

THE INTERACTIVE DATA VISUALIZATION WITH Java 3D

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Abstract

NIFS (National Institute for Fusion Science) is engaged in developing a real-time monitoring system for their LHD (Large Helical Device) experiments. The system allows users to remotely participate in the experiments. The monitoring system is utilizing Java technology to accomplish these tasks. Some of the tasks include the ability to monitor experiments in real-time and data retrieval from remote stations. Also with this technology, an alarming system, as presented in this conference, has been constructed to notify researchers by some physical method (i.e. email, pager, etc...). The goal is an easily used and complete monitoring system that can be used from any browser. To achieve part of this goal, a graphical representation of the various aspects of the monitoring system is needed and is being developed with Java 3D technology. By using Java 3D, integration with the Java based monitoring system is easily and efficiently realized. Java 3D allows for a quick, easy, and interactive interpretation of the vast amount of data and geometry associated with the experiments. This allows participants to efficiently analyze key aspects and to quickly identify malfunctioning parts or troublesome areas in the experiment. From this aspect, we are studying the Java, including Java 3D, technology and its internet capability to carry on monitoring, data capture and data analysis of real-time LHD experiments with remote participation.

1 INTRODUCTION

Large-scale experiment, such as accelerator experiments or a nuclear fusion experiments produce huge data. LHD was constructed and has been operating in NIFS since the end of March, 1998 [1]. This is the largest superconduction fusion experimental device. Because LHD makes a complicate shape, a lot of sensors are required to study various aspects of the plasma and the machine operation. LHD experiment produces about 10MB data per one plasma discharge typically in present time, and 10,000 shots per year will be achieved. In addition to such a periodical measurements, the continuous monitoring is required to realize a stable operation. To accomplish this task, the LHD monitoring

system has been studying and developing [2-4]. This system uses the Internet and Java technologies, so technically researchers can monitor the sensor data and can operate the ADC controller interactively while they are outside of the control room. One of the advantages to use Java is that it is OS independent, this means that one can run the program on any operating system that implements the JDK1.1 runtime environment. The other advantage is about the maintenance of the system. Because the program is downloaded to the clients when they connect to the servers, it is easy to upgrade the program. As the next step of this system, 3D graphics feature was added. This feature enables researchers to recognize the phenomena easily and intuitively. This paper shows the study of the temperature visualizing system, which monitors the temperature of the vacuum vessel. This helps the understanding the status of the plasma peripherals, such as magnetic distribution in the diverters.

2 COMPUTER SYSTEM AND GRAPHIC MODELING

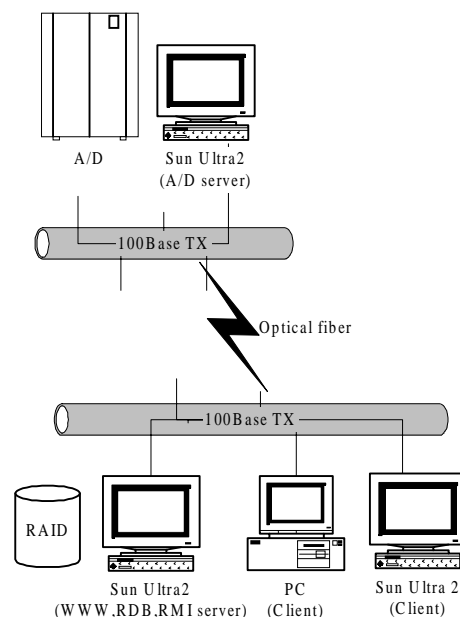


Figure. 1: network configuration

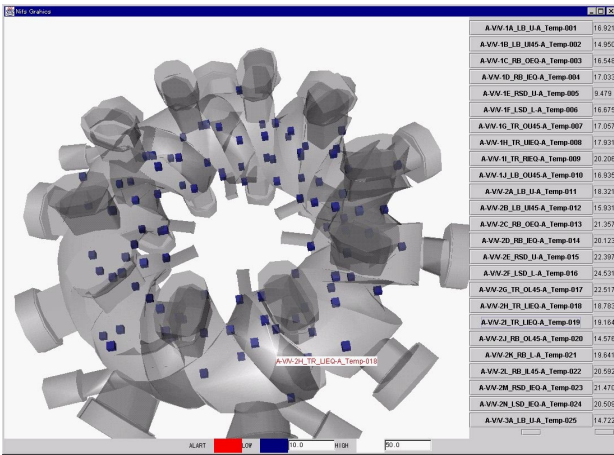


Figure 2: temperature distribution
The temperature distribution is superimposed by the translucent geometry of the vacuum vessel .

Table 1: system configuration

	server	client(WS)	client(PC)
CPU	Ultra Sparc 166MHz ×2	Ultra Sparc 166MHz×2	Pentium II 450MHz ×1
VIDEO		Creator 3D	Matrox Millenium G200
OS	Solaris 5.5.1	Solaris 5.5.1	MS Windows NT4.0 SP4
JDK	1.1.6	1.2β	1.2
Java3D		1.1	1.1 (OpenGL)
DB	Sybase System 11		
JDBC driver		Sybase jConnect 5.0β	Sybase jConnect 5.0β

The configuration of the LHD monitoring system is shown in Fig. 1. The A/D server acquires the data from the A/D converter, and it converts the raw signal data to physical value. Both raw and physical data are delivered to the all connected computers on the subnet using multicast, and the HTTP server stores the received data. The client applet can get the data from the HTTP server by Java RMI (Remote Method Invocation). The client side programs are written in Java language, and using JDBC (Java DataBase Connectivity) they retrieve the information of the experimental instruments such as the amplifiers, the sensors, and the power suppliers from the database server, on which the HTTP server also runs. The 3D graphics application reads the geometrical information of the vacuum vessel from the file, and displays the vacuum vessel shape and the location of the sensors retrieved from the database. One output of this

application is shown in Fig.2, the sensors are represented by the cube and superimposed on the vacuum vessel model. These sensors are colored depending on the magnitude of the temperatures. The temperature is indicated by the graduation of the color, the higher the temperature becomes it is colored by white, the lower the temperature gets down, it is colored by blue. The color of the sensor is also used as the alarming system, and if the magnitude of the temperature excess the limit, the color turns to red. The hardware and software used in this application are listed in table 1.

3 EXAMPLE OF DATA VISUALIZATION

Figure 3 plots the temperatures of the sensor during NBI (Neutral Beam Injection) experiment. The vacuum vessel was heated by the NBI, and the temperatures went higher after the beam injection. The temperature distribution of the vacuum vessel is the results of the energy deposition of the NBI heated plasma. Figure 4 shows the temperature distribution before/after the NBI. The temperatures higher than 29.0 °C were drawn by orange, and the temperatures lower than 28.75 °C were drawn by dark blue. The temperatures between the above two values were drawn by the neutral tints.

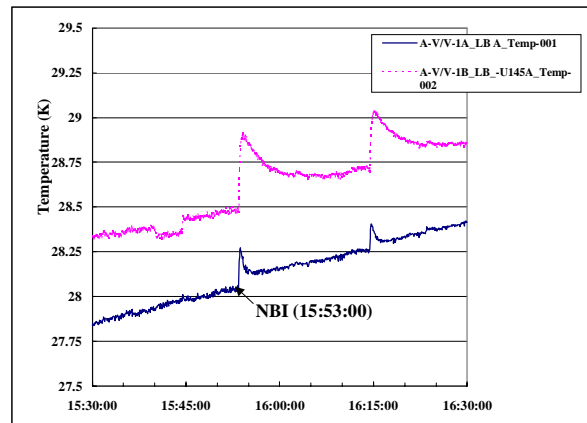


Figure 3: temperatures of the sensors
The temperatures became high after the NBI.

4 DISCUSSION AND CONCLUSION

Through the development of this application, Java 3D is a useful 3D-visualisation tool. This system uses 22,000 triangles for the vacuum vessel geometry, and retrieves 100 values of the sensors from the RMI server every five seconds, and redraws them by the color depending on their values. Because today's rapid progress of CPU and graphics cards, even a mid-range class PC (Pentium II 300MHz, with 3D accelerator) has enough power to run the 3D applications written in Java.

In the Internet world, VRML [5] is widely used as a three-dimensional description language more than Java 3D. The concepts of both languages are similar, but there are significant differences, and VRML has some

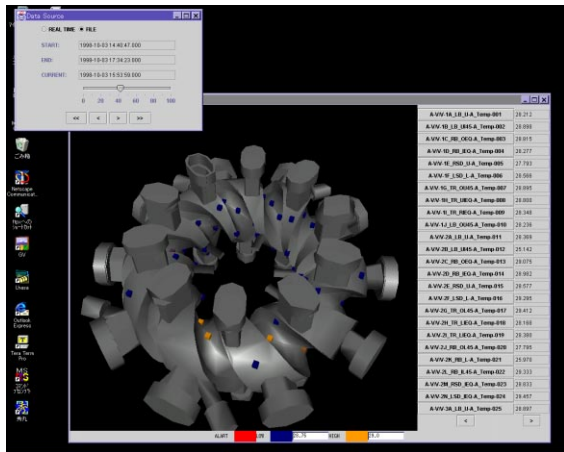
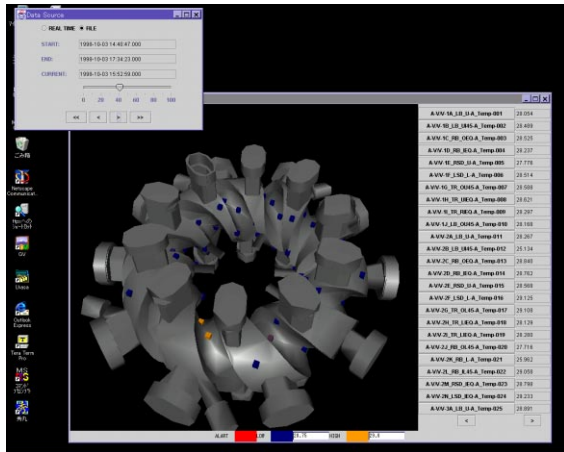


Figure 4: The temperature distributions before/after the beam injection
The higher temperatures are drawn by orange.

advantages. Because VRML is an interpreter language, it is easier to develop than to use Java 3D. There are many tools to edit and viewing VRML source. However, it is difficult to write practical applications only by using VRML, and therefore, it is necessary to combine other languages to realize a more complicated application. On the other hand, because Java 3D is an API of Java language, it is easier to build an ordinary application only by using Java, but there are few modeling tools directly produce Java sources. Because it is a burden to build three-dimensional objects only by Java 3D, a realistic way to make an application is to use both languages. The comparison of VRML and Java 3D is listed in table 2. This application uses VrmLoader class to load the VRML sources which describe the geometry of the vacuum vessel.

The application visualizes the data composed of only spatial dimensions in this case, but the three-dimensional visualisation technology can be applied to mixed dimensional data, which means the spatial and chronicle, or other dimensions. Since in the plasma experiment, there are various kinds of data which have multi-

Table 2: Comparison with Other Language

	Java 3D	VRML	C/C++ (OpenGL, Direct 3D, etc.)
OS Independence	YES (Win32 and Solaris in the present time)		NO
Tools	FEW	MANY	MANY
Performance			FASTEST
Run on WEB Browsers	YES	YES	NO
Actual Programming	YES	NO	YES
Programming	RATHER EASY	EASY	DIFFICULT
Released Date	1998	1994	

dimension of spatial, time, and physical quantities, 3D graphic technology can be the important tool to progress. The next task to study is how to visualize these data

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