E-AIRS: AN AEROSPACE RESEARCH PORTAL SERVICE ON THE E-SCIENCE TECHNOLOGY

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ABSTRACT

The aerospace engineers often require the large amount of computing resources for the simulation of the problems treating very massive and intensive data. And, they also need very large experimental equipments such as subsonic/supersonic wind tunnels. However, most research groups can not fully provide such computational and experimental equipments. In order to overcome this situation, this paper suggests the e-Science Aerospace Integrated Research System(e-AIRS) which exploits the Grid computing technology to establish an integrated and collaborative environment supporting distributed computational simulation and remote expriments. The e-AIRS provides an easy-to-use portal service where computational and experimental services include application design, execution, monitoring, and visualization.

INTRODUCTION

Modern aerospace engineering researches require system-integrated activities. In order to design an aircraft, the engineers in various disciplines have to collaborate and integrate their research products. In addition, as the research target becomes more and more complex, the necessity of collaboration among the engineers in various fields also increases. However, the key infrastructure for computational and experimental simulations such as parallel cluster computers and wind tunnels can not be fully equipped in all organizations due to the very high cost. Thus it is urgent to set up an efficient integrated research environment which allows each researcher not only to work together but also to share research result and direction. In this sense, the e-Science[1] environment based on the Grid computing technology[2,3] provides an very efficient engineering method. By linking various research resources such as cluster computers, personal computers, experimental equipments, and human researchers, the Grid technology enables active and powerful collaboration among available resources and the expansion of research topics. In order to integrate nationwide research resources within the e-Science environment, the e-Science Aerospace Integrated Research System(e-AIRS) has been developed. The e-AIRS is constructed to provide an internet-based system which serves both automatic CFD(Computational Fluid Dynamics) simulations and remote wind tunnel experiments. The e-AIRS users can carry out both simulations and experiments through the easy-to-use portal website anytime and anywhere only if internet is available.

E-AIRS PORTAL

The e-AIRS portal is a problem solving environment composed of various portlets which are developed within the framework of the GridSphere[4]. The GridSphere portlet framwork provides a solution to construct an open-source web portal[5]. The GridSphere supports standard portlets, and these can be extended or added in the form of new portlets. The portlets are implemented in Java and can be modified easily. The main goal of the e-AIRS is to establish the powerful and user-friendly research/collaboration environment to aerospace engineers. The portal provides an interface to various processes required in the CFD simulation and the remote wind tunnel experiment. The brief schematic of the e-AIRS is depicted in the Fig. 1.

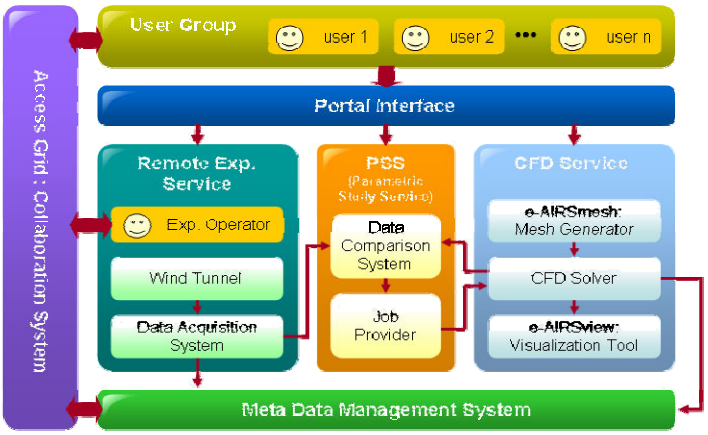

Figure 1. The architecture of the e-AIRS portal

COMPUTATIONAL SIMULATION SERVICE

The computational simulation service has the three main components of mesh generation service, CFD solver service, and monitoring & visualization service. The computational simulation portlet provides the services of selecting data files and computational resources, job submissions to remote machines, and file transfer between mesh generation and CFD simulation. All instructions concerning mesh generation, CFD calculation, and visualization are executed interactively using a graphical user interface.

Mesh Generation Service

The e-AIRS portal provides a mesh generation service supported by the e-AIRSmesh Java applet. The e-AIRSmesh has an convenient interface to create a new geometry, to make a mesh system, and to specify boundary conditions. In addition, to create the mesh for the complex geometry, the CAD2MESH software has been developed. The Fig. 2 shows the e-AIRSmesh and CAD2MESH interface.

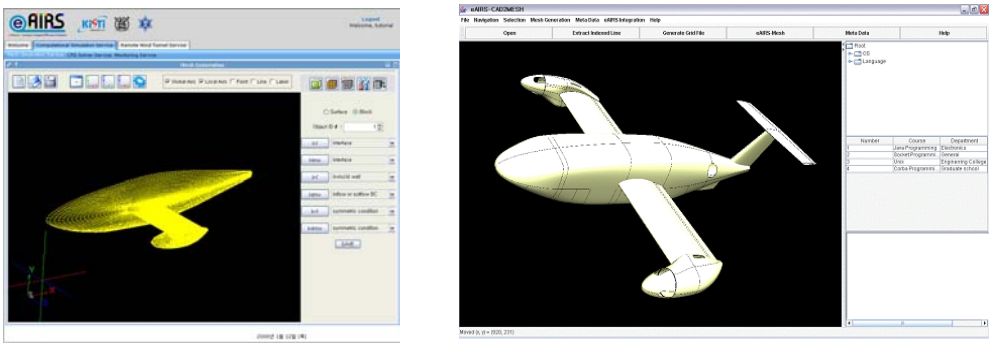

Figure 2. The interface of the e-AIRSmesh mesh generator(left) and CAD2MESH(right)

CFD Solver Service

The execution of the CFD solver requires several flow parameters such as Mach number, Reynolds number, Inflow pressure/temperature, and so on. These parameters are created by the user input and written on a flow condition file. With this flow condition file and the prepared mesh data file, the parallel CFD calculation is executed as follows.

1. The solver divides the mesh data into multiple partitions and transfers them to the distributed computing resources of the e-AIRS.
2. Execute parallel solver at each computing resource.
3. Exchange related boundary data among subdomains.
4. When the solver has converged, the result data are collected for postprocessing.

Upon the completion of a job, the server collects the outputs of the tasks, aggregates those data, and stores the final result file in the data storage.

Monitoring and Visualization Service

With monitoring and visualization service, a user can monitor the latest status of his/her calculation. The user also can see the convergence history graph for error check. With this information and temporary results, the user can interrupt a calculation if it turns out to be is wrong. When the computation finishes on remote computing machine, all output data are transferred to a storage server. The user can download or visualize the result data through the portal interface. The e-AIRSview is used for the visualization of the temporary and final result data. Fig. 3 is the example of the visualization of the computational results by the e-AIRSview.

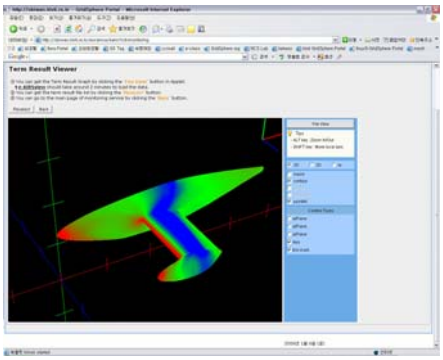

Figure 3. e-AIRSview interface

REMOTE EXPERIMENT SERVICE

The remote experiment service of the e-AIRS is a wind tunnel test through the portal interface without visiting wind tunnel facility. The clients use the e-AIRS portal as a

communication interface with an experiment operator who actually carries out experiments and manages the wind tunnel. The remote experiment service provides aerodynamic force/mement measurement and PIV(Particle Image Velocimetry) experiment[6]. The remote experiment service consists of three services: the experiment request service, the experiment managing service, and the experiment information service.

PARAMETRIC STUDY SERVICE(PSS)

The PSS(Parametric Study Service) supports the comparison of the CFD and experimental data. With this system, users can validate the research results. If the users want to calculate the intermediate cases, the PSS is able to create subcases automatically and instruct HTC processes.

COLLABORATION ENVIRONMENT

The collaborative research teams require collaborative communication system. The Access Grid[7] technology is adopted in the e-AIRS project as the collaborative communication system. The experiment operator, client users can discuss their computational and experimental data through shared applications such as the shared PPT, the shared browser, the shared PDF, the shared desktop and shared GNUPLOT.

CONCLUSIONS

The e-AIRS provides an easy-to-use research environment. Through the portal services, the non-experts can produce their own research outputs without knowing the detailed knowledge of the Grid system architecture. The Grid portal with many service modules and user-friendly UI makes the research environment more convenient and collaborative. In the e-AIRS portal, the main modules of service framework for sequential CFD calculation were presented. The remote experiment service was prepared for client researchers who can not access wind tunnel facility directly. With the Access Grid system and collaborative activities, aerospace engineers can share and compare their research data very conveniently.

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