

Improvement of the Execution Performance for 3-D Impedance Method by Clarification of its Matrix Form Representation

Yukihisa Suzuki^{*(1)} and Masao Taki⁽¹⁾

(1) Tokyo Metropolitan University, 1-1, Minamiosawa, Hachioji, Tokyo, 192-0397, Japan,
e-mail: y_suzuki@tmu.ac.jp; masao@tmu.ac.jp

Recently, numerous research institution and companies conduct the investigation and the development of wireless power transfer (WPT) systems. Especially, WPT systems using intermediate frequency band, e.g. around 85kHz, magnetic field have gained attention for the charging method of electric vehicle. Therefore, there is growing concern about health effects induced by magnetic fields (MFs) of the intermediate frequency band. The 3-D impedance method (IM) is one of the techniques to evaluate the induced electric field and current density within the biological body caused by MFs exposure in the intermediate frequency band for which quasi-static approximation is applied.

The successive over-relaxation (SOR) method has been widely used to solve large scale simultaneous linear equations of the 3-D IM. However, numerical solutions derived from the IM does not rapidly converge to appropriate values by use of the SOR method as the matrix equation solver. Meanwhile, there are many numerical libraries to solve large scale simultaneous linear equations efficiently with sparse matrix forms. It is expected that using them make code development more efficient. Therefore, it is required to clarify matrix structure of a problem in order to use numerical libraries.

In this study, the specific structure of matrix for the impedance method is clarified to apply for widely used numerical matrix solvers as shown in Fig. 1. It is confirmed that appropriate solution for 3-D IM is obtained by using the matrix we have constructed in this study. For example, it is performed that a calculation using the voxel human model and shown the usefulness of the matrix form representation of the 3-D IM. Furthermore, parallelized algorithm of matrix solver, which is the biconjugate gradient stabilized (BiCGSTAB) method applying algebraic multigrid (AMG) [2] for IM, is implemented on the Graphics Processing Unit (GPU) accelerator. Consequently, it is found that calculation speed of the AMG-BiCGSTAB method with the GPU accelerator achieves approximately 1800 times faster than that of the original SOR method.

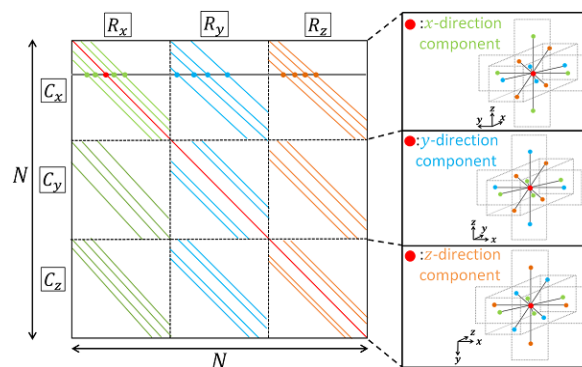


Figure 1. Schematic of the matrix form of 3-D impedance method.

References

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