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비주얼 시뮬레이터를 이용한 KALIMER 가상현실 구현

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Simulator development Using Information Visualization Into Virtual Reality Laboratory for KALIMER

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Abstract

The Real-Time Best-Estimate simulator NPA4K is being developed for providing an efficient nuclear power, KALIMER, simulation environment for transient safety analyses using information visualization. The advanced features of NPA4K simulator are the Once-Through Running Environment, Functionalities of displaying the several X-Y Plot on one system, and Multi-thread Processing. The objective of NPA4K simulator is to realize the Virtual Reality Environment through Network and Internet technology in Nuclear Power Plants.

Key Word : Information Visualization, Simulation, Virtual Reality

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1. Introduction

Until Recently, the term visualization meant constructing a visual image in the mind. But now it has come to something more like a graphical representation of data or concepts.

One of the greatest benefits of data visualization is sheer quantity of information that can be rapidly interpreted if it is presented well.

Also, Computer Simulation with Information Visualization has covered area of industrial applications. In this paper, Using Computer Simulation through Information Visualization, how to handle Analyses Results in Nuclear Plants is invoked.

2. Real-Time Simulator Develop-ment for KALIMER Using Information Visualization

2.1 Overview of NPA4K Simulator Development for KALIMER

KALIMER[1] Reactor has been developed R&D project as Liquid Metal Reactor Design Technology Development in Korea Atomic Energy Research Institute, Korea.

As part of KALIMER's sub project, SSC-K[2],Computational Code for Transient Safety Analysis of KALIMER has been developed.

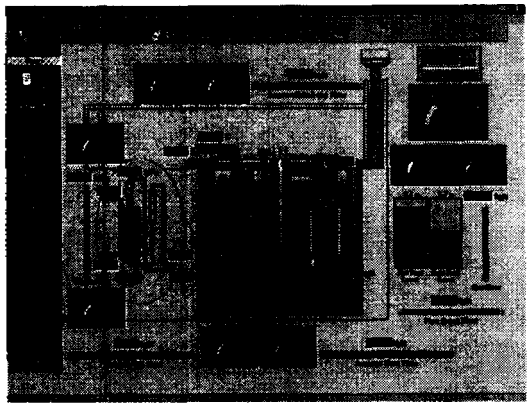

Figure 1. Graphic Information Visualization Simulator NPA4K

To add the Efficiency and Convenience of SSC-K, Graphic Information Visualization Simulator, NPA4K[3] is under development.

The objective of this NPA4K is to simulate Accident with Real-Time for Transient Accident Analyses for KALIMER.

2.2 Visualization Stages

There are three basic stages in the process of data visualization, together with a number of feedback loops.

1) Korea Advanced LIquid MEtal Reactor

2) Super System Code for KALIMER

3) Nuclear Plant Analyze for KALIMER

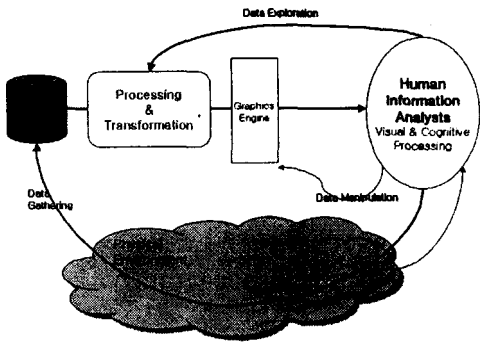

Figure 2. A Schematic diagram of visualization process

(1) The collection and storage of data itself

(2) The preprocessing designed to transform the data into something we can understand

(3) The display hardware and the graphics algorithms that produce an image on the screen

The Longest feedback loop involves gathering data itself. A data seeker, such as a scientist, may choose to gather more data to follow up on an interesting lead. Another loop controls the computational preprocessing that takes place prior to visualization The analyst may feel that if the data is subjected to a certain transformation prior to visualization, it can be persuaded to give up its meaning. Finally, the visualization process itself may be highly interactive. For example, in 3D data visualization, the scientist may fly to a different vantage point to better understand the emerging structures. Alternatively, a mouse may be used interactively, to select the parameter ranges that are most interesting. Both the physical environment and social environment are involved in the data -gathering loop: The physical environment is a source data, while the social environment determines in subtle and complex ways what is collected and how it is interpreted.

One of the greatest benefits of data visualization is the sheer quantity of information that can be rapidly interpreted if it is presented well. A number of the advantages of visualization are as follows:

(1) Visualization provides an ability to comprehend huge amounts of data. The important information from more than a million measurements is immediately available.

(2) Visualization allows the perception of emergent properties that were not anticipated. In this Visualization, the fact that the pockmarks appears in lines is immediately evident.

(3) Visualization often enables problem with the data itself to become immediately apparent. It is common for a visualization to reveal things not only

about data itself, but about the way it is collected. With an appropriate visualization, errors and artifacts in the data often jump out at you. For this reason, visualizations can be invaluable in quality control.

(4) Visualization facilitates understanding of both large-scale and small-scale features of the data. It can be especially valuable in allowing the perception of patterns linking local features

(5) Visualization facilitates hypothesis formation.

2.3 How to realize Visualization

Evolutions in technology have provided us with a wealth of new opportunities for exploring and interacting with such as 3D worlds, both real and virtual.

The definition of Virtual Reality is these: A computer system used to create an artificial world in which the user has the impression of being in that world and with the ability to navigate through the world and manipulate objects in the world.

The definition above is often quoted in the literature and is an accepted working definition of virtual reality. However, in order to define the essence of virtual reality, we need to examine the concepts implied by this definition.

Firstly, Virtual Reality(VR) is a computer system used to create an artificial world. An artificial world, a virtual environment, is a simulation generated by a computer. In practice, this means that a computer renders three-dimensional graphics in real-time and that the environment has a defined behavior. The simulation can be imaginary, abstract, or represent a real environment. The computer does not necessary have to simulate the laws of physics nor does it necessarily have to depict objects with photo-realistic detail. What is important is that the artificial environment presents information in a clear, illustrate, manner that users ca comprehend.

Secondly, the user has the impression of being in that world. Two very important words in the field of virtual reality are presence and immersion. VR immerses the user in the simulation so that the user has a sense of being present in the virtual environment. The degree of immersion depends primarily on the hardware technology used whereas presence is achieved by making an environment that cause the user to suspend disbelief and accept the computer-generated experience as 'real'. For example, a pilot in an advanced flight the (virtual) aircraft. It is an information intensive experience in which the user concentrates on information presented by a computer. Immersion is the hallmark of

genuine VR systems, where the user's primary sensory inputs are fed with data generated by a computer. For instance, the user sees images through a stereoscopic head-mounted display, hears sounds through headphones, and interacts with gloves. The user is immersed in the virtual reality.

Thirdly, the user has the ability to navigate through the world and manipulate objects in the world. A computer system that generates an artificial world that fools the user into feeling part of it would not be a complete definition of VR because it lacks the vital computer of interactivity. VR is a three-dimensional user interface in which the user can perform actions and experience their consequences. It is a multi-dimensional real-time simulation rather than a linear animation with predefined camera movement. This is what separates VR from recorded, computer generated, images used in films and on television and from real-time computer animation where the user is a passive viewer, such as the animation sequences used to tell a story between stages of three-dimensional computer games - so called 'clip scenes'. in which the user can perceive information and perform tasks in a more natural manner than using conventional two-dimensional graphical user interface.

Eventually the concept of virtual reality is of a user interface technology where the interface between man and machine is completely transparent.

2.4 The Application for Visualization

An application is a set of software and data that accomplishes a given task. The definition of what constitutes an application has evolved greatly in recent times. At one time an application was a specific piece of software that user purchased, took home in a box, installed on his/her computer, and then spent hours learning to operate. Nowadays an application might be downloaded and installed via the web, or it would be accessed directly and used without installation. Neither training seminars nor manuals are necessary for learning to use such software. A different paradigm is a at work. Instead of a user buying an application and mastering it over time, it is borrowed for a brief period and is immediately usable.(E. Douglas Jensen ,2000)

2.4.1 The familiar of Application for Visualization

In its more basic form, an application consists of a user interface, a model, and data. The user interface allows the user to talk to the application and the application to talk to the user. The model listens to the user and modifies the data accordingly, and it listens to the data and notifies the

user interface if data changes occur. It is an important milestone in object-oriented design because it separated out the major user interface and non-user interface elements.

2.4.2 The dream of Application for Visualization

The web is redefining our notion of what an application is. Some changes are architectural in nature, with pieces of the application flung to the four corners of the world. The client is in one location; the server is in another location; the database is elsewhere; and the whole apparatus is connected by the global Internet and squeezed through the browser on your desk or in your TV. Other changes, which some say are revolutionary, are sociological in nature, with the whole way we internet with others and do business at a distance being redefined. Although the VR dream is still science fiction, the intuitiveness of VR's user interface and its ability to make the abstract tangible is not lost on people.

2.4.3 The reality of Application for Visualization

E-commerce is currently riding the crest of the Internet wave. As an industry it has high visibility because it is promising to fundamentally change the way we do business. The applications that everyday users utilize must be innately intuitive. 3D offer on of the ways for applications to achieve this. 3D user interface techniques are bound to find their way into mainstream applications of all sorts. Which application will use 3D? The ones that need it. 3D must stand on its own alongside other user interface techniques and multimedia technologies.

2.4.4 The rebirth of Application for Visualization

The users now expect to be able to sit down in front of their computers and get something done, quickly and easily. This means that web application have to be smaller, nimbler, and more task-specific than older applications.

2.5 The User Interface for Visualization

What is a computer user interface? The user interface is everything having to do with the computer that the user can touch, see, and hear. Although this is a true statement, it probably isn't very meaningful. Delving into the matter a bit more deeply, the user-computer dialogue conducted through the user interface can be described from three different views.

2.5.1 The primal of User Interface for Visualization

This level of the user interface deals with matters such as hand-eye

coordination, stimulus-response, and reflexes. the dialogue between the user and the computer is almost primal. Short of a direct connection between the computer and the user's brain. the user must rely on using eyes, ears, and limbs to interact with the computer. The user sees and hears what the computer hat to say through its display screen and speakers, and in response the user talks to the computer through the mouse and keyboard. At this most fundamental level, the dialogue is important, but it is by its nature limited in content.

2.5.2 The virtual of User Interface for Visualization

The application tells the user what the state of its 'virtual' world is, and the user tells the application how he would like to change that state. The virtual world is built from data provided by the application or created within the application by the user. From application to application, there is no predicting what the data might be. It could be as disparate as clothing draped on life-like mannequins is a sales application, or modular office furniture in a facility management application.

In this view of the user interface, the application and computer-the system-are working hard to maintain the illusion that the data is real and the user can really change it. The system generates an aesthetically pleasing presentation of the data on the display screen.

2.5.3 The analytical of User Interface for Visualization

Sandwiched between the other two views of the user interface is where the work gets done-getting the application and its interface to do something useful. The user talks to the application through something called control, and sees the system's response through something called visualization. Taking a closer look at these inner workings, you would also notice a second dialogue going on between the application and the user, called feedback. Such feedback offers help to the user when the person is actually in front of the computer trying to do something. This is the essence of the learn-as-you-go philosophy that is prevalent in many web applications.

2.6 The Computer System for Visualization

It refers to the capabilities of the analog telephone system that was established in the early twentieth century and hadn't appreciably changed in function or capability until the end of the century. With the advent of new functionality and digital services, there was a need to identify the old unadorned system that most of the world still used, which is

POTS. With the development of new types of applications we find ourselves in a similar situation; we need to differentiate the typical computer system from the atypical.

2.7 Data Visualization

Visualization is the process by which an application presents its data to the user. Visualization is what comes to mind for most people when they think about the human-computer dialogue in a GUI application. The user operates the controls, and the system changes the visual presentation of-or visualizes-the data accordingly. In control applications, the user is allowed to interact with the system in which data state is being presented, such as turning a virtual valve in a remotely controlled chemical plant. In a design application, the user is often allowed to directly manipulate the data in the presentation.

3D applications generally deal with one of two types of environments: those modeling something that could conceptually exist within the real world, and those representing abstract spaces that have no tangible equivalent. Techniques for visualizing these models abound. 3D visualization aids the process rather than radically transforming it. The best form for an application depends on the nature of its data and it users. Often, multiple forms can be effectively used in a given application.

Models of real-world situations often involve data corresponding to real-world objects, such as reactors and pump in a chemical plant. They can also involve less material data, such as temperature and pressure, which cannot be represented by real objects. In terms of next-generation applications, the distinction between concrete data, representing real-world objects, and abstract data, representing quantities, relationships, and abstract information, is an important one.

2.7.1 The data visualization in a concrete world

The visual representation of concrete data is meant to approximate that of the real objects in the real world, or at least a world that is reasonably plausible or which does not compromise the veracity of the object. Concrete data often needs to be put into a plausible and useful context, which would be a concrete one.

2.7.2 The data visualization in a abstract world

Since abstract data does not represent real objects, it can be represented in any number of forms and contexts. Its visual representation is not meant to approximate a real view of the world even though the

information may describe the real world.

When abstract data are involved, the emphasis of the visual presentation is to maximize the user's understanding of what the data represents and its relationships, making it easy to extract information from the data. As such, abstract data is usually the subject of relationships. In a control application, the visual dimension of color might represent the data dimension of content. Decorations such as indicators and callouts might provide flow direction, quantitative pressure measurements, and alarm conditions.

2.8 NPA4K User Interface

The operating environment of NPA4K is the desktop or portable PC platform. And because of Graphic User Interfaces, it is easy-to-use and easy-to-understand simulation environment.

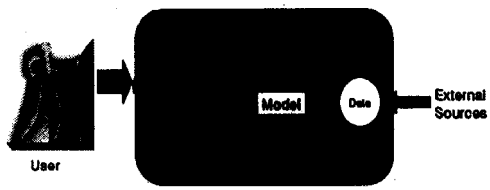

Figure 3. Application based on the model-view-control pattern

2.9 NPA4K Simulator Running Environments

The functionalities of NPA4K simulator consist of analyzing main variables into easy-to-understand numbers and gauges on nuclear system diagram. The Information Visualization of NPA4K simulator composed of various system mimics and control panels vividly displays in-depth plant information and calculation analyses results in real time. In addition, it provides a full range interaction between the user and various systems and components through graphic visualizations

2.10 The Advanced Features of Simulator for KALIMER

The advanced features of Graphic Information Visualization Simulator NPA4K are made up of 3 merits. First, the running environment of NPA4K is Once-Through.

The Once-Through means that from collecting variables and parameters through handling actions under unusual condition to capturing and printing data, images, the running environment are triggered on platform at once.

Second, graphic visualizing several variables X-Y plotting can be realized. The NPA4K graphic simulator make performances of a lot of visualized X-Y plot figures.

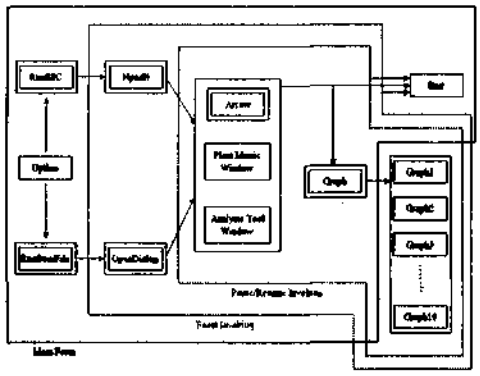

Figure 4. NPA4K Simulator Running Flow

Third, The process of NPA4K is multi-thread processing. In the middle of operating the analyses with NPA4K simulator, arbitrarily command 'stop' can be executed. And then immediately re-running operations call the appearance of NPA4K.

With the powerful capability and enhanced functions, NPA4K simulator comes to close realistic simulation of overall operating characteristics.

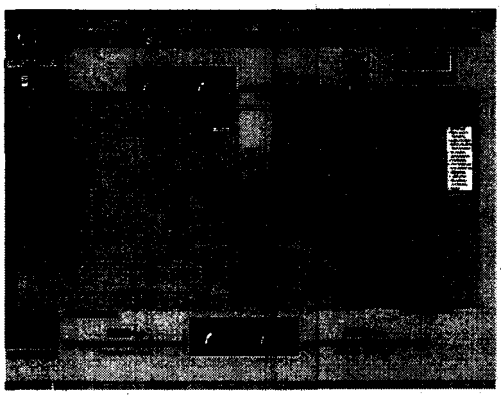

Figure 5. Variable X-Y Plots

2.11 The Configurations of NPA4K Simulator for KALIMER

The software configurations of NPA4K Simulator consist of Process Model, Graphic User Interface, and Simulation Executive. The Process Model is composed of simulation of plant behaviors and detailed models for systems and components. The Graphic User Interface (GUI) is made up of Dynamic Display and Interactive simulation control. The Simulation Executive consist of simulation control and database management (Empirical Database)

2.12 The Application Area of Simulator for KALIMER

Using this NPA4K simulator for KALIMER, it is possible to real-time simulate that Core Reactivity Mode, Core Heat Transfer Model, Pool Analysis Model, and Multi-dimensional Hot Pool Model of KALIMER Reactor.

3. The Vision for KALIMER in the Future

The NPA4K Simulator will be developed up to Real-Time Simulator by Code Robust improvement, Code fidelity improve

-ment, and Overall Scope Simulating.

Currently, the simulation technology for Reactor changes into Virtual Reality step by step. Virtual Reality technology for Reactor progressively is in advance. The Virtual Reality for KALIMER will be anticipated to make real-time monitoring and remote-controlling realize with Network Environments emerged from Local Network within Reactor Operating Environments together with information technology like advanced Expert System, Web, Java and XML.

4. Conclusions

The Real-Time Best-Estimate NPA4K Simulator for KALIMER provides a full range interaction between the user and various systems and components through graphic visualization. With the powerful simulation capability and enhanced functions, NPA4K Simulator provides an efficient nuclear power plant simulation environment for engineering analyses and operator. I believe that it is possible accomplish efficiently the project Liquid Metal Reactor Design Technology Development with this NPA4K simulator.

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