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A New Approach for Optimal Operation of Thermal Power Plant

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ABSTRACT: Now a day's one of the critical issues in a thermal power plant is to improve the efficiency of individual equipment. The various works found in literature shows that efficiency and availability depends on high reliability and maintainability of the equipments. But in present scenario with the concept of e–maintenance reduces the overall maintenance cost. The use of intelligent fault detection systems plays an important role for fault diagnosis and supervision in process control. Artificial intelligent applications in process control helps in timely detection, diagnosis and correction of abnormal operating condition in the thermal power plants. When the plant is in operating condition and within controllable region, detection and diagnosis of process faults at very early stage improves overall efficiency of operation.

This paper, presents the theoretical approach on use of intelligent system for fault monitoring, control and fault diagnosis of thermal power plant operation. . So as to utilise minimum fuel to generate maximum steam as per demand of load which lead to thermal power plant optimization. The main objective of this paper is to proposed data driven, analytical and knowledge based approaches for thermal power plant by integrating various earlier solutions available for optimization of process operation.

KEYWORDS: intelligent system, fault detection, diagnosis, supervision optimal operation. Power plant, intelligent controller

I. INTRODUCTION

In the recent era of industrial revolution, power plant industries facing wide range of challenges in the field of process engineering. As performance of any system depends upon its optimal operation at stated condition and reliable operation [1]. Therefore power industry is getting demands on maintaining high performance, operating flexibility, reliability and availability at the time of reducing man power. Hence intelligent automation tools are needed to help for operating at optimal level of performance [2, 3]. On this related process operational information must be analysed and presented in a manner that reflects the important underlying trends or events in the process [4]. Different Artificial Intelligent methods are associated with intelligent decision support systems for optimal operation of power generating plants [10, 11]. It is observed that no single method has the entire desirable characteristic that we need for a particular fault diagnostic system [5, 6]. Therefore some of these methods can be combine together to give a better result for desired fault diagnostic purpose [7, 8, 9].

In this paper, review of some of these general trends in this direction, important role of fault diagnosis and correction in wide range of power generating process are presented. At the end, the various challenges in research and development in technology are explain for the designing and application of intelligent controller in the field of supervision, correction and diagnosis [17].

II. CONCEPT OF TRADITIONAL SYSTEMS

In modern power plant automation, fault diagnosis is most important part since it provides the basic of fault tolerance, reliability or security of power generation systems. Here the complete operations of the power plant i.e. from feed water and fuel to power output are properly monitored and corresponding data's are transmitted to the procedure associated with the fault detection [12, 13, 14]. The minimum requirement during fault detection is to register an alarm during any abnormal situation develop in the total monitoring system. When even any fault is detected in any control loop such as three elements control, air fuel ratio or de superheating. Faults cause due to blow down monitoring, dry flue gas temperature, reducing furnace temperature and so many causes of the abnormality must be identify by diagnosis [15, 16]. The total fault detection and diagnosis technique are based upon the use of different control loops and through the identification process. In addition to the mathematical model used in controller design, statistical as well as quality model are increasingly being employed. Data from the monitored plant is input to various algorithms and output is compared with corresponding plant output [5]. If any dissimilarity, then it is an indication that at least one fault has occurred. The next task is to determine the location of this fault. Again a representative model not necessarily the one used in fault detection, is employed. In some instances the location of the fault may be deduced by the type of fault. Here hybrid model and rule induction system can be used to classify the faults [11]. The general and traditional system for optimal operation is as shown in fig.1.

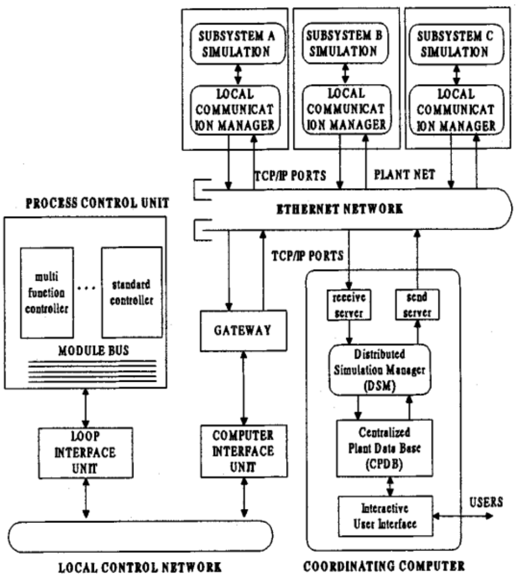


Fig-1 (Traditional system of optimal operation)

III. PRAPOSED MODEL FOR OPTIMAL OPERATION

A) Supervision & Fault Detections

a) Knowledge based fault detection

Supervisory function is useful for collecting information for undesired or unpermitted process and it helps to take action for proper operation and prevent damages of equivalent or accident in a process. Various functions associated with supervision are as follows

a) Operation monitoring
b) Protection to the system automatically
c) Fault diagnosis through proper supervision

Hear all the variables that can be measured, checked with respect to their ranges and corresponding alarms facilities are provided. When the process is in male operating condition, the automatic protection system takes a counter action which is appropriate to balance the miss happening. Then based on the variable measured, different signals are generated to show symptoms of any abnormality to take proper decision before counter action start. Fig.2. shows the proposed loop for fault detection and diagnosis. The main task can be subdivided through analytic symptom and heuristic symptom generation.

1. Analytic Symptom Generation

The quantitative and analytical data base can be generated by the analytical knowledge on the process. Then first characteristic values are generated by data processing with the earlier measured process variables as mention below:-

(a) Limit the value checking process of directly measurable signal characteristics, to prevent to exceed signal tolerance limit.
(b) Various signal models like correlation function, frequency spectra, and autoregressive moving average models can be used for signal analysis by directly measured signal.
(c) Mathematical process models with parameter estimation any party equation u for process analysis purpose.

2. Heuristic Symptom Generation

Heuristic symptoms are developed with qualitative information from concern operators. The process history in form of maintenance performed, repair earlier fault, live period of the device and load given are act as secure of further heuristic information. The experience on the same or similar process can be added to this. So this symptoms are expressed in linguistics form as (size, shape, quality/quantity).

b) Model based fault detection

Fig-2 (Proposed model for optimal operation)

Mathematical models are already developed for different approaches to detect faults. It consists of faults detection in the process which includes actuators and sensors by taking the input and output measuring parameters.

Three important model based fault detection methods are: parameter estimation, state estimation and parity equation out put error.

B) Fault Diagnosis Methods

The basic block diagram of total proposed fault diagram necessary for thermal power plant for proper fault control is presented in fig.3.

The task of fault diagnosis consists of determining the type of fault with as much details as possible such as the fault size, location and time of detection. The diagnosis procedures based on the observed analytical and heuristic symptoms and the heuristic knowledge of the process.

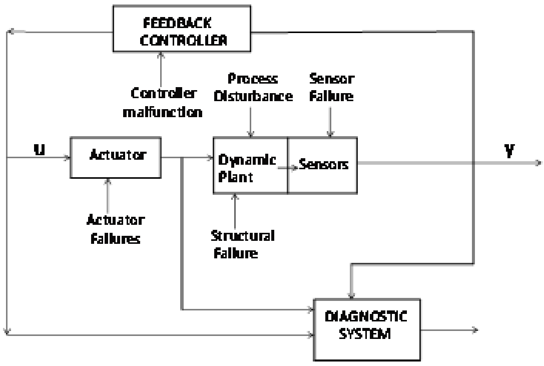


Fig-3 (Block diagram of fault diagnosis & detection)

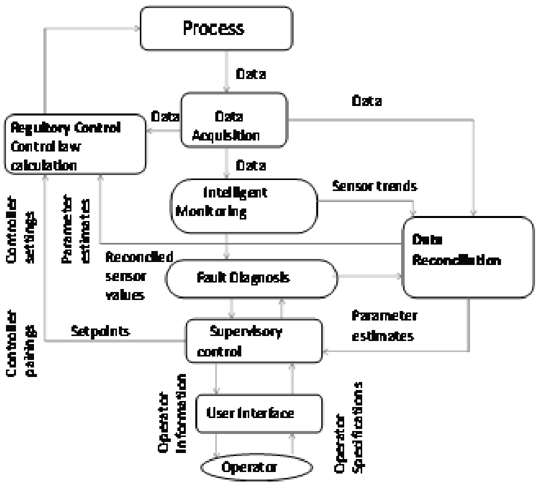
In this section the heuristic part of the knowledge and inference mechanisms for diagnosis are described in order to build up on-line expert systems for fault diagnosis

a) Unified Symptom Representation:

Further processing of all symptoms in the inference mechanism, it is advantageous to use a unified representation. One possibility is to present the analytic and heuristic symptoms with confidence number and treatment in the sense of probabilistic approaches known from reliability theory. Another possibility is the representation as membership function of fuzzy set. Using these fuzzy sets and corresponding membership functions all analytic and heuristic symptoms can be represented in a unified way within the range. These integrated symptom representations are the inputs for the inference mechanism.

b) Heuristic knowledge representation:

For establishing heuristic knowledge bases for diagnosis several approaches are present. In general



specific rules are applied in order to set up logical interactions between observed symptoms (effects) and unknown faults (causes). The propagation from appearing faults to observable symptoms in general follows physical cause-effect relationships where physical properties and variables are connected to each other quantitatively and also as functions of time. However, the underlying physical laws are frequently not known in analytical form or too complicated for calculations. Therefore heuristic knowledge in form of qualitative process models can be expressed in the form of IF- THEN rules.

c) Diagnostic Reasoning

Based on the available heuristic knowledge in form of heuristic process models and weighting of effects different diagnostic forward and backward reasoning strategies can be applied. Finally the diagnostic goal is achieved by a fault decision which specifies the type, size and location of the fault as well as its time of detection. A review of recent developments in reasoning oriented approaches for diagnosis was given in by using the strategy of forward chaining rule, the facts are matched with the premise and the conclusion is drawn based on the logical consequence. Therefore with the symptoms Si as inputs the possible faults F are determined using the heuristic causalities. In general the symptoms have to be considered as uncertain facts. Therefore a representation of all observed symptoms as membership functions of fuzzy sets in the interval (0, 1) is feasible, especially in unified form.

d) Approximate Reasoning with Fuzzy Logic:

With the structure of a fault symptom tree a fuzzy-rule-based system with multiple levels of rules can be established. Fuzzy fault diagnosis properties are differs by

1) Inputs are mostly no crisp measurements, but detected symptoms represented as fuzzy sets
2) Not only one level of rules does exist, but mostly several levels
3) Frequently it is difficult to specify the membership functions of the intermediate events because of very vast and use full knowledge

e) Neuro-Fuzzy Systems for Diagnosis

The knowledge acquisition and tuning for fault diagnosis usually take much effort and time. Therefore adaptation mechanisms of the establishment of rules and membership functions are required. Considering now the similarity between fuzzy logic and neuronal networks, adaptive neuro-fuzzy systems can be developed. It is shown that a combination of the bounded operator for fuzzy-AND and the bounded sum for fuzzy-OR leads to an adjustable ANDOR-operator, which can be approximated by a sigmoid activity function. Furthermore, by applying Gaussian membership functions, adjustable symptom membership functions can be obtained. By measurement of faults and symptoms the neuro-fuzzy diagnosis system is adapted by a back propagation method.

IV. CONCLUSION

As the thermal power plants are more complex in operation, the reliability of implemented concept is more important as it needs the support of hard ware/ soft ware or combination of these. With regards to the primary modules making up an advance control system, neural network nonlinear system theory, robust control, knowledge based system are the areas which are to be concentrated by researchers and designers. Area that will require more attention is to translate raw data into useful information, which improves the measuring methods and multivariable predictive control based neural methodologies. .A major obstacle to realising the full potential of modern control techniques for power plant is the lack of exposure to advance technology in this field. This can be over come by the development of portable proposed model based systems.

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