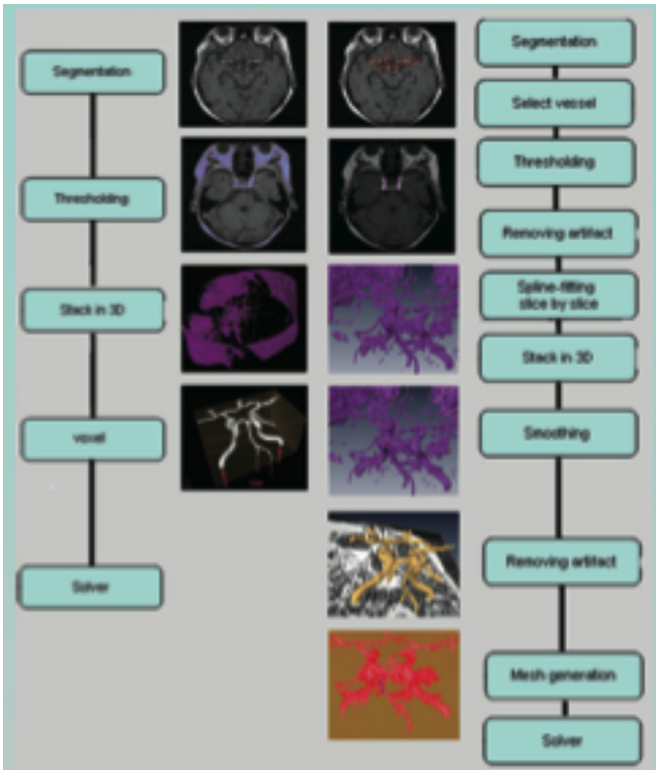
１． Intoduction:

Flow simulation in a vascular geometry are performed by various numerical methodologies to understand the relation between biomechanical analysis and the development of vascular diseases. The purpose of this study is to introduce a supporting tool based on FVM (finite volume method) with several FD(finite difference) discretizations on Eulerian description by AOF-VOF (fractional Area Of Fluid - fractional Volume of fluid) to compensate for the weakness of fixed rectangular mesh with volume fraction method and to optimize voxel size.

２． Materials and Method:

Before solving Navier- Stokes Equation, Flow in a simplified vascular geometry and a realistic geometry from Medical data are divided into fixed non-body-fitted grids on Eulerian frame in figures (a) and (b). The disadvantage of the fixed Cartesian grid would be compensated for by AOF-VOF method and optimal grid size.



(a) fixed mesh Eulerian system, (b) body-fitted mesh Lagrangian system
Figure 3. comparison of procedures to reconstruct geometry from medical images for Eulerian system and Lagrangian system.

３． Results and Discussion:

Biomechanical factors are calculated by Navier-Stokes Equation solver based on the combination of both a finite volume method and a finite difference method with highly simplified MAC method (HSMAC), coupling velocity and pressure. Comparisons the present results with the previous numerical solutions with high accuracy and mesh independence analysis with five level grid refinements were done. It is noted that results on proper grid size have good agreements with early results.

4. Conclusions:

Therefore, our findings confirm the fixed voxel-based simulation can be applied to blood flow simulation for biomedical analysis with simple procedure and without complicate mesh generations

5. Schedule and prospect for the future:

The calculations with the improved interface of vascular configuration are scheduled. Vessel segmentation techniques are developing. Flow in a complicate vascular model would be calculated by the present voxel system.

6. If you wish to extend your account, provide usage situation:

The flow in a vascular geometry has been performed and the grid convergence test has been completed. Improvement of the present methodology would be suggested and need to validate by a calculation. The flow in a more complicate realistic vasucular model would be calculated by the present voxel system.

平成 24 年度　RICC 利用研究成果リスト

【国際会議、学会などでの口頭発表】

1. K.E. Lee, Y. Ishimine, S. Noda, S. Takagi, 血管内の血流シミュレーションソフトウェアの研究開発一次世代ナノ・ライフ合同シンポジウム、 (March 5-6, 2012, Kobe, Japan)

2. K.E. Lee, Y. Ishimine, S. Noda, S. Takagi, Numerical simulation of steady flow in a simplified geometry and a realistic vascular geometry by using non-body-fitted grids. – World congress on Medical Physics and Biomedical Engineering 2012 (May 26-31, 2012, Beijing, China)

3. 李　慶恩、石峯　康浩 、 野田　　茂穂、高木　周, 血管内の血流シミュレーションソフトウェア開発・ 検証研究, ISLiMソフトウェア研究開発報告会, (Jan 10 -11/ 2013, 東京)

4. 李　慶恩、石峯　康浩 、 野田　　茂穂、高木　周, 血管内の血流シミュレーションソフトウェア開発・ 検証研究, 文部科学省「革新的ハイパフォーマンス・コンピューティング・インフラ（HPCI）の構築」HPCI戦略プログラム「グランドチャレンジ・アプリケーションの研究開発」公開シンポジウム（March 11, 2013, 東京)