Double Screen Multimedia Simulation Training System for Operators in Hydro-Power Plants

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Abstract

This paper presents a PC based double screen multimedia training system suitable for operators working in the computer monitored hydro-power plant. The major characteristics of such a training system compared with the ordinary simulators is that it combines the operating simulation and multimedia knowledge training into an entirety, and makes the interactive operation training interface to be closely matched with the programs simulating the operating equipment. The training system is connected with ether network forming a multimedia training classroom and has been used in Ge He Yan Power Plant in Hubei Province, China. Satisfactory results have shown that it can greatly attract the trainees' interest and enhance the training efficiency.

1. Introduction

Nowadays computer monitoring and control system has been extensively applied in most large and medium scale hydro-power plants. The automatic control system of the power plant is comprised of a main control center, generating set on-site control unit and switch on-site control unit. Double redundancy ether network is used for communication between the control units. Operators usually issue control commands and monitor the production procedure in the main control center, but sometimes they have to check the operation of equipment or make an emergency operation at the on-site control units. The man-machine interface that the operators face to is CRT and digital control keyboard.

The multimedia simulation training system supplies an operation simulating environment and a knowledge background training associated with the operation for operators in hydro-power plants. It is aimed to improve the operators' capability in their operation and control under various operating conditions. The operation skill training is closely coordinated with the knowledge training. According to what happens in the operation, the related knowledge and the accumulated experience will be demonstrated to the trainee in order to enhance his understanding and deepen his impression on the correct operation. It is necessary that the man-machine interface of the training system should be consistent with the real interface of the SCADA system, the simulation models should as correctly as possible describe the performance and operating states of the generating set with real time calculation, and the knowledge contents should be closely matched with the operating simulation.

Trainer-trainee structure is used in the system and a double screen PC is adopted as the trainee machine with one screen for simulating the monitoring interface and another for knowledge training. The trainer machine is used to assign tasks, set fault or abnormal states for the training and manage the trainees' training records. Information of the training tasks input by the trainer, including fault and abnormal settings, is stored in a data base, based on which simulation program works. In the trainee machine, the trainee may be required to make a normal adjustment or deal with various unpredictable abnormal events by interacting with the monitoring interface, and he can

simultaneously obtain the necessary knowledge or instruction concerning his operation from another screen. The combination of operation skill training and related knowledge training is effective because it tells the operator *both how to operate* and *why to do so*.

2. System Description

2.1 Knowledge Training

Knowledge training contents is displayed in the right screen which is involved in various fields such as hydraulic power, mechanical engineering, electrical machinery, electronics, computer application, etc. The contents are divided into many knowledge points and each knowledge point is compiled into an independent package. Each knowledge point has its own attribute which is located in the attribute table. The attribute indicates which kind of operation this knowledge point is related to, the difficulty of the point, how about the relationship with other points, etc. Multimedia technology is used in the demonstration of each knowledge point, and 3D animation is introduced to explain the inner structure and make the physical fields visualized in the corresponding knowledge points. For example, Figure 1 shows the animated generator structure with the rotor lifted up to show the stator and braking system, which is aimed to explain the working principle of the generator.

The knowledge points are compiled using Authorware, one of the famous multimedia authoring tools.

During the operation training, the control program will index the attribute table and search for the related knowledge contents to be demonstrated in the right screen, which makes the trainee deepen his impression about the corresponding operation.

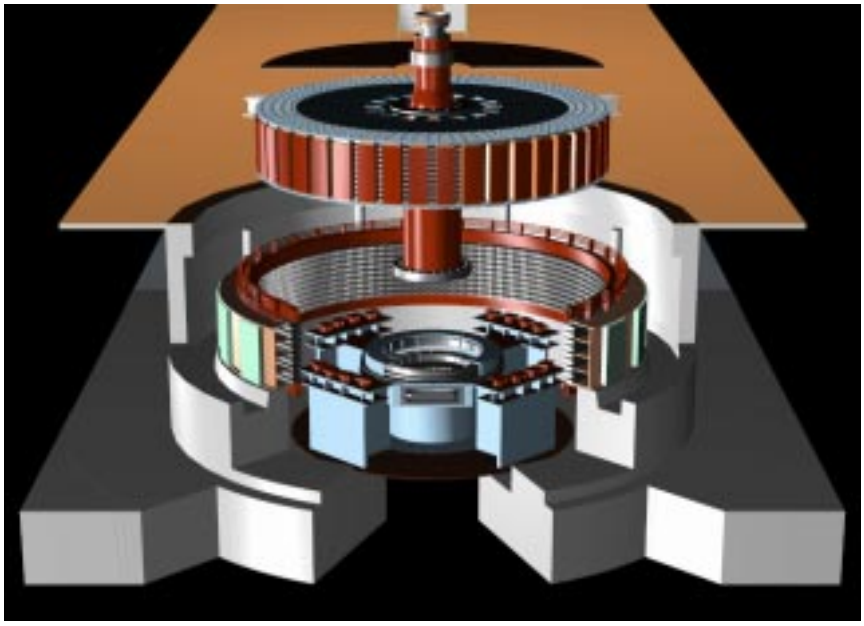


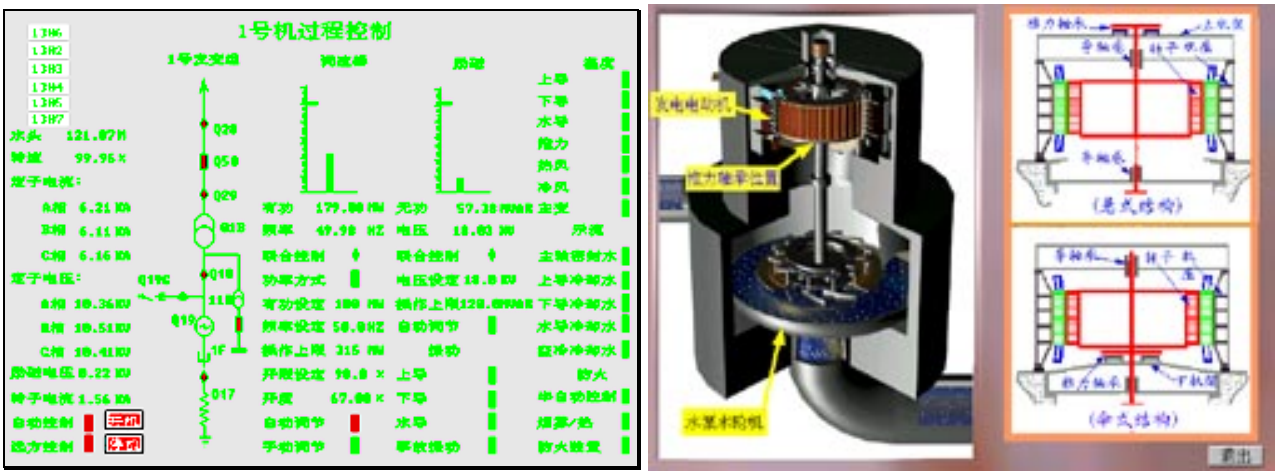
Figure 1 3D animation of generator structure

2.2 Operating Simulation and Training Modes

The operation training interface is developed using Intouch. Intouch has a strong capability of dynamic data exchanging (DDE) for the interaction. A dynamic data base is designed to store the real time calculation results of the generator model such as voltage, current, active and reactive power, etc., which are used for updating the display of meters in the interface through DDE hot link.

There are two operating modes in the training system, that is, the trainer mode and trainee mode. In the trainer mode, the instructor can insert several fault or interrupting points in the training sequence, set time scale for the training and add or delete contents in the knowledge screen. As for the trainee mode, the student may have two choice of learning methods, i.e., comprehensive training method which combines the operation simulation and the

related knowledge training into an entirety, and simulation training method which makes a similar operating circumstance as the real production procedure. In the comprehensive training method, the system will show the trainee in the simulation screen how to issue instructions for the normal operation or how to react during emergency states and accidents and, at the same time in the knowledge screen, it will explain to the trainee why to do so and demonstrate the operating states of the local equipment and instrument dynamically corresponding to the operation. The time scale can be adjusted for the simulation procedure so that the trainee can catch up with the operation dynamics and knowledge contents by expanding the time scale, or make the long operation procedure shortened to concentrate his attention on some special operation that he interests in. Figure 2 shows a sample interface for the training of normal adjustment.



(a) Left screen simulating the real control window (b) Right screen for the knowledge training

Figure 2 Double screen interfaces for operating training

In the simulation training method, the simulation sequences are closely matched with the real production procedure with the similar time scale. The knowledge screen functions only as to display the necessary information.

There are three kinds of models for the operating simulation, i.e., static mathematics models and dynamic models simulating generator set, logic models indicate the logic states and relationship, such as the switch on-off or the network topologies. In order for the convenient modification, management and calling, some simple digital and text variables are supervised by Microsoft Excel, and the dynamic models and some complex static models are integrated and managed by a specially developed dynamic data library.

2.3 Coordinating Operation for the Two Screens

An important effort for developing the training system is making the knowledge training and operation training interfaces to coordinately work so as to achieve the best training effect.

First of all, the coordinate operation in training contents has to be carefully studied. The contents for the operating simulation should exactly simulate the real operation environment, and for the contents for the knowledge training it must take into consideration of the trainees' level. Usually the educational background of the Chinese operators is quite different, especially in hydro-power plants because hydro-power plants are usually located in remote areas and well educated graduates are reluctant to work there for a long period. To be suitable for the trainee, the knowledge points are classified into three difficult levels corresponding to three levels of operators, that is, those graduated from high schools, technical colleges and universities. During the registration, the trainee is asked to select the difficult level. Suitable knowledge points could be picked out by their attributes

according to the selected level.

During the simulation of machine startup and shutdown procedure, control commands are executed in sequence, the control sequence is divided by 80 sub-steps. In each sub-step, the main control program will run the simulation module displayed in the left screen and start the corresponding knowledge training module and make the knowledge module to operate independently in the right screen according to the knowledge point attribute table. During the normal operation stage, DDE communication is used to coordinate the contents of the two screens, that is, the main control module issues commands and distributes corresponding data to the associated screen. The relationship among the modules is shown in Figure 3.

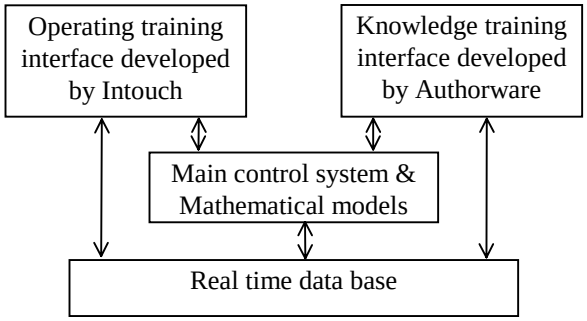


Figure 3 Data communication among modules

3. Conclusion

Double screen PC based multimedia simulation training system combines operating skill training and related knowledge training into a unity. The training system has been applied in Ge He Yan Hydro-Power Plant in Hubei Province, China. There are four 200 MW generating sets in the power plant with a central control and monitor room. Most operators are under 30 years old and have to accumulate operating experience during the operation. The PC based training system supplies a convenient simulated operating environment for the young operators. The related knowledge training has enhanced their understanding about the operation and the simulation training sophisticated their operating skills. It has been demonstrated that the combination of knowledge training and operation training can greatly improve the training efficiency and make the training more interesting.

References

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