

# Collaborative Tool and Its Applications

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## ABSTRACT

The desk side laboratory (DSLAb) which makes it possible for users who are in far places geographically to do research and development through internet on their web browsers, has been developed only using commodity products. It has easy-to-use user interface. It has been shown that DSLAb is useful for collaborative research of particle image velocimetry in fluid dynamics, collaborative system development, and e-Learning. It is emphasized that, when used with digital equipment such as digital microscope, DSLAb has a wide range of applications. It is expected that both of time and of travel cost needed in research and development are reduced largely.

**Keyword:** *Problem Solving Environment, Remote Collaboration, Data Sharing, Easy-to-use User Interface, and Flash Technology*

## 1. INTRODUCTION

The marvelous march of computation progress linked to “Moore’s Law”<sup>1)</sup> and the advance of network according to “Guider’s Law”<sup>2)</sup> have led us to have powerful networking and information technology (IT) resources: computer power and network bandwidth, respectively. Problem solving environment (PSE) defined as “a computer system that provides all the computational facilities necessary to solve a target class of problems” for scientific computing<sup>3)</sup> is actively being studied<sup>4)</sup>. In addition to PSE, it is needed to learn knowledge on usage of advanced networking and IT resources, and knowledge of

application and mathematics such as physics and numerical method for scientific computing.

We have noted particle image velocimetry (PIV)<sup>5)</sup> for fluid dynamics research and development. There are a few PIV researchers who have powerful IT resources such as PIV system, visualization hardware and software at their own sites. We have developed PSE system<sup>6)</sup> for PIV whose PIV application software is Korea Maritime University –PIV (KMU-PIV)<sup>7)</sup>, using UNICORE<sup>8)</sup> based grid technology<sup>9)</sup>. Stills and animations have been visualized by computer graphics package Amira<sup>10)</sup> on a powerful visualization workstation, Silicone Graphics Fuel. The system has been often used from Korea, the States, and Japanese places other than Kanazawa. The system has been shown to be very useful for understanding fluid phenomena on delta wing of a jet fighter<sup>11)</sup> and couette flow inside micro test section<sup>12)</sup>. However, some issues to this system have been pointed by the users from the viewpoints of user interface, easiness to operate, and cost performance, etc. This has suggested a hint that this would be able to make it possible for users who are in far places geographically to do PIV research and development on their web browsers, namely, PIV collaborative research environment. Further, we have become ware of needs of collaborative research environment other than PIV.

The purpose of this paper is, on the basis of our experience mentioned above, to provide PSE system using grid technology and to develop general purpose, easy to use collaborative research environment using commodity products, and to show usefulness of the environment system.

## 2. LABORATORY GRID SYSTEM

Before proceeding to development of collaborative research and development environment, a grid system which can be used only inside laboratory and a PSE system to establish usage of its grid system have been developed. These are laboratory grid system called LabGrid<sup>6)</sup> and GridPSE<sup>13)</sup>, respectively. The middleware of the LabGrid is Windows version of UNICORE ported from UNIX version by ourselves<sup>6)</sup>. The LabGrid is shown in Fig. 1. The LabGrid has been shown to be useful over a wide range of research and development such as PIV, mobile communication design simulation, base alignment query from human genome data base, etc.

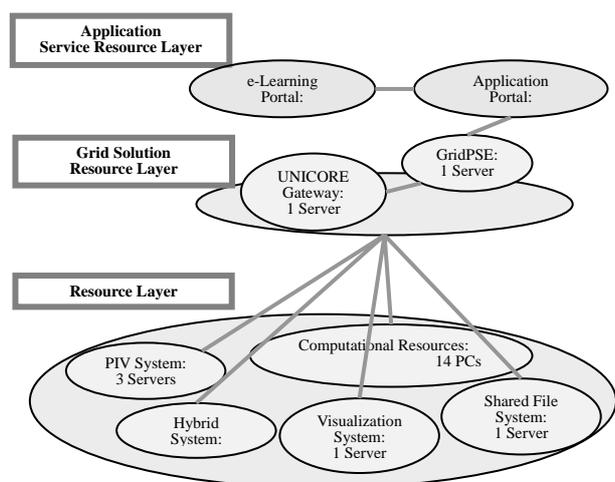


Figure 1 System overview of LabGrid

## 3. DESK SIDE LABORATORY

On the basis of recognition that networking and IT resources are provided by LabGrid and knowledge for its usages is learned by GridPSE, we have brought our focus into development of collaborative research environment for various applications.

### 3.1 Requirements to Collaborative Research Environment

Projects related to state-of-the-art research and development such as nanotechnology, biotechnology, environmental science, and so on, are proceed by multidisciplinary approach using advanced networking and IT. Therefore, easy and smooth communications with researchers who are in far places geographically and have expertise in discipline, play an important role. The video conference is so popular. It, however, has been used mainly for a large-scale conference. Appearance of the meeting facility which small number of scientists and

engineers can discuss with each other is strongly expected in many applications. For example, such facility is needed in research and development, system turn-up, e-Learning, call center, etc. Call center is popular, but there is a defect that it has only verbal capability, but no visual capability, i.e., a customer and an operator can neither see their faces nor communicate each other through images on display interactively. Therefore, collaborative research environment can be used not only as a research and development collaborative tool for scientific computing, but also as scientific and business meeting, e-Learning, call center, etc.

Questionnaire was e-mailed to the expected users to get requirement data of hardware, device, and software needed in development of collaborative research environment at the beginning in 2004. The results are shown as follows:

- 1) Requirement of hardware and device
  - a. PC installed OS WindowsXP/2000 or Mac OSX
  - b. headset, or speaker and microphone which can be connected to PC appeared in marketplace
  - c. web camera appeared in marketplace
  - d. high speed internet connection
- 2) Requirement of software
  - a. web browser (Internet Explore6 or Netscape7)
  - b. plug-in software of web browser

It is noted that a user does not wish any investment to other than a web camera and a headset, and strongly wishes easy set up and easy access to system for use of collaborative research environment.

### 3.2. Technology used in Desk Side Laboratory

There exist the following three factors that realize collaboration and easy-to-use interface. The first factor is video/audio streaming which is one of core technologies in video conference. The second is data sharing. The third is synchronized operation.

Concerning video /audio streaming, there is AccessGRID.org<sup>14)</sup> which is useful for large number of collaborative member. However, AccessGRID.org is so complicated for software installation and set-up of hardware, devices and software. Concerning data sharing, Macromedia Breaze<sup>15)</sup> is noted, which makes it possible to share presentation and to do e-Learning easily. Further, there exist some systems which make use of Microsoft Word/Excel. However, it is troublesome for

researchers and engineers to do real time collaboration. Concerning synchronized operation, the existing current collaborative tools pay attention to data sharing, but not easy-to-use. Synchronized operation that researchers and engineers wish to use in collaborative research environment is a mouse pointer.

We have developed desk-side laboratory (hereafter, it is called DSLab) with concurrent realization of text chat, audio chat, and video chat. The DSLab has been developed using Flash contents<sup>16)</sup>, Flash Communication Server (FCS)<sup>17)</sup>, PHP<sup>18)</sup>, MySQL<sup>19)</sup> and Apache<sup>20)</sup> in order to enjoy various collaborations only by accessing easily the DSLab on web browser. A web camera and a headset are commodities which are appeared in marketplace. By DSLab, such collaborative functions as video and audio, text editor, presentation and contents viewer has been able to be fulfilled. User interface is synchronized only in some operations whose security is kept, and avatar of the members within predetermined group in DSLab is displayed. Avatar means the virtual reality character in cyberspace or virtual space. To realize this system and provide users with the best environment, DSLab has used the following software: PHP4.3.2, MySQL4.0.13, FlashMX2004, and FCS1.5. The DSLab is outlined in Fig. 2. Operation in cooperation with flash player, flash contents, and FCS has realized real time audio/video streaming. The DSLab is in Kanazawa University. Facility of users denoted as researcher 1... N is only WindowsXP/2000 PC or Mac with web camera and headset, or a combination of speaker and microphone.

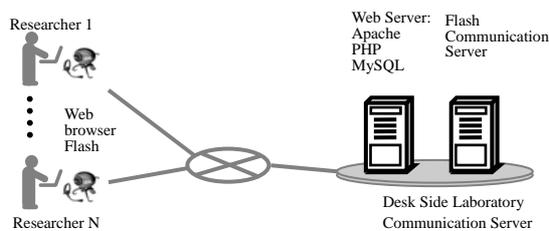


Figure 2 . System overview of desk side laboratory (DSLab) in Kanazawa University

### 3.3. Feature of DSLab

The functions of DSLab can be classified into two categories. The first is collaborative functions which are known as text chat, audio chat, video chat, video and presentation streaming, collaborative image viewer, text data sharing, and collaborative mouse pointer. The second is the following usage environmental elements: generation of user-ID with time expiry and dynamical

selection of a user group.

The feature of DSLab is two. The first is synchronization of keyboard input, mouse operation and some operations on graphic user interface (GUI) in the same user group. Therefore, the user who uses the system for the first time can get any kinds of support from a skilled user. The second is that a specified user has the authority to issue user-ID. The published-ID is limited to time expiry. By this function, a new user is widely opened from the troublesomeness of the waiting procedure for the issuing user-ID. As a result, user enables collaboration each other quickly.

### 3.4 Easy-to-Use User Interface

User has access to communication server of DSLab through web browser for user login. User belongs to at least one of user member groups. When user login is done, avatar is displayed at the display in order to show the connection mode of member such as “active”, “interactive”, “denied” and “busy”. See Fig. 3. Therefore, user can start collaboration with other users depending on the above-mentioned connection mode. As shown in figs. 4 and 5, contents viewer and shared text editor are used.



Figure 3 A screen of avatar function

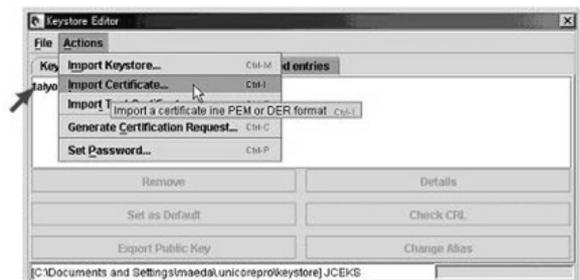


Figure 4 A screenshot of a sample contents by contents viewer



Figure 5 Snapshot of shared text editor

#### 4. RESULTS AND DISCUSSIONS

The DSLab has been used in the following attempts: collaborative research and development, collaborative system tune-up, e-Learning and collaboration with digital equipment. We have some research collaboration projects with Japanese firms. The system has been frequently used as meeting tool between Kanazawa University and firms in Japan.

##### 4.1. Collaborative Research and Development

Figure 6 shows turbulence of a jet fighter wing with and without leading edge extension (LEX), which has been obtained from PIV web laboratory (PIV-WL)<sup>6</sup>. The shape and the size are important elements for design of the wing. The design meeting with aeronautics, PIV, and visualization specialists has been held using DSLab. The DSLab has been shown to be useful for time and cost reduction of jet fighter wing design using PIV-WL.

Mobile communication design simulation requires so many parameter sweeps. The meeting for determination of level of these parameters has been held by communication engineer and computational scientist using DSLab. It has been shown to reduce the design time markedly, when used with design of experiment and distributed computing.

A group of Professor Mari Ohshima, The University of Tokyo is doing collaborative research of cerebral hemodynamics based on PIV, fluid dynamics simulation, finite element method simulation and medicine. They are under using DSLab.

##### 4.2. Collaborative System Tune-up

In the development of PSE system for Grid, it has thus far been difficult for the developers to meet needs both from the users and system administrators and to do the system tune-up. The DSLab has been applied for system monitoring and determining

environmental parameters on CyberGRIP<sup>21</sup>), which is PSE system for Grid and middleware provided by Fujitsu Laboratories, Ltd. Real time monitoring and discussions between Kanazawa University and Fujitsu Labs., Ltd. where is 250 miles distant, have been realized. It has been possible for them to communicate the data and contents with each other with great accuracy. Status of system can be easily understood and real time determination of system parameters has been realized as shown in Fig. 7. In order to make more useful collaborative system tune up, on-line and real time reporting function is under planning.

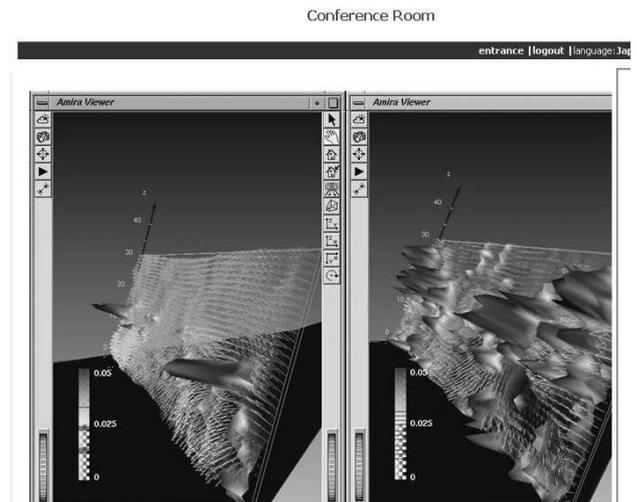


Figure 6 PIV analyses meeting using image of visualization. The left is with LEX and the right without LEX.

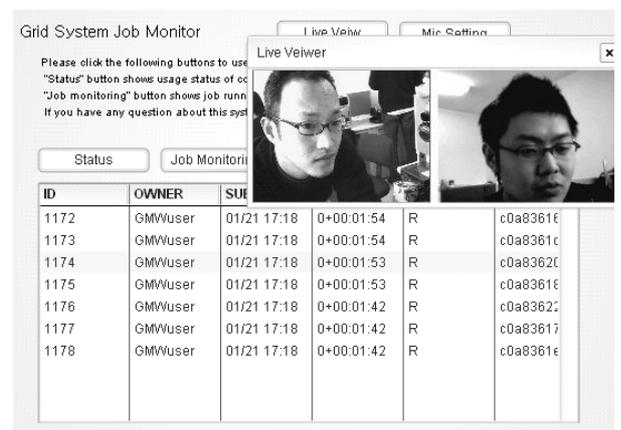


Figure 7 System monitoring and tune-up for development of grid application using Fujitsu CyberGRIP

##### 4.3. e-Learning

The prototype version of DSLab was used in science and technology course using computer for local senior high school

students held in summer, 2004. Professor Moon-Joon Kim, Pukyong National University, Busan, Korea who has an expertise in acoustics, had his lecture on sound wave simulation. The lecture was done in Japanese. Japanese students could have their valuable experience of international e-Learning. The DSLab has been recently applied to an intensive course on usage of structural analysis system “NAVISTRUCT<sup>22)</sup>” for junior student class in Kanazawa University. The students have easily learned how to use NAVISTRUCT according to instruction by a structural analysis specialist in Kyoto where is 150 miles distant as shown in Figs.8 and 9.

These two e-Learning cases mean students can easily learn knowledge of applications from a specialist who is in far place geographically and large reduction of travel cost can be expected. By-product of e-Learning is its easy extension to call center scheme which a customer and an operator can see their faces and communicate each other through images on display interactively.



Figure 8 Classrooms in Kanazawa University for NAVISTRUCT usage



Figure 9 Help and support

#### 4.4. Connection to Digital Equipment

It is useful to operate high performance equipment such as electronic microscope where is in far geographically. Demonstration of an ultra-high-voltage electron microscope between Osaka University and University of California, San Diego ego is famous in research of access grid<sup>23)</sup>.

The scheme to send microscope images in biology, chemistry, and geology is needed for identification of samples by so many researchers. Digital microscope is connected to DSLab through USB port and observation images are shared by researchers where is in far geographically. Figure 10 shows that an observer is sending image by using Olympus MIC-D Digital Microscope©, and Fig. 11 shows that a researcher receives the image.

When used with Flash, commodity PC has easy on-line connection to many kinds of digital equipments through USB port. As a result, the case of connection of digital microscope makes us expect appearance of new type of access grid, using collaboration with digital equipments.



Figure 10 Sender of Olympus MID-D digital microscope's © streaming

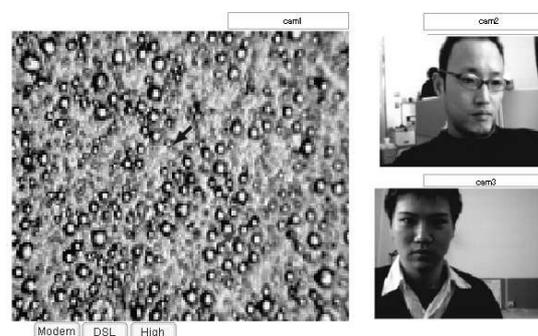


Figure11 A screenshot received from Olympus MIC-D digital microscope© and real-time Discussion

## 5. CONCLUSIONS

General purpose collaborative research environment called DSLab has been developed using commodity products and grid technology. The DSLab is so easy for software installation and set-up of hardware, devices and software. It takes only within a half minutes. The DSLab has easy-to-use user interface and on-line real time usage function. The DSLab has made it possible for users to enjoy collaboration over a wide range of applications only through internet on web browser, regardless of their possession of computational facilities at their own sites. The DSLab has provided productive and fruitful project meetings. It has been shown that, when used with an intensive course on usage of structural analysis system NAVISTRUCT, DSLab is useful for usage training of NAVISTRUCT. Real time determination of system tune-up parameters has been realized in collaborative system tune-up. It is expected that, when used with a digital microscope, DSLab can be applied to geology, medicine, chemistry, etc.

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