INTERNATIONAL JOURNAL OF INTELLIGENT CONTROL AND SYSTEMS
VOL. 14, NO. 2, JUNE 2009, 147-155

Dynamic Operation Permission System for Oil Refinery Plants

Akio GOFUKU and Takahiro SATO

Abstract- **The safety operation of the plants in the chemical industry is very important. The authors proposed a conception called dynamic operation permission to support safety operation of nuclear power plants. The main idea of the dynamic operation permission is to prevent only evident commission errors and to leave operators behave as they like as far as they take operations following operation manuals and various operation rules and the action by operators does not induce bad effects in plant condition. In general, an operator support system will be a complicated and big software system because it should have many operator support functions. An agent-based system configuration has many advantageous features in the development, extension, and maintenance of a big software system. This study develops a dynamic operation permission system to check and guide suitable operations based on operation manuals and a functional model as an agent system for oil refinery plants.**

***Index Terms*—Operator support system, Dynamic operation permission, Agent-based system, Operation manual, Multilevel flow modeling**

1. INTRODUCTION

The safety operation of plants in the chemical industry is, of course, very important because the influence of an accident in a plant to the environment is very large. For an operator, the plant tends to become complex by the introduction of various advanced control systems to produce high quality chemical products. The veteran operators of Japanese chemical plants are retiring because many chemical complexes were constructed in 1960s. In addition, the chances to manage small troubles are decreasing for operators because of the enhancement of reliability of plant components. Therefore, the skill succession from veteran to young operators is one of major problems in Japanese chemical plants. The authors think that one of promising solutions for the problem is to develop a human-centered operator support system in order to support the activities of operators in an abnormal situation of plants.

Extensive studies[1-4] were made to develop operator support systems for large-scaled safety-critical systems such as chemical plants and nuclear power plants. Moreover, many studies[5-8] are devoted to detect faults occurred in chemical plants because a runaway accident gives severe economical and environmental influences. As to nuclear power plants, the SPDS (Safety Parameter Display System)[9] to display important plant parameters for plant safety was introduced in all US nuclear power plants after the TMI-2 (Three Mile Island Unit 2) accident. Alarm handling systems[10] were developed to suppress unnecessary alarms for easy understanding plant conditions in abnormal plant situations. Recently, cognitive aspects of operators of nuclear power plants are studied to reduce human errors by operators[11, 12].

This study deals with an operator support technique to reduce commission errors by operators. A commission error is a kind of human errors to take an erroneous operation. Another type of human errors is an omission error not to take a correct operation. The computer-based procedures to indicate the guidance on the display of main control room of a plant are expected to improve the performance of operators and to reduce human errors by operators in especially an abnormal plant situation[13]. The study[14] dealing with a model of distributed knowledge and action pointed out the importance of operating procedure directives and goals that constrain the system operators' actions to guide human intervention in the system as well as causal relationships and system state trajectories over time.

In the previous studies, the authors proposed the conception of dynamic operation permission to reduce commission errors for the operations of a nuclear power plant[15, 16]. The authors also have been developing a dynamic operation permission system for a pressurized water reactor plant[17, 18, 19]. There are two main parts of a dynamic operation permission system. One is to make the permission determination from the standpoint if an operator action follows the typical operations described in operation manuals. The other is to make the permission determination from the standpoint what influence will be given by an operator action on plant future behavior. The estimation of the influence is made by a model-based technique[18, 19]. The base model utilized is constructed by a functional modeling technique, Multi-level Flow Modeling (MFM) [20, 21].

Usually, an operator support system will be a complicated software system if many operator support tasks are assigned to it. This will induce many problems in the maintenance and extensions of the software systems for the operator support system. The agent configuration[22] of a large software system will mitigate the problems because of its advantages[23]. The authors developed an agent-based production planning system[24] of ethylene plants on a distributed cooperation environment[25] and confirmed the advantageous characteristics in the

Manuscript received May 6, 2009; revised September 4, 2009. This work was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (S), 16101005, 2004. This paper is extended from "Dynamic operation permission system for oil refinery plants" published at *The 2009 IEEE International Conference on Networking, Sensing and Control (ICNSC2009)*, Okayama, Japan, March, 2009.

Akio Gofuku is with Graduate School of Natural Science and Technology, Okayama University, 3-1-1 Tsushima-Naka, Kita-ku, Okayama, 700-8530, Japan (e-mail: fukuchan@sys.okayama-u.ac.jp); and Takahiro Sato is with Graduate School of Natural Science and Technology, Okayama University