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THE DEVELOPMENT OF SIMUPRO SERIES OPERATOR TRAINING SYSTEMS FOR COMPLICATED INDUSTRIAL PROCESSES

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Abstract: SIMUPRO series operator training systems(SOTS) for complicated industrial processes are introduced in detail in this paper, which discusses their main structure, software design, functions and features. SOTS have been successfully applied in practice. Operation results verify that SOTS are effective tools for operator training.

Key words: operator training system, distributed control system, industrial process
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INTRODUCTION

Operator training systems(SOTS) can model phenomena such as startup, shutdown, routine operations and accidents in an actual factory. It needs no raw materials, and not like operator training on some sites in a large petrochemical plant, operater training systems pose no danger to the trainee or equipment. The operator trained by this operator training system for several weeks can get more experience than operating in the field for two or five years. Use of operater training systems not only reduces the training time, but also the training fee. As a scientific training method, operater training systems has attracted the attention of people(Wu et al., 1993).

Since the middle of the eighties, with the developments of computer technology, distributed control system(DCS) has been widely applied in industrial process control. Accordingly, based on panelboard operator training system, the development of operator training system is oriented to simulated DCS operator training system(Wu et al., 1996).

SIMUPRO series operator traiming systems developed by the National Engineering Research Center of Industrial Automation of Zhejiang University, have been successfully applied in many complicated industrial processes, such as those for chemicals, petrochemicals, steels, power stations and pharmaceuticals, and are highly rated by many users because of SOTS excellent training capability, practicability and reliability.

In this paper, the system structure, software design and powerful functions of SOTS will be introduced in detail.

STRUCTURE OF SOTS

As shown in Fig.1, SOTS are based on local area network(LAN), composed of an instructor station, several simulated distributed control system(DCS) operator stations and field operator stations, where the instructor station is also used for computation of the mathematical model.

1. Instructor station

The instructor station is used to monitor and control the running of the operator training system and has various training functions, like process state(Startup, shutdown, routine) set, setting up of various disturbances and accidents, training state resume and memory, etc. The instructor station also provides the teacher corresponding information on the trainee operated operator station, and assesses the operation result and files trainee information.

2. Simulated DCS operator station

The simulated DCS operator station is an interface between operator and operator training system, and is used to simulate functions of real DCS. For effective training, the simulated DCS operator station has the same features, such as appearance, configurations, displays and operating modes as the real DCS. The trainee operator is trained on the operator station to observe and control industrial process.

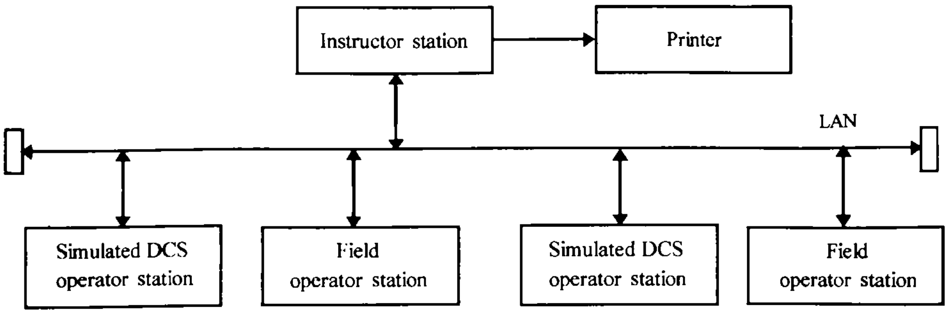

Fig. 1 Structure of SOTS

3. Field operator station

The field operator station is used to simulate the operations of control panels, pumps and valves in the actual field, and to cooperate with the simulated DCS operator station to model phenomena such as startup, shutdown and accidents.

4. Network communication system

The network communication system is based on LAN with NetBios communication protocol, which has many virtues, such as rapid communication rate, good transplantable property, etc.

DESIGN OF SOTS SOFTWARE

The simulation training software in SOTS can be classified as system supporting software and system functional software on the whole (Fu et al., 1996). The system supporting software provides network communication between instructor station and operator stations. The system functional software, which is called simulation training software in short, is composed of three main modules: instructor module, operator station module, mathematical model module. The SOTS software runs under Windows NT or Windows 95, and is developed by C + + program language.

1. Instructor module

The instructor module is the running platform of the operator training system software, and includes instructor interface, mathematical model interface, etc. Its structure is shown in Fig. 2. The module can be connected with mathematical models of various industrial processes. In the design of the instructor module, real-time database configuration is used. The instructor module can fit in with various industrial processes with little modification.

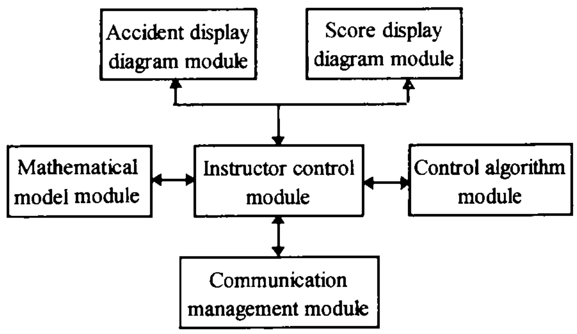

Fig. 2 Structure of instructor module

2. Operator station module

The operator station module has most displays and operating functions of the real DCS. An event-driven method is adopted in the design of this module, which the operations of simulated DCS keyboard and mouse are obtained by message cycle of application object in programming. Meanwhile, by using GUI (Graphic User Interface) technique, the simulated DCS operator station offers an operating environment similar to that of the real DCS. Main displays of simulated DCS operating station include: system overview display, process flowchart display, field operation process display, group display, detail display, trend display, alarm display, help display, etc. The program flowchart of the operator station module is shown in Fig. 3.

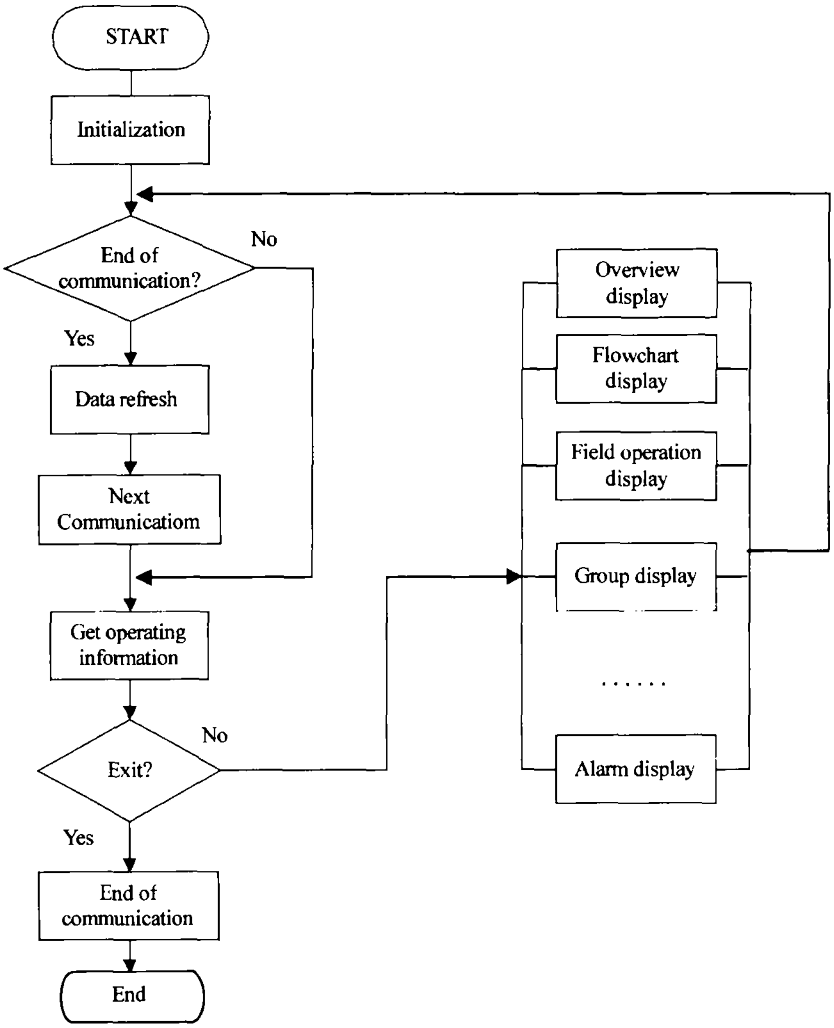

Fig.3 Flowchart of operator station module

3. Mathematical model module

In the operator training system, the mathematical model is substituted for real equipment. When trainees operate on operator training system for startup, shutdown, accident operations, the mathematical model should give the almost same responses as that of real equipment. So the mathematical model module is the soul of the operator training system. The precision of the mathematical model decides the effect of the training(Zhao et al., 1993). The large-scope dynamic nonlinear models of complicated industrial processes developed in SOTS based on mechanism analysis include whole operating state and whole process flowchart, and have high model precision (steady state error of less than 2%,) and high fidelity(the dynamic trends accord with the responses of the real process).

FUNCTIONS AND FEATURES OF SOTS

Besides all functions of the current operator training system, SOTS have more flexible functions, including:

1. Operating as a multifunctional operating console: The SOTS can not only run in several computers on the network, but also in one computer. Increase or decrease in the number of operator stations has no effect on the running of the system.

2. Assigning training content of operator sta-

tion arbitrarily(Need not modify any settings of system): Every operator station can be assigned different or same training program, so operations on each operator station can be independent or interactive. Meanwhile, the simulating DCS operator station can be assigned arbitrarily to be separated from or combined with the field operator station.

3. Setting the time scale on-line: 13 time scale steps(from 1/12 to multiples of 12) can be chosen for training, and changing of time scale has little effect on precision of model calculation.

4. Easy setting of accidents: accidents can be chosen arbitrarily by the teacher from the accident set, or automatically set by computer.

5. Choosing various kinds of memory, such as standard, random, and automatic memory. The interval of automatic memory can be changed on-line.

6. Assessing the operations of trainee scientifically: The system can assess the trainee by his operating quality, operating steps , times of malfunction and Alarm, etc. And file trainee information automatically.

7. Displaying training information clearly: Through multiwindow, such as group, unit, trend, record display, the teacher can easily monitor the operations of trainee.

8. Achieving more training effect by using of multimedia technology.

CONCLUSIONS

SOTS for complicated industrial processes is introduced in detail in this paper, including their main structure, software design, functions and features. Now, SOTS including simulating TDC3000, CENTUM, MOD300 and I/AS have been successfully applied to practice. Their operation results verify that SOTS have abundant training contents, high precision of mathematical modelling and high fidelity of simulating DCS operations. SOTS not only provide an effective tool for training operators, but also furnish the basis for optimizing operations and control.

References

Fu Lieyong, Gu Zhongwen, Zhou Chunhui , 1996. Development of operator training system for catalytic reforming process. *Control and Instruments in Chemical Industry*, **23**(3): 32 - 37. (In Chinese, with English abstract)

Wu Chongguang, Shen Chenglin, 1993. Development of operator training system for petrochemical process. *Journal of System Simulation*, **5**(1): 31 - 39 (In Chinese, with English abstract).

Wu Chongguang , Shen Chenglin, 1996. Study of DCS simulation software development. *Journal of System Simulation*, **8**(2): 7 - 11 (In Chinese, with English abstract).

Zhao Yuhong, Gu Zhongwen, 1995. Dynamic modeling of distillation columns for catalytic reforming process simulator. *Control and Instruments in Chemical Industry*, **22**(6): 15 - 18 (In Chinese, with English abstract).