The Virtual Reality in Fossil Power Plant Operator Training Simulator

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ABSTRACT

In these days many large scale plants are attempting to use the Virtual Reality technology in the process analysis. Their goal is to reduce the development time by more effective information management as Simultaneous Engineering point of view, and by connecting the CAD datum and all kinds of products information. Generally, it is taken for granted that when a plant is equipped with a Virtual Reality technology, they are able to review the design and analyze the engineering performance of the product before actually building it, so that their goal to reduce costs and enhance the initial quality can be achieved.[1][2] In this paper we will look into the application the virtual reality technology Hadong fossil power plant. And we will also define the concepts of virtual plant by summarizing requirements and thoughts from the people who are in working in the actual site.

1. Introduction

Virtual Reality technology offers users to assemble and manipulate their product which is modeled by 3D CAD in the designing phase. By doing so, we can check the design quality, reduce costs and development time so that we achieve higher level of quality. Since CAD was developed for modeling use, we can't get satisfactory operating time when checking the functions of the construction interactively in real-time and can't visualize the results. For this reason there are a couple of software packages in the market that offers only the Virtual Prototype solution. But each package has different functions which eventually give us different kinds of utilities for the same system in interest. Also the client company's diverse demands lead to different functions for the same solution. The requirements from the clients and the functions offered by the solution software packages have functions as the followings.

(1) Visualization of Large Assemblies
(2) Real Time Collision Check between Complicated Structure Parts
(3) Real-time Function check of product
(4) Real-time communication between collaborate team designers or operators

2. Virtual Plant System

A Virtual Plant System is a kind of a Virtual Prototype System for plants such as atomic or thermoelectric power generator plants to utilize it for basic design, operator training, O&M(Operation & Maintenance). Human Manikin module which is needed to check the operator's work space, process simulator, interfaces between the Virtual Prototype are additionally needed to realize the Virtual Plant System. Specially the operator training system and O&M are being heavily required in the actual field. Calculation of the work time in the radio active region by EDF(The Research and Development Division of Electric de France) located in France, and TRW's(located in U.S.A) atomic power generator equipment's radiation decontamination training simulator and main control room Virtual Reality Simulator are good examples of Virtual Plant System which is developed and used in particular independent system.

(1) Virtual Plant System applied to O&M and Operator Training System

An enormous amount of data is acquired in the process of designing, building, operation and maintenance, and finally disposal in plant industry. Since the amount of these datum are large and their format and application fields are different and also maybe put to good use in operation and maintenance, they need to be managed systematically. Presently the plant's design and operation data such as drawing data, manuals, all kinds of specifications etc. are managed without any standards at this moment which leads to time and man hour loss looking for the data in interest. When the drawing data is in 2 dimension we need professional knowledge to understand it. Therefore we need to acquire the shape and configuration data from the actual site when at work. This is very cumbersome and in some cases it will be impossible to approach the scene which may lead to misunderstanding of the design and the As-built condition.

So there will always exist a possibility for time and man hour loss. Plant life-cycle management system using the Virtual Plant is being welcomed by the industry life-cycle management system. [5] With Virtual Plant we can achieve efficient maintenance training in high radioactive or closed areas. Especially when immersive Virtual Plants that offers the users with actual size and distance inside the plant, are made possible with HMD(Head Mounted Display), CyberGlove, Position tracking device as input and output devices, we can get better results in finding the path through the plant or finding the sequence for maintenance, and acquire better lookout over the operation and also achieve high quality maintenance training. Additional advantages are as the following; O&M time reduction, safety enhancement, cost reduction, safer maintenance, reduction in radiation inspection time, checking for over estimated inspection for radiation, effective training in the virtual control room, ergonomic evaluation, understanding the emergency situation and visualization of detail design etc..

(2) Virtual Plant System applied to Basic Engineering Design for SBD

Recently there are attempts to utilize Virtual Plant System not only to O&M and operator training system, but to SBD(Simulation Based Design) which is for the basic engineering design. This means that Simultaneous Engineering can be applied in the developing process by making it possible for the operator or the maintenance-men of the client company to go inside the virtual plant and check to see if there is enough working space or convenience required.

3. The Application of Virtual Plant in the power plant – focusing on Hadong VRBT

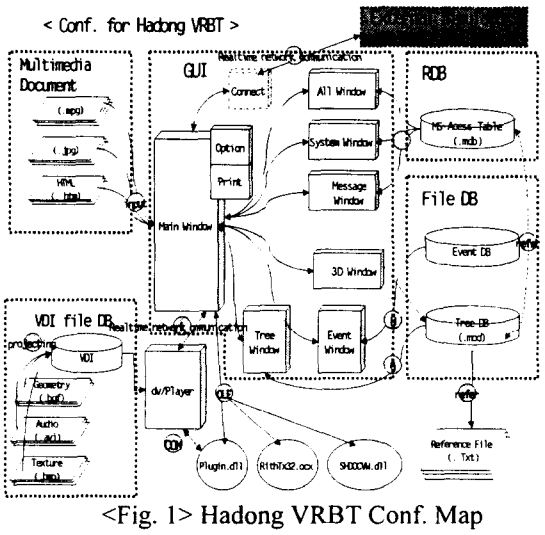
3.1. Goal of this project

The final goal of this project is to develop VRBT(Virtual Reality Based Training) system to give the operators a more effective training. Since the fossil power plants are related to the nation's economics and everyday living, they give their operators much more training compared to other industries to avoid any kind of mistakes. But because of the human-limited areas in the plant, some training cannot be carried out to give only a written reference manual. By using VRBT the operators can train for various situations inside the virtual plant which will give satisfactory results. Following is more detailed contents of the goal of this project

(1) To let operators to be trained in a interactive and semi-immersive desktop.
(2) To let operators to get much understood on equipments and its operation.
(3) To let operators to increase their ability on the operation technology
(4) To contribute for the safe and efficient operation on the power plant

3.2. VRBT's Conf. Map and Implementation process

<Fig 1> shows the total configuration map of VRBT. As this conf. shows, this development of VRBT got very hard and complicated implementation process. Following is the outline of this development process



<Fig. 1> Hadong VRBT Conf. Map

(1) 3D modeling of Hadong Fossil Power Plant

We gave tremendous time to modeling Hadong plant. We used Microstation CAD system with PDS modules. The major targets of 3D modeling which is discussed below are landscape , important buildings , Main Turbine, Boiler and Furnance, Feed Water system, Condenser in 3-rd boiler building and so on.

(2) Geometry Optimising VR model

Generally, a graphic performance gets the trade-off relation with graphic quality. To solve this problem, a developer have to do conversion process from math model to VR tessellated surface model with many times until he can reach the satisfactory state, we can call this iterative process as "experienced conversion process". In this process, we uses CG tool as 3D Studio Max, other 2D authoring tools to increase the graphic quality of VR model. In addition of geometry conversion, we use the dv/reality as VR authoring tool which enable the graphic object in VR to get "AIP", namely, Autonomy, Interaction, Presence property.

(3) Developing the Course-Ware program

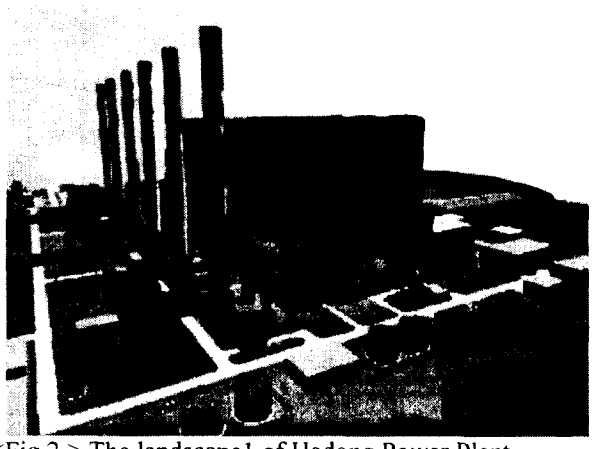
This VRBT is used as training system for a operator in Hadong Power Plant so that this system have to get the user familiar GUI in Korean Alphabet. We used the VC++, VB, and other COM object like as ocx, dll to increase the productivity of development. More details is discussed in next section.

3.3 Implementation Contents of VRBT

3.3.1 VR on landscape of Hadong-Power Plant and allocation of major equipments

In this section, we tried to focus on letting operators to get understood in allocation of major equipments and buildings that compose Hadong-Power Plant. <Fig-2> represent the achievement of this section and following gives the details.

(1) To let operators to be enable to fly through all of the equipments and buildings (CWP, Main TR, AUX TR, electric sended instruments, Storage Tank, Stack, and so on) of power plant including seashores,



<Fig.2 > The landscape1 of Hadong Power Plant

(2) To let operators to be enable to change view-point by himself so that he can observe object very conveniently.

(3) An object that clicked by operator can show its attribute in window-form

(4) By using CG technology, to let operators to feel reality extreamly..

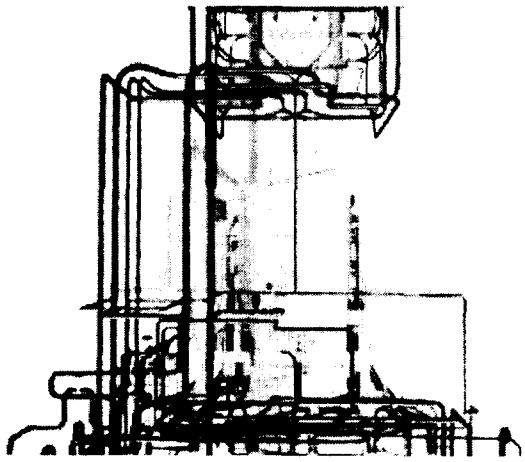
3.3.2 VR on Boiler & Furnance System

In this section, we tried to focus on letting operators to understand the structure and functionality of Tube, Header, and Boiler body based on Hadong Power Plant #3 boiler-building. <Fig-3> represent the achievement of this section and following gives the details.

(1) By 3d-modeling from Economizer gate to final Supper Heater Outlet and from Reheater Inlet to Outlet, to let operators to be enable to understand the path of pipes in Boiler building

(2) By 3d-modeling lower-header and Spiral Tube, to let operators to be enable to understand the structure of Boiler & Furnance

(3) By color-process on pipe, to let operators to be enable to understands the flow of material(water, steam) easily



<Fig. 3> The Boiler system processed by VR tool

3.3.3 VR on Main Turbine System

In this section, we tried to focus on letting operators to get understood on the structure and functionality of Main Turbine that is in one body composed of Generator and Exciter .

(1) By 3d-modeling MS(Main Stop Valve) and CV(Control Valve), to let operators to be enable to understand main steam to flow from Main Tube through HP, IP, to LP

(3) By disassembling Main Turbine, to let operators to be enable to understand internal turbine system

3.3.4 VR on Feed Water

In this section, we tried to focus on letting operators to get understood on the structure and function of BFP(BFP-I, BFP-M). Feed Water System means the pipe flow from De-aerator through BFP #6,7,8 Heater to entrance of Economizer.

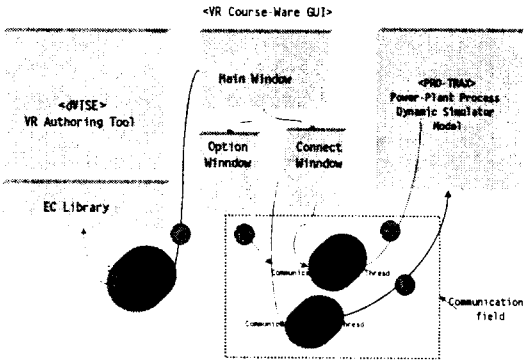
3.3.5 VR on Condenser System

In this section, we tried to focus on letting operators to get understood on the structure of inner and outer Condenser and its connection to other piping systems. Because of the mass number of pipes(44,000 units) in condenser, we traded off the number of pipes taking it into account of the loss of understanding this system to be minimized.

3.3.6 Connection Function with dynamic simulator

In this section, we tried to connect the VRBT to a external dynamic simulator that is modeled on Pro-TRAX. We set the goal of this section only with a research meaning. <Fig-5> shows the result of connection between Pro-TRAX dynamic model and Main Stop Valve of Main Steam Turbine. <Fig-4> shows the configuration of this base process which is datum communication in

real-time

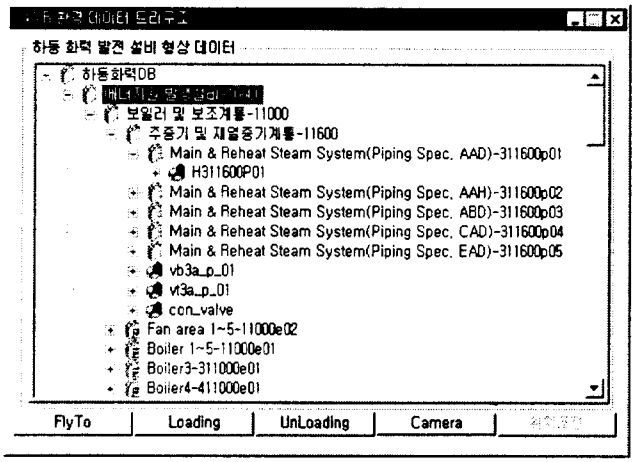


<Fig. 4> The Connection Between dynamic simulator and VR model with Main Stop Valve parameter(described by diagram)

<Fig. 5> The Connection Between dynamic simulator and VR model with Main Stop Valve parameter(described by scene)

3.3.7 O&M system Function

In this section, we tried to show the possibility of extension to O&M system with the result of VRBT so that we set the goal of this section only with a research meaning. <Fig-6> shows the O&M tree datum structure which is broken down in the O&M window, when a user would click the geometry object, with correspondent object node to be showed



<Fig. 6> The O&M data structure especially at energy generation section

4. Conclusions

In this paper, focusing on Hadong VRBT application, the present situation of Virtual Prototype System technology and the concept of Virtual Plant System which is drawed much attention and its problems when applying it to practice were stated. Many companies that were equipped with Virtual Reality technology emphasized the notion to form a Virtual Reality market, concentrating on fields like internet shopping malls which the market is easier to form. Ships and plant companies that build large complex structures started to use Virtual Reality tools to visualize large complicated three dimensional design data in real time, and in high graphic quality. The plant industry trying to use Virtual Reality tools in diverse area at high expenses will require professionals who has professional knowledge in both domains, plant domain and Virtual Reality domain. And in the case of Virtual Plants, it's more complex and it will need experts who have expertise in ergonomics and process simulator development. It is anticipated the upcoming days there will be more interest and new policies that will bring the design technology and O&M of plants to a new level.

Reference

[1] Institute for systems research, Virtual manufacturing : VR background project report, U, of Malyland, 1994

[2] DR. -Ing. P. Drews and Dipl. -Ing. M. Weyrich. "Virtual Manufacturing –An Overview", VR News, Vol.6, No.3, pp18-22, April 1997.

[3] Division Inc., "Building and Interacting with Universal Virtual Products : White Paper", Bristal, UK, 1997.

[4] Daewoo Heavy Industry, The Research for Ship Modeling Technology Development 2-year report, National Industry Depute, 1997.

[5] Kwan-Hee Han, Seog-Chan Oh., "A Virtual Prototyping for More Effective Product Design", Information Process Journal , Vol. 5, No.2, pp28-34, 1998. April

[6] Howard Rheingold, "Virtual Reality", JBAI,1993