A Grid Web Portal for Aerospace

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Abstract—A wind tunnel simulation requires high-performance computing power like supercomputers and deep knowledge of this subject. Those requirements make win tunnel simulation difficult. Grid technology will make these difficulties simpler by providing easy to use grid web portal. By using grid web portal, scientist can execute simulation and access to high-performance computing power without any serious difficulties. In this paper will present a grid web portal for a wind tunnel simulation that is used in Aerospace area.

Keywords: Grid, Portal wind tunnel simulation.

1.0 Background

Current e-science research areas can be categories in five big subjects; High energy and particle physics, bio- and chemical-science, engineering, and medical-science. Among those subjects this paper will concentrate engineering application area especially for wind tunnel simulations of Aerospace. Many researchers are actively involving in this area of research in many ways. We are mainly interested in to develop easy to use web portal for a wind tunnel simulation.

Current aerospace area researchers are using computational simulation for their researches because of lock of experimental equipments due to the high cost and time consuming processes of experiments. Computational Fluid Dynamics (CFD) [4] is used for common computational simulation method.

Most caring facts of CFD field are accuracy and efficiency. So far, most of the CFD researches have been focused on how to solve flows around complex and large-scale geometry accurately within limited computing resources. This is the primary reason why CFD researchers actively adopt the high computational technologies like parallelization and Grid computing. But, absorbing the latest computer technology may make people get troubled as they have to be an expert in computer science as well as in CFD. Therefore, the present research is focused on developing a user-friendly PSE for CFD simulations that supports latest computer technologies. On the basis of Cactus framework, some of the modules have been improved and some are newly added for CFD simulation. And, compressible / incompressible flow solvers are modularized and implemented into the current Cactus framework. Additionally, a new support routine for unstructured mesh system is developed and validated within the range of current Cactus structure.

2.0 Overview of CFD

CFD is one of the main research strategies for fluid dynamics. As the computer technology progresses, a computational simulation research has become a common way and, CFD result is widely accepted as accurate as the experimental data.

Fluid dynamics is mainly categorized into two branches. One is the incompressible flow and the other is compressible flow. When velocity is sufficiently large, fluid density become a variable and flow compressibility is an important physical factor. On the other hand, in incompressible flow regimes, density is set to be constant. Then, even though all the fluid dynamic researches have the same goal of finding solutions to satisfy mass, momentum and energy conservation in a given flow condition, numerical techniques to handle incompressible and compressible CFD become totally different. In compressible fluid dynamics, all of the flow variables are coupled and thus density, velocity and energy field have to be solved simultaneously. But in incompressible analysis, governing equations are decoupled and total number of flow variables becomes less than the number of equations. And, an additional treatment for imposing mass conservation becomes important. Therefore, compressible and incompressible CFD solvers cannot be integrated.

In addition, depending on the type of computational domain, structured and unstructured systems can be present. As proved by various researches, structured mesh usually yields better solution for turbulent flow analysis and is amenable to parallelization. But, when complex geometry is modeled, mesh system shows a large distortion and, structure of flow solver may become complicated when multi-boundary conditions are applied. Conversely, on unstructured mesh system, automatic mesh generation and mesh regeneration for complex geometries can be achieved much more systematically. But, unstructured solver shows complex data hierarchy and it requires more mesh points for an accurate solution. Thus, computational support for CFD analysis cannot be definitely chosen as either structured or unstructured method. Rather, both structured and unstructured drivers should be supported for scientists and engineers to choose one of the methods depending on the characteristics of application problems.

3.0 Architecture of portal

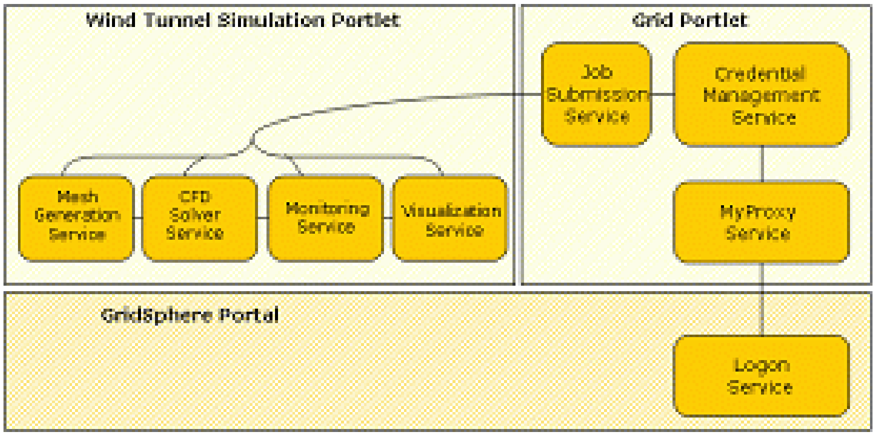

Figure 1. Wind Tunnel Simulation Service Architecture

To make best use of Grid environments, we must develop suitable work environments for each subject rather than make general environments that can be used for many subjects (actually it is very difficult and almost not possible). However, we can extract some components that will be used to almost every Grid environments like user management tool, remote execution of program, and distributed resource information. Because those components are commonly used, there are many existing tools for those components make Grid portal. Among many portal frameworks we are using GridSphere [3] as our basis. GridSphere provide user managements, session managements, group managements, and layout managements as their basis. When users are making their Grid portal, those basic components are very useful and make users life easier.

Like figure 1 shows, our portal contains two major portlets; wind tunnel simulation portlet and grid portlet. Grid portlet is developed by using GridSphere's basic components like user log-in, and user management components. Grid portlet also provide authentication and authorization, job submission, and FTP service.

Wind tunnel simulation service portlet contains three major parts: "Mesh Generation Service" which can make shape of object and its grid, "CFD Solver Srvice" which will perform actual calculation, "Monitoring Service" which will provide intermediate results and error history of running job, and "Visualization Service" which will provide visualization of final result in 3D format.

Detailed information on each subject will be discussed in following section.

4.0 Wind Tunnel Simulation Portal

Flow of wind tunnel simulation service can be distinguished into three parts which is pre-process, calculation, post-process. Pre-process will produce mesh which will be used in calculation by using “Mesh generation Service.” Calculation part will actually perform calculation of CFD. CFD simulation will be distributed in many computational resources to get a best performance. Post-process can make view of calculation result in visualization tool in 3D format. Each process will be discussed in depth in next few sections.

3.1 Mesh Generation Service

Main purpose of mesh generation service is to make an object and it’s grid before computationally solve aerodynamic form.

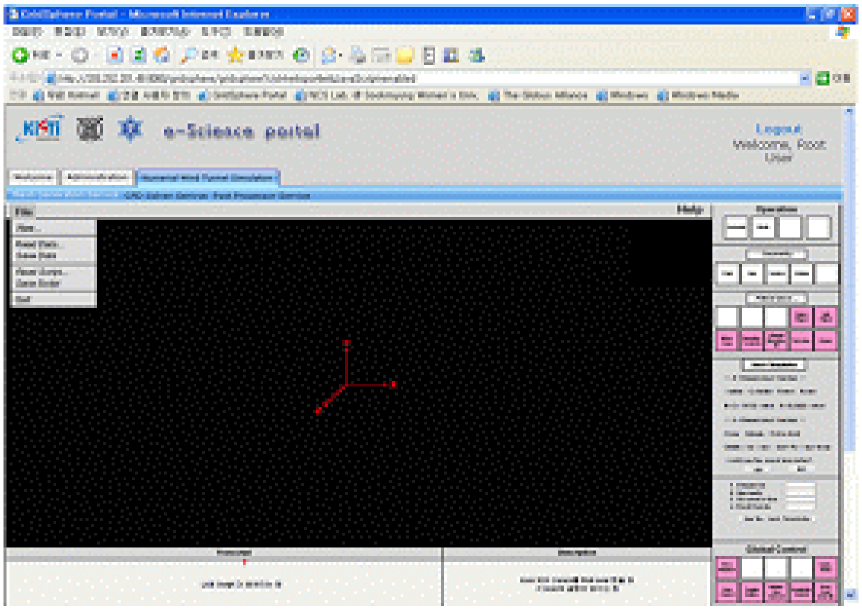

Figure 2. Mesh Generation Service Interface

3.2 CFD Solver Service

After make mesh by using mesh generation tool, user have to put boundary condition parameters in portal. Those parameters will be stored in file and will be used as input file for CFD solver. Other then boundary condition parameters user has to consider more information to run a job like how many machines, how many CPUs, and how many memories like to have to run a job. Current status of free machines, number of CPU, and memories and more information will provide to users to make their chose easy. After finishing interstate needed resources user finally can submits their job. After submit a job user can check status of job by using monitoring service which is discussed in next section.

3.3 Monitoring Service

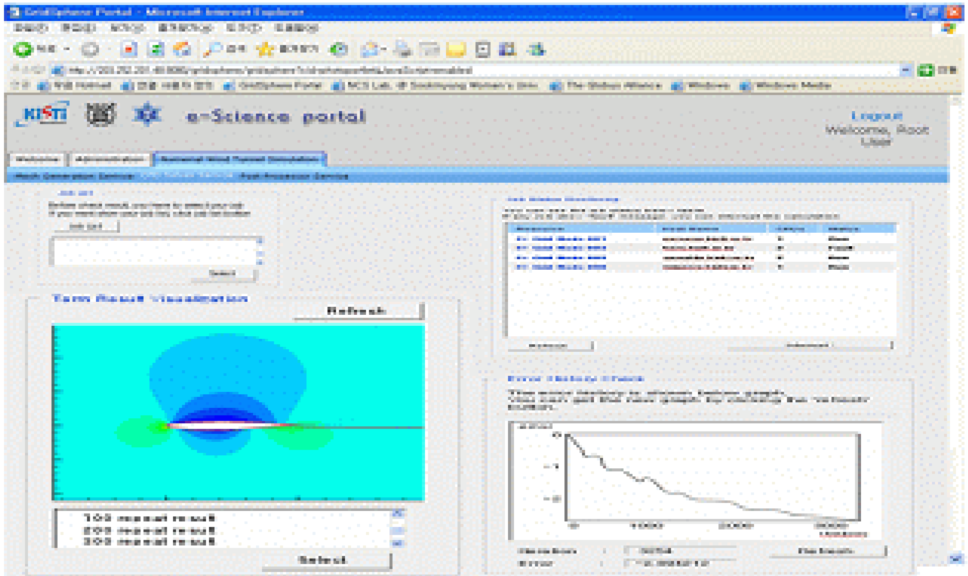

Figure3. Monitoring Service Interface

Figure 3 shows monitoring service interface in our portal framework. Information of current status and intermediate result of currently running job will be monitored in this portal. Progress of jobs that is running in distributed resources will be monitored by using Globus Resource Allocation Manager (GRAM) [5] which provided by Globus. Three main features are provided in this service: intermediate result view, error history graph, and job interruption service. Intermediate results of currently running job are provided to users. Those results can be viewed by graphical tool. And error history graph have to converge other wise it indicate that something wrong with simulation. Users can judge correctness of their job based on intermediate results and error history graph information and can interrupt current job if something goes wrong without waiting for a long to job finish. This interrupt feature will save great deal of users' time.

5.0 Reference

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