A Monitoring and Controller Display Method for each Operation Mode based on Log Analyses of Operator Actions

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1. Introduction

The traditional HMI (Human Machine Interface) design approach for Korea NPP (Nuclear Power Plant) is heavily mimic-based hard-paneled interface based on P&ID (Piping and Instrumentation Diagram). Over the last years parts of the nuclear industry has moved towards replacing the traditional, panel-based interfaces with computerized operation environments [1].

This is expected to minimize the operator's movement and enable the operator to operate even when seated, greatly enhancing the operator's macro performance. On the other hand, since the information based on the existing P&IDs is implemented as a hierarchical structure on the VDU (Visual Display Unit) with the display space constraint, it requires additional tasks such as information navigation in addition to primary tasks such as monitoring, situation assessment, planning and implementation.

Currently, the information display of the digital based control room of Korea NPP is operated with hierarchy structure of the system-oriented, component-oriented and function-oriented based on existing P&IDs. The operator obtains the monitoring and the controller information necessary for operation through the information navigation by hierarchically distributed information over five or more display pages to perform a particular operation mode. As a result of the intervention of these additional tasks, the reaction time is delayed and it is difficult to maintain the cognitive context, and it can cause the cognitive error in the situation like the emergency.

Therefore, it is necessary that an information structure and visualization shall be designed to minimize the cognitive burden of recognition, memory, and judgment on the relationship between complex systems when an unexpected event occurs. The information structure and visualization design is based on careful analysis and understanding of the work domain of the operator.

In order to solve the above problem, the designer has to decide how to reduce the amount of information to be displayed on the screen so that the user can work easily.

Also, it is important to provide a means for the operator to easily move the information display space and naturally make a cognitive transition in the display design with a large amount of information networks.

This paper proposes a monitoring and controller display method for each operation mode based on log analyses of operator actions to overcome the above problems. This method minimizes the existing information navigation by providing monitoring and control means necessary for the operator to perform a specific operation mode on one or two display pages.

The method provides the monitoring and controller information for each operation mode of NPP to operator based on the understanding of the work domain of the operator. And the method complements the monitoring information and the control means for each operation mode through analysis of the operation behavior log obtained during operation to improve the efficiency of the display for each operation mode.

2. Methods

Fig.1 shows the monitoring and controller display method for each operation modes based on log analyses of operator actions, detailed descriptions of each module are as follows:

2.1 Monitoring and controller DB for each plant mode

Monitoring and controller database for each operation mode is composed of initial analysis information and complementary information based on the operation log analysis during operation. The initial analysis information means the basic information of the monitoring and the controller to be provided to the operator for each operation mode. It was confirmed through the task analysis of the operator for NPP. The complementary information is the condition evaluation and the action data for each the operation mode based on the operation behavior log analysis.

And the initial analysis information and complementary information is stored at database in the

form of ECA rules (on Event if Conditions then Action). Basic display information for each operation mode and complementary information based on operation behavior analysis are added / deleted / modified to the shared memory through the rule interface, which is an operator interface module. The rules interface is an interface for system users and designers to define, manage, delete, and modify display rules.

2.2 Monitoring and controller management module for each operation mode

The management module is a main module that drives the monitoring and controller database to provide the information indicator with the monitoring and the control information necessary for the task in each operation mode. This module is consists of a display condition evaluator for each operation mode and a display actor for each operation mode.

If the operator selects a specific operation mode, the management module provides necessary information for the corresponding monitoring and controller means to the operator. And this module is responsible for running operator's demands. The display condition evaluator for each operation mode is connected to event and rule triggering to sequentially drive the display rule. Then, the condition of this rule is evaluated, and if the condition is satisfied, the action of the rule is executed.

2.3 Operation behavior log analysis and complementary module

In order to complement the monitoring and control information required by the operator according to the operation mode, this module logs and stores the object and control means monitored by the operator according to the operation mode. Then this module preprocesses and performs statistics and correlation analysis on periodically stored log information.

The analysis result is prepared by condition evaluation and action data for displaying necessary information for each operation mode. The complementary module generates only the data to be supplemented during online operation and reflects the complementary data to the system after confirming the operator according to the administrative procedure.

3. Results and Future Plans

Traditional HMI design approach of NPP was heavily based on P&IDs. A clear trend in Korea NPP is to modernize control rooms, moving from panel-based traditional control rooms to computerized solutions. A significant amount of work was done on process control HMI design using ecological interface design and the operator centered interface. These designs are applied

to a limited set of screens and did not differ largely from the traditional HMI design in that the layout the information is somewhere similar to P&IDs [2].

This paper proposed the monitoring and controller display method for each operation mode based on log analyses of operator actions. This method provides the monitoring information and control means necessary for the operator according to operation mode to perform a specific operation. This method can reduce the information searching process time and the transition between the display pages. So, this method can be provided as an alternative to overcome the problems of P&IDs based hierarchical information provision.

This method will be validated by establishing a validation facility in the future. And this concept is added to the concept of operator support with the existing display configuration and navigation as it is, and it extends its application range while actually utilizing it.
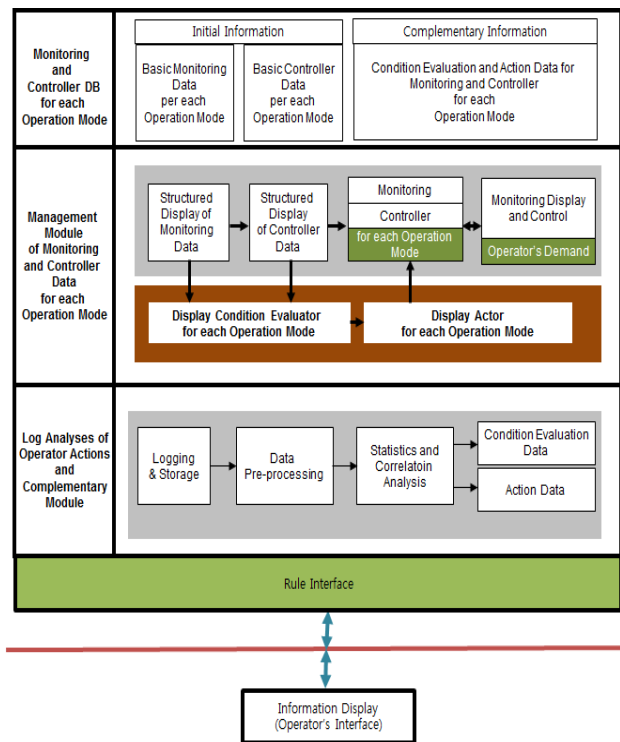

Fig. 1. A Monitoring and Controller Display Method for each Operation Mode based on Log Analyses of Operator Actions

REFERENCES

[1] A.O.Braseth, C. Nihlwing, Lessons Learned from Halden Project Research on Human System, Nuclear Engineering and Technology, Vol.41 No.3, April, 2009.

[2] S.Y Kim, J.V.Wormer, Human-Machine Interface Design for Power Generation Plant Operators