17. EDUCATION

Distributed Collaborative Computation and Visualization Techniques for Computational Electromagnetics in Engineering Education

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Abstract — This paper presents a novel approach to a distributed collaborative computation and visualization system for computational electromagnetics. The techniques developed in this research can be used for multiple users to analyze the electrical and electronic engineering problems and design the device through network or Internet concurrently at different places. Unlike single user based conventional computation techniques and a centralized collaborative visualization approach, this new technology can provide users with the collaboration at different simulation stages during the computational processing, such as Co-programming, Co-pre-processing, Co-Computation, and Co-post-processing between multiple users with multi-disciplines. This distributed collaborative computation and visualization technology will provide us with a new concept of design and modeling for engineering education and industry applications.

I. INTRODUCTION

Interactive visualization allows us to visualize the results or presentations on the screens in different perspectives (for example, angles, magnitude, layers, levels of details), and thus help us to understand the results better. Scientific and engineering applications can comprise computer simulations, database access, and interactive visualization. Each task could require both human and computing resources that are distributed geographically.

Collaborative technologies will play a major role in scientific grid computing, as most real world scientific and engineering problems are carried out as collaborative teamwork. Collaboration between groups of scientists and engineers has shown to be one of the most effective ways to achieve some of the best results. Therefore, technologies and systems for supporting collaborative teamwork have become a major area of research in computer science and software engineering [1]. However, teamwork has not yet been supported in any interactive visualization systems for computational electromagnetics and product design. Single user oriented CAD/CAE systems still dominant scientific analysis and engineering design. Data analysis and interactive visualization play critical roles in the scientific process, and sometimes real time computation results are very important to scientists and engineers. Unfortunately, these tasks are often performed only as a post-processing step after a large-scale batch job. This paper introduces a novel approach to computational electromagnetics. The proposed real-time collaborative computation and visualization system supports a group of users to work collaboratively at the same time via Internet.

II. THE CONCEPT OF COLLABORATIVE WORK IN COMPUTATIONAL ELECTROMAGNETICS

Interactive visualization is closely related to high performance computation that utilizes visualization techniques to deal with the high complexity of computational electromagnetic problems. With today's large and complex applications, scientists and engineers have increasing difficulty analysing and visualizing vast amounts of data, and the most important tasks are often done by groups of people. Groupware or CSCW (Computer-Supported Cooperative Work) are computer-based systems that support groups of scientists and engineers engaged in a common task and provide an interface to a shared problem-solving environment. The CoWord [2] and CoPowerpoint [3] are representative solutions in the area of collaborative editing systems. In high performance collaborative computation and visualization systems, users can collaboratively write a computation program on CoMATLAB based environment at the programming stage. After the completion of programming work, users can move on to the next three basic simulation steps, which are called Co-pre-processing, Co-computation and Co-post-processing, but under the collaborative working environment.

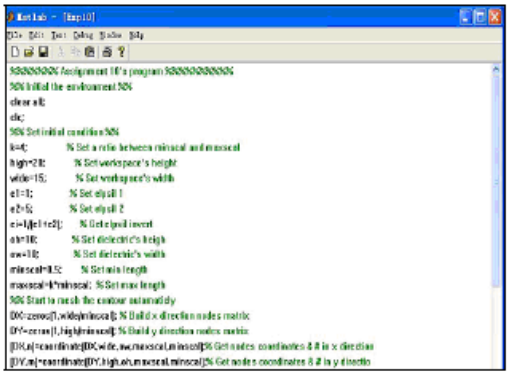
III. APPLICATION OF COLLABORATIVE VISUALIZATION

A. Co-Programming between Multiple Users

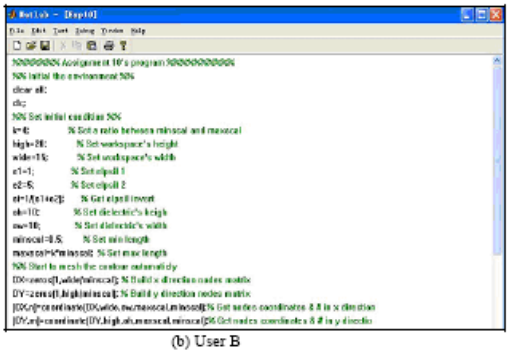
The task is to develop a Finite Element Method program for electrostatic field analysis. The system allows multiple users to write and modify the source code, add and delete code through a web server under the same co-programming environment, as shown in Fig. 1.

B. Co-Pre-processing between Multiple Users

Like any conventional pre-processing in a simulator, Co-Pre-processing is held for the model attributes, such as defining geometry, material properties, boundary conditions, and excitations collaboratively, as shown in Fig. 2. After the final model has been modified and confirmed, the FEM mash can be generated from any user's terminal. During the Co-Pre-processing stage, each user will have the same geometric structure on its screen and each change in one location will be transferred to all other users, and appeared on their screens.

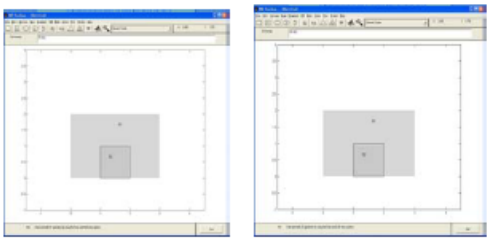


(a) User A



(b) User B

Fig. 1. Two users are writing FEM program for CEM together under the same Co-Programming environment via Internet.



(a) User A (b) User B

Fig. 2 Collaborative model attributes, where user A is drawing a large metal block, and user B is adding a small dielectric block on it.

C. Co-Computation in Distributed Computing System

After completed collaborative model attributes, the computation job can be carried out by any computational engine (PDE solver) in the back running job state and share the computation result. Normally the fastest computer sever will be considered in the first case. Other users can also run the simulation on their own computers as a distributed computer system located in different places and connected by Intranet or global Internet. This flexible computation system can be named as Co-computation system shown in Fig. 3.

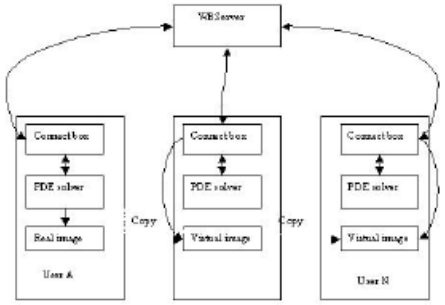
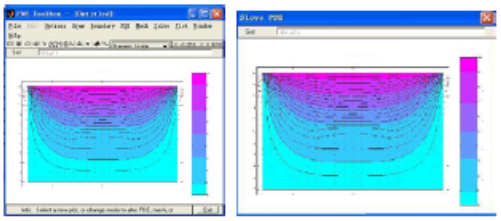


Fig. 3. Co-computation system using distributed computing system.

D. Co-Post-processing between Multi Users

The Co-visualization as Co-post-processing is also called collaborative visualization. After the computation job is completed, user N will present the computation result on the screen, and the potential contour will be broadcasted to all other users' computer as shown in Fig. 4.



(a) User A (b) User B

Fig. 4. Co-Post-processing can carried out by any computer.

IV. CONCLUSIONS

A novel collaborative computation and visualization system has been developed for CEM based education and product development. Further development on consistency and efficiency of the collaboration system will be carried out. The future work will focus on the coupled-domain problem, where multiple computation servers will be used for multi disciplines.

V. REFERENCES

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