A Diagnostic and Control Expert System Based on a Plant Model

ABSTRACT

A conventional plant control system based on heuristics cannot deal with "unforeseen abnormal situations" in a plant due to the lack of heuristics. This system compiles plant control rules from a plant model, and deals with such situations.

KEY FEATURES

(1) Hybrid reasoning architecture with both heuristics-based approach and model-based approach.

(2) Diagnosis by the Qualitative Causal Model and the symptoms clustering technique.

(3) Compilation of plant control rules by the Device Model and the Operation Principle Model.

(4) Verification of compiled rules by the Dynamics Model.

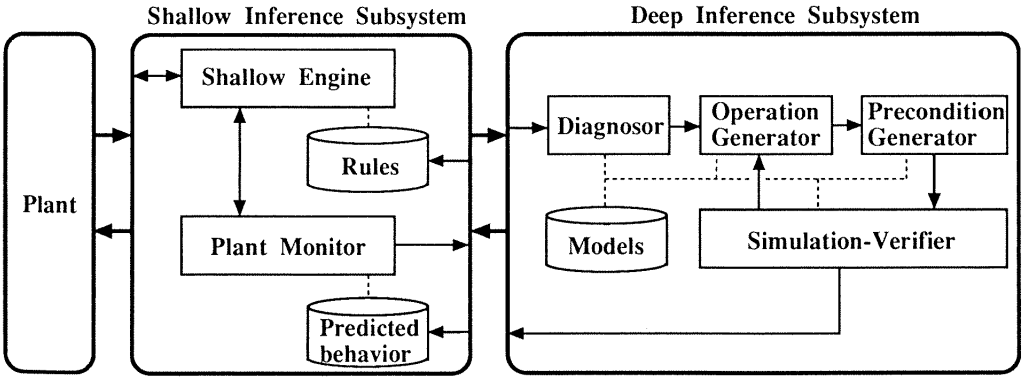


Figure 1: System configuration

Outline of MMI outputs

Case: the Deep Inference Subsystem is active

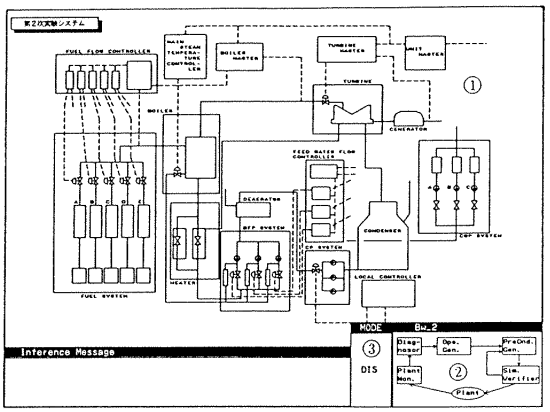
① Plant configuration display window
This window shows plant devices modeled in the system. This window highlights the target devices while the modules run.

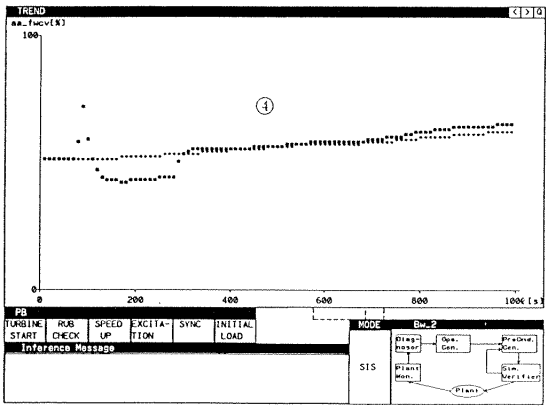
② Active module indication window
This window indicates the currently activated module.

③ DIS/SIS indicator panel
This panel indicates which subsystem is currently activated.

Case: the Shallow Inference Subsystem is active

④ Trend monitoring window
This window shows both the predicted plant behavior and the observed one by the Plant Monitor.





Demonstration schedule

Only the Deep Inference Subsystem is demonstrated. The experimental results of the whole system, which consists of the Deep Inference Subsystem, the Shallow Inference Subsystem and the plant simulator, is demonstrated using the video tape.

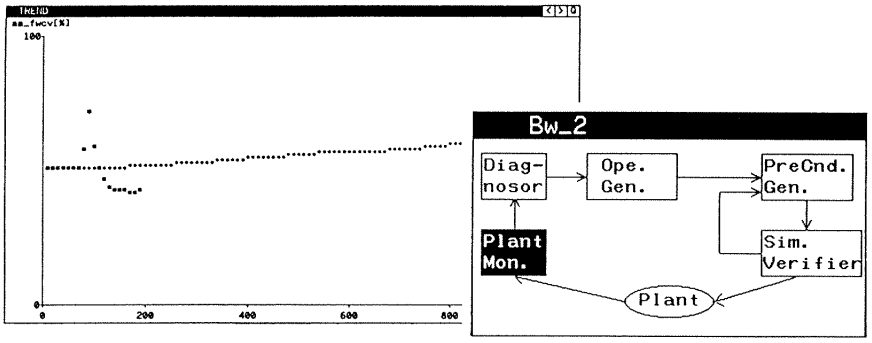
Step1) Occurrence of an unforeseen abnormal plant situation

The case of multiple faults is demonstrated below. The video tape reproduces the scene of the abnormal plant situation caused by the malfunction of the plant simulator. In this demonstration, this occurrence is a manual input into the system.

performance drop of a boiler-feed-water-pump & stuck close of a circulation-water-control-valve

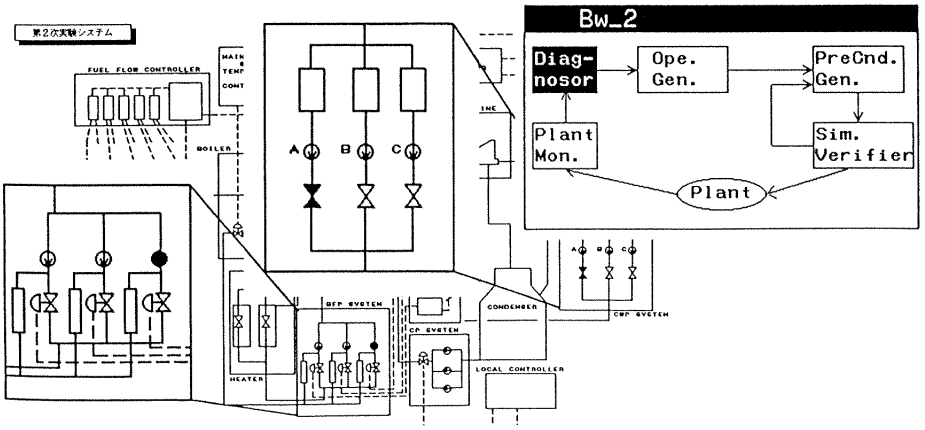
Step2) Detection of the symptoms

The Plant Monitor detects the unallowable deviations between the predicted plant behavior and the observed one. After that, the Deep Inference Subsystem is activated.



Step3) Activation of the Diagnosor

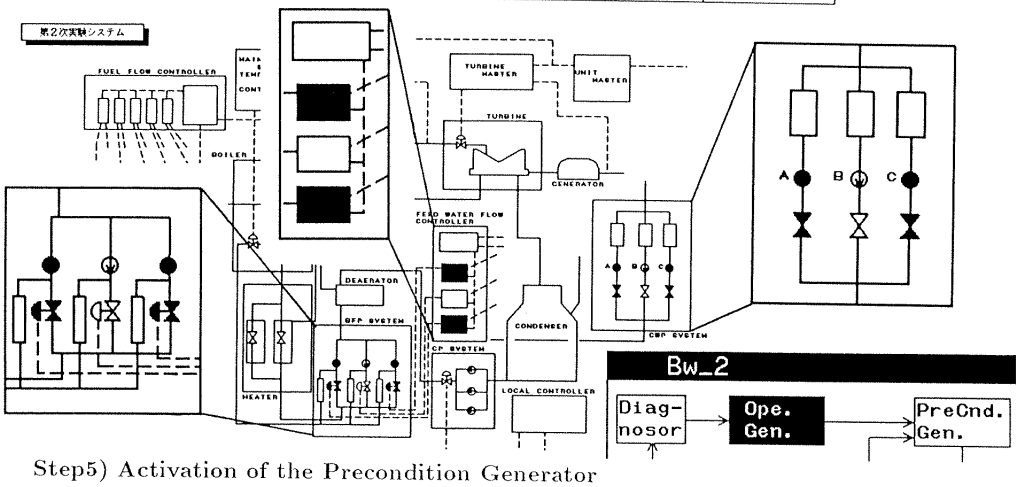
The Diagnosor calculates the possible disorders for the detected symptoms by using the Qualitative Causal Model and the symptoms clustering technique. After that, the Diagnosor outputs the plant operations to stop the malfunctioning devices.



Step4) Activation of the Operation Generator

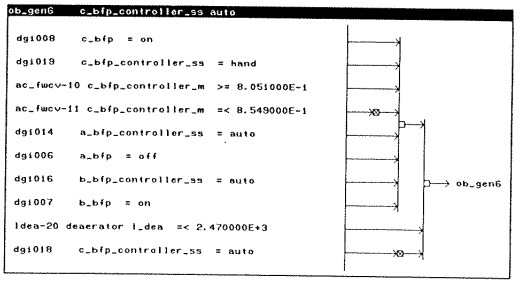
The Operation Generator figures out the necessary plant operations to deal with the unforeseen abnormal situation. This module utilizes the Device Model and the Operation Principle Model.

op.1	op.2	op.3	op.4	op.5
c_cwp on	c_cwv open	c_bfp on	c_fwcv open	c_fwcv auto
op.6	op.7	op.8	op.9	op.10
a_fwcv hand	a_fwcv close	a_bfp off	a_cwv close	a_cwp off



Step5) Activation of the Precondition Generator

This module generates the preconditions for each plant operation, and compiles plant control rules as follows.



Step6) Activation of the Simulation-Verifier

This module verifies the compiled rules by predicting the plant behavior to be observed when the plant is operated according to the compiled rules.

Step7) Execution of the plant operation

The video tape reproduces the scene of a plant whose operations are executed by the Shallow Inference Subsystem according to the compiled rules. To clarify the system's capability, the video tape also reproduces the scene of a plant being shutdown when none of the generated operations are executed.