Service Oriented CFD Environment Using Web-based Simulation from Pre-Process to Post-Process in e-AIRS

Jeoung-su Na*, Kum Won Cho*, Jinho Kim§, Chongam Kim§, Jang-Hyuk Kwon§§

*Supercomputing Application Technology Department,
Korea Institute of Science and Technology Information (KISTI),
Eoeun-dong 52-11, Yuseong-gu, Daejeon, 305-806 Republic of Korea
{ninteger, ckw}@kisti.re.kr

§Aerospace Engineering, Seoul National University ,
Seoul, Republic of Korea
{jhkim, chongam}@snu.ac.kr

§§Department of Aerospace Engineering
Korea Advanced Institute of Science and Technology(KAIST)
jhkwon@kaist.ac.kr

Key Words: Integrated Research Environment, Portal, Remote Mesh Generation, Solver Service, Remote Visualization, Wind Tunnel, Collaboration, Access Grid

ABSTRACT

The aim of this paper is to present a service-oriented CFD environment construction in the e-Aerospace Integrated Research System (e-AIRS) which runs on an Internet portal and to investigate advantages of this web-based simulation for future design, and also to establish the powerful and user friendly collaboration environment to aerospace researchers. Through the user friendly portal, the e-AIRS provides an integrated numerical simulation and experiment system. This environment will enable the aerospace researchers to save time and cost by sharing resources and providing organized services: data storage, mesh generation, automatic partitioning of computational domain, remote job executing, remote visualization service. For the validation case, we performed 2D extension wing and 3D smart UAV simulations through the web based simulation.

One of the most changes by the Internet may be enhancement of communication and discussion among scientists and engineers. The trend will more tend to be activated in the future and most of the scientists are agree about the change. As well as documents, we have already transmitted data, program files, and even multimedia files through e-mail. In addition, with the fast development of computing power and network speed, a global concept, the Grid was emerged recently suggesting that the project will provide limitless computing resources. With the project, many subsidiary projects and development have been doing now, and thus, the computing power and high speed of network were embedded in our society. In some projects, there are services that are preparing for scientific challenging problems. However, the sequential process from mesh generation to visualization after numerical simulation has been a traditional research manner to the CFD engineers until now. Since these processes are performed by individual research group with sequential way, it make less efficient. Sometimes making a good quality of

mesh will be more significant than choosing a good solver. But the messing has been bottleneck to CFD engineers. When they finish their numerical simulation, they can meet huge data that they made, and difficulties of finding affordable visualization methods. Also, if they want to check the results with reference or experimental data, they would have to ask other researchers by e-mail or delivery services. According to *Web-based Modeling and Simulation*[1], there are many factors that can make the simulation process less efficient with the following features:

- *heterogeneous computing environment:* from personal computer to supercomputer and from Fortran language to JAVA[2] language must make users forced to become familiar with these demanding;
- *lake of interoperability:* numerous CFD codes, visualization, software packages, and CAD are employed to synthesize and evaluate designs;
- *possible data loss among geographically separated design group:* multidisciplinary and analysis is frequently carried out by geographically dispersed engineering group so that the data can be missing.

To improve these drawbacks, we choose a web based integrated system. On the web, we can make a portal which is connected pre-existed CFD software. And we are able to make well organized system for specific researchers. Then, the end users don't need to worry about new languages or computer environment. Also, if the system provides the modules of interoperability, they can save time and efforts during the working. Also, when we store data into the central repository and check the result data together with research members on the portal, the researches would be more fast and accurate.

However, the construction of the integrated system is challenging one. Providing web based mesh generation and post-processing services can give conveniences to users, but dealing with huge data on the web can be difficult. Considering that CFD legacy codes have been set up for beyond 30 years, the legacy code must be used in the portal environment to maximize user efficiency. However, it requires many difficult software configurations. Also if we use individual pre and post programs that we have used before, it does not requre further efforts, but these programs was made without concerning integration and collaboration in the Internet. Therefore, the softwares can not be used directly in the web environment.

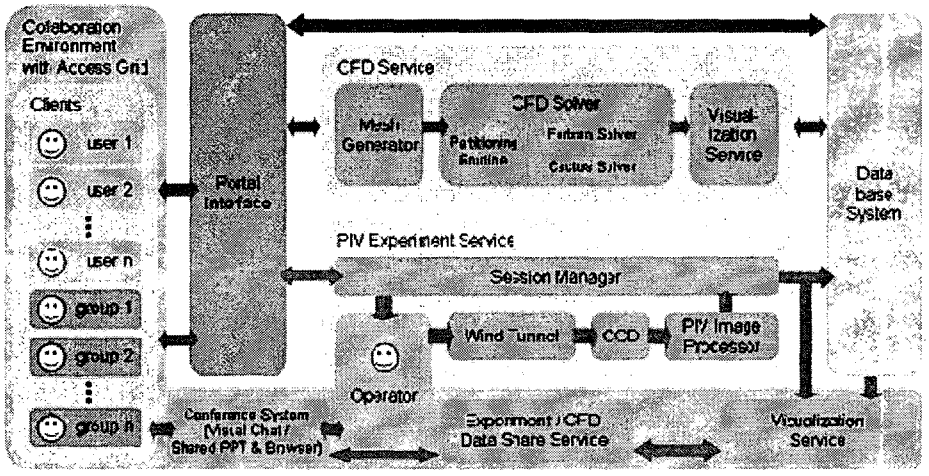

Figure 1 The Schematic of e-AIRS

With the objective of establishing a total integrated system, we designed the schematic of e-AIRS as shown in **Figure 1**. Multi users can access the PSE through the web portal interface

which categorized into two main services: CFD service, Particle Image Velocimetry (PIV) experiment service. The former service CFD service includes three steps: Mesh Generation, CFD Solver and Remote Visualization. The latter service, PIV Experiment service provides remote management system of wind tunnel experiment and a collaboration environment using Access Grid. And this environment is connected with gird resources and super computers those are used for solver or data storage.

From the number 1 to number 12 of the **Figure 2**, it shows the procedure of the CFD solving in e-AIRS. Users can make mesh data directly web mesh generator of the e-AIRS or use pre-made files in client side. And they transmit the data to middle ware side by FTP. After checking available computing resource, the portal executes simulation on grid infrastructures or a supercomputer.

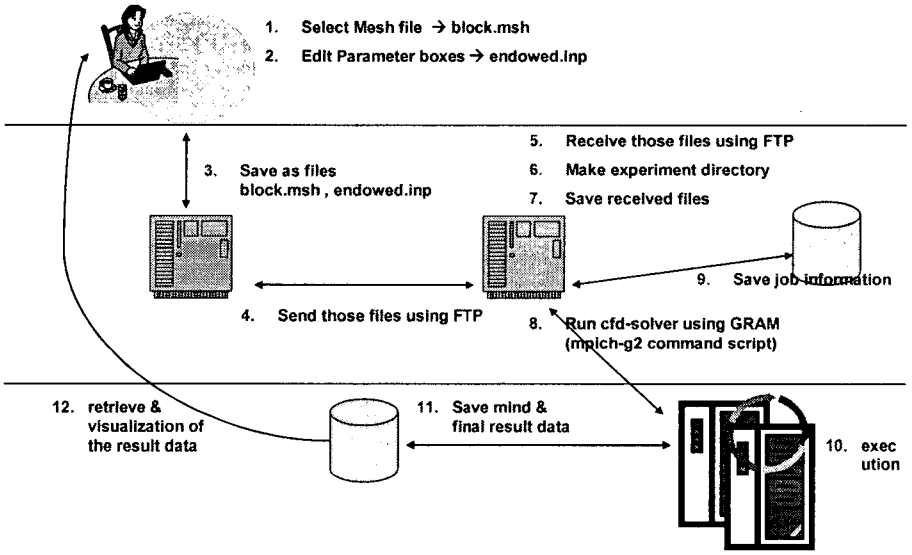

Figure 2 e-AIRS CFD Solver Operation

The developed services are shown in **Figure 3 and Figure 4** with a numerical simulation. After login the portal, users can not only make mesh file directly on the web portal through the remote mesh generation program but also use pre-maid mesh files. The program was maid by Object Oriented Programming (OOP)[3] method for the further organized extension using JAVA classes. The User Interface was designed like **Figure 3** for user convenience. After meshing work, users can run a simulation through the portal interface which provides choosing number of CPU, job parameters, etc. During the simulation, users also are able to monitor of the running and computing results like an error history graph, intermediate results of the currently running job. Furthermore, for the fast identification and analysis of the simulated results, we made the remote visualization program as shown in **Figure 4.** The most of merit would be the validation of their comparison system and it enables researchers to save time and cost for optimization cycle.

Through this development, we can make sure of a possibility of web based simulation and its efficiency. This provides an integrated research system which has the organized numerical simulation software and remote wind tunnel experimental system. With the system, users can discuss about their results on the line and use powerful computing resources that they need. Also using Access Grid system, we can make a collaboration system that will be an essential

tool among research groups. It can be used to the research groups requiring collaborative ways such as validation between numerical calculation and experiment reseals, Fluid Structure Interaction (FSI) including Computational Aeroelastic Analysis(CAA), and Multi Disciplinary Optimization (MDO). The ongoing development will be extended to save R&D time and increase of productivity.

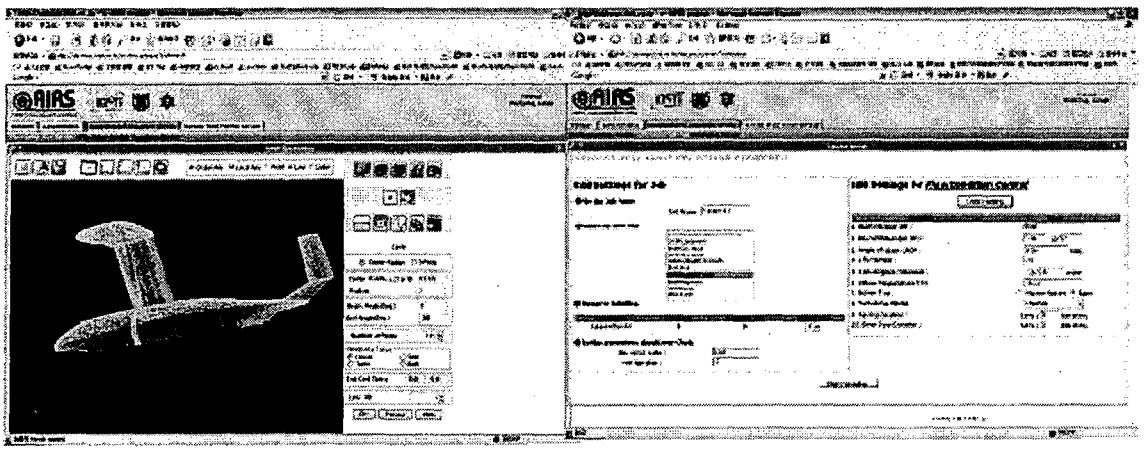

Figure 3 The Mesh Generation & Solver Services

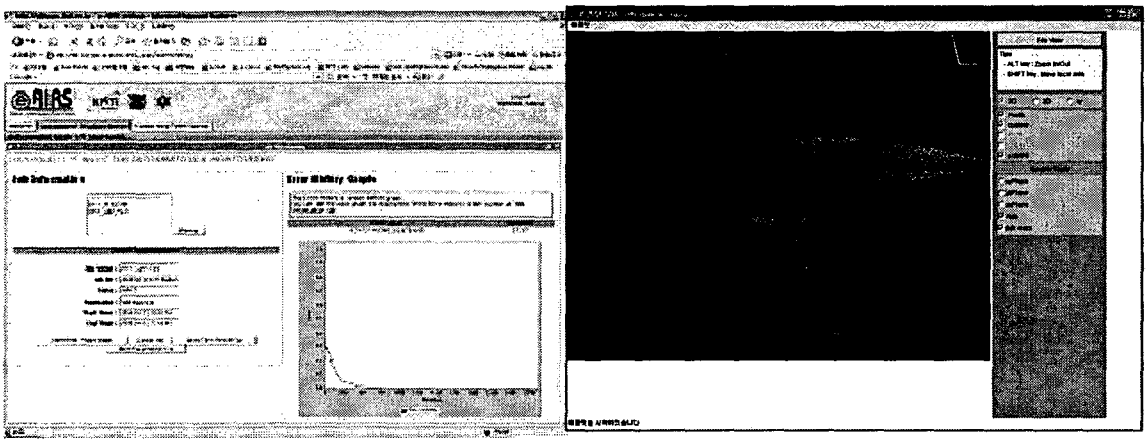

Figure 4 The Remote Monitoring & Visualization Services

REFERENCES

[1] FISHWICK P.A. 1996. Web-based Modeling and Simulation: Some personal observations. In Proceedings of the Winter Simulation Conference(WSC'96, Coronado, CA, Dec. 8-11), J.M. Charnes, D.J. Morrice, D.T. Brunner, and J.J.Swain, Eds. ACM Press, New York, NY, 772-779.

[2] http:www.javasun.com.

[3] ARNOLD, K. , GOSLINGG, J. 1997. The Java Programming Language. Addison-Wesley, Reading, MA.