Intelligent System for Efficiency Enhancing Program of Thermal Power Plant: A Case Study

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ABSTRACT: Thermal power plant being large and complex, the design of its control system involves numerous problems, such as costs, quality, environmental impact, safety, reliability, accuracy, and robustness. Thus, the use of a multidiscipline approach is suggested to satisfy these requirements in an acceptable and well-balanced manner and a hybridization of soft computing with hard computing proves to be a natural and practical use. Although the soft computing technology has distinguished features, the use of soft computing technology would be ineffective, if it is improperly associated with conventional hard computing technology and control processes. Proper integration is key to success and a general mode of fusion is worth examining. In this paper, through a survey of published literature, a general model of fusion is shown at the system level. In the system level, soft computing is applied to the upper level in a hierarchical control system, performing human-like tasks such as forecasting and scheduling or applied to ill-defined process models for carrying out intelligent control. It is found that intelligent system has suitable & desirable performance as compare to conventional system which helps to improve the overall operational efficiency of total system**.**

KEY WORD : intelligent system, fuzzy control, neural control, hybrid system boiler efficiency. Losses control

I. INTRODUCTION

Efficiency of any Boiler depends upon minimization of various indirect losses of the boiler. So the amount of energy input in the boiler by burning the fuel can be maximum utilized for generation of steam and cost of steam can be minimized ultimately. The following indirect losses can be minimized for efficient boiler efficiency.
□. Dry Flue Gas Loss
□ .Fuel Moisture Loss
□. Blow Down Losses
□ .Incomplete Combustion Loss
□ .Air Moisture Loss
□. Radiation and Convection Loss
After knowing the various heat losses it is possible to take counter action
Intelligent system offer one of the most potentially profitable usages in recent developments. IS have been used in a broad range of applications in optimization, prediction and automatic control of process in a power plant by concentrating on following action over the mention losses control loop.

Combustion Control Optimization ----- Combustion controls adjust coal and air flow to optimize steam production for the steam turbine/generator set. However, combustion control for a coal-fired is complex and impacts a number of importent operating parameters including combustion efficiency, steam temperature, furnace slogging and fouling, and NOX formation. The technologies carbon levels in ash, coal flow rates, air flow rates, CO levels, oxygen

levels, slag deposits and burner metrics as well as advanced coal nozzles and plasma assisted coal combustion.It can increase efficiency by0.15% to 0.84%.

Cooling System Heat Loss Recover -----   Recover a portion of the heat loss from the warm cooling water exiting the steam condenser prior to its circulation thorough a cooling tower or discharge to a water body. The identified technologies include replacing the cooling tower fill (heat transfer surface) and tuning the cooling tower and condenser It can increase the overall efficiency by,0.2% to 1% efficiency

Flue Gas Heat Recover --   Flue gas exit temperature from their preheated can range from 250 to350°F depending on the acid dew point temperature of the flue gas, which is dependent on the concentration of vapors phase sulphuric acid and moisture. For power plants equipped with wet FGD systems, the flue gas is further cooled to approximately 125°F as it is sprayed with the FGD reagent slurry. However, it may be possible to recover some of this lost energy in the flue gas to preheat boiler feed water via use of a condensing heat exchanger. This contributes increase of efficiency by 0.3% to 1.5%

Low-Rank Coal Drying --- Sub bituminous and lignite coals contain relatively large amounts of moisture (15% to 40%) compared to bituminous coal (less than 10%). Significant amount of the heat released during combustion of low rank coals is used to evaporate this moisture, rather than generate steam for the turbine. As a result, boiler efficiency is typically lower fop ants burning low-rank coal. The technologies include using waste heat from the flue gas and/or cooling water systems to dry low-rank coal prior to combustion.There by Increas e of the efficiency by,0.1% to 1.7%

Soot blower Optimization---   Soot blowers intermittently injecting velocity jets of steam or air to clean coal ash deposits from boiler tube surfaces in order to maintain adequate heat transfer. Proper control of the timing and intensity of individual soot blowers is important to maintain steam temperature and boiler efficiency. The identified technologies include intelligent or neural-network soot blowing (i.e., soot blowing in response to real-time Conditions in the boiler) and detonation soot blow, this in increase the efficiency by ,.0.1% to 0.6

Intelligent systems (IS) provide a standardized methodological approach to solve important and fairly complex problems and obtain consistent and reliable results over time .The development of digital computers made possible the invention of human engineered systems that show intelligent behavior or features.

 AI builds up an intelligent system by studying first the structure of the problem (typically in formal logical terms), then formal reasoning procedures are applied within that structure. Alternatively, non-symbolic and bottom-up approaches (in which the structure is discovered and resulted from an unordered source) to intelligent systems are also known. Fuzzy logic (FL), Neural Networks (NN) and Evolutionary Computation (EC) were integrated under the name computational intelligence (CI) as a hybrid system

PAPER ORGANIZATION
II. INTELLIGENT SYSTEM

Soft computing is oriented towards the analysis and design of intelligent systems. It is based on fuzzy logic, artificial neural networks and probabilistic reasoning including genetic algorithms. Chaos theory and parts of machine learning has the attributes of approximation and dispositionality Although in hard computing imprecision and uncertainty are undesirable properties In soft computing ,the tolerance for imprecision and uncertainty is exploited to achieve an acceptable solution at a low cost, tractability, high Machine Intelligence. Soft computing, is a consortium of methodologies providing a foundation for the conception and design of intelligent systems,aimed at a formalization of the remarkable human ability to make rational decision in an uncertain and imprecise environment. The guiding principle of soft computing is: Exploit the tolerance for imprecision, uncertainty and partial truth to achieve tractability, robustness, low solution cost and better rapport with reality.

Fuzzy logic (FL) is mainly concerned with imprecision and approximate reasoning, Neural Networks (NN) mainly with learning and curve fitting, Evolutionary Computation (EC) with searching and optimization. The constituents of soft

computing are complementary rather than competitive. The experiences gained over the past decade have indicated that it can be more effective to use them in combined manner rather than exclusively.

1 Fuzzy Logic

Fuzziness refers to no statistical imprecision and vagueness in information and data. Most concepts dealt with or described in our world are fuzzy. In classical logic known as crisp logic, an element either is or is not a member of a set. That is, each element has a membership degree of either 1 or 0 in the set. In a fuzzy set, fuzzy membership values reflect the membership grades of the elements in the set. Membership function is the basic idea in fuzzy set theory based on fuzzy logic, which is the logic of "approximate reasoning." It is a generalization of conventional (two-valued or crisp) logic. Fuzzy sets model the properties of imprecision, approximation or vagueness. Fuzzy logic solves problems where crisp logic would fail. Fuzzy logic is being applied in a wide range of applications in engineering areas ranging from robotics and control to architecture and environmental engineering.

2 Neural Networks

An artificial neural network (briefly: neural network) is an analysis paradigm that is roughly modeled after the massively parallel structure of the brain. It simulates a highly interconnected, parallel computational structure with many relatively simple individual processing elements. It is known for its ability to deal with noisy and variable Information.

3. Evolutionary Computing

Evolutionary computing comprises machine learning optimization and classification paradigms roughly based on mechanisms of evolution such as biological genetics and natural selection. The evolutionary computation field includes genetic algorithms, evolutionary programming, genetic programming, evolution strategies, and particle swarm optimization. It is known for its generality and robustness. Genetic algorithms are search algorithms that incorporate natural evolution mechanisms, including crossover, mutation, and survival of the fittest. They are usedfor optimization and for classification. Evolutionary programming algorithms are similar to genetic algorithms, but do not incorporate crossover. Rather, they rely on survival of the fittest and mutation. Evolution strategies are similar to genetic algorithms but use recombination to exchange information between population members instead of crossover, and often use a different type of mutation as well. Genetic programming is a methodology used to evolve computer programs. The structures being manipulated are usually hierarchical tree structures.

Particle swarm optimization flies potential solutions, called particles, through the problem space. The particles are accelerated toward selected points in the problem space where previous fitness values have been high. Evolutionary algorithms have been applied in optimization to multiple-fault diagnosis, track determination, schedule optimization, conformal analysis, load distribution, neural network explanation facilities, and product ingredient mix optimization. Classification applications include rule-based machine learning systems and classifier systems for high-level semantic networks.

4. Hybrid Systems

Hybrid systems combine two or more individual technologies (fuzzy logic neural networks and genetic algorithms)for building intelligent systems. The individual technologies represent the various aspects of human intelligence that are necessary for enhancing performance. However, all individual technologies have their constraints and limitations. Having the possibility to put two or more of them together in a hybrid system increases the system's capabilities and performance, and also leads to a better understanding of human cognition. Into the following four categories:

Combination: typical hybrid architecture of this kind is a sequential combination of neural networks and ruler fuzzy rule-based systems.

Integration: this architecture usually uses three or more individual technologies and introduces some hierarchy among the individual subsystems. For example, one subsystem may be dominant and may distribute tasks to other subsystems. Fusion: a tight-coupling and merging architecture usually based on the strong mathematical optimization capability of genetic algorithms and neural networks. When other techniques incorporate these features, the learning efficiency of the resulting system is increased.

Association: the architecture that includes different individual technologies, interchanging knowledge and facts on a pair wise basis. with.”Fuzzy logic is mainly concerned with imprecision and approximate reasoning, neural networks mainly with learning and curve fitting, evolutionary computation with searching and optimization.

III. INTELLIGENT MODELING OF BOILER

 In this paper we are using a model which is composed of ELM ,ANFIS and PS ABC .to   . build a global model. Hear and ANFIS is applied to identify and compensate the training error of the main model., ELM in order to improve the precision of hole model andPS--ABC is use to optimize input weight and hidden layer . In order to set this model validity, it is applied to set up the mapping relation between the boiler efficiency and operational condition of a 300MW coal fired boiler. This method can be applied to minimizes thermal losses through proper regulating of associate control loop. ELM   EXTREM LEARNING MACHINE belong to the artificial neural network ANN FAMILY. It is a single layer hidden feed forward neural network. One key principle of the ELM is that the hidden nodes parameters are   randomly chosen and fixed ANFIS is class of adaptive multilayer feed forward networks, The ANFincorporate the self learning ability of neural network with the linguistic expression function of fuzzy inference. Namely ANFISallowes the if = then rules and the membership function to be constructed based on historical data and synchronously it includes the adaptive nature for automatic tuning purpose
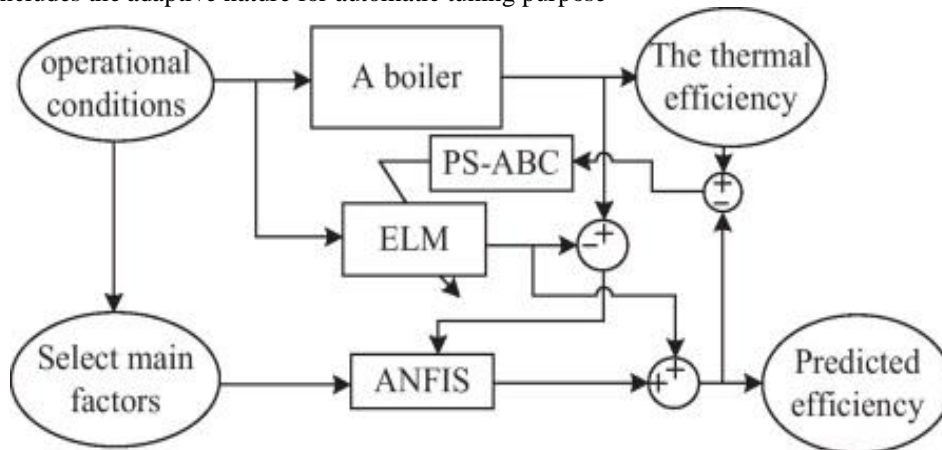
(Fig 1:intelligent modeling of boiler system)

The ABC algorithm has already proved to be a very effective optimization technique for solving global optimization problems. ABC not only is a high performance optimizer which is very easy to understand and implement. The PS-ABC algorithm is a modified high efficiency hybrid ABC algorithm. It has extremely fast convergence speed and owns better search ability.
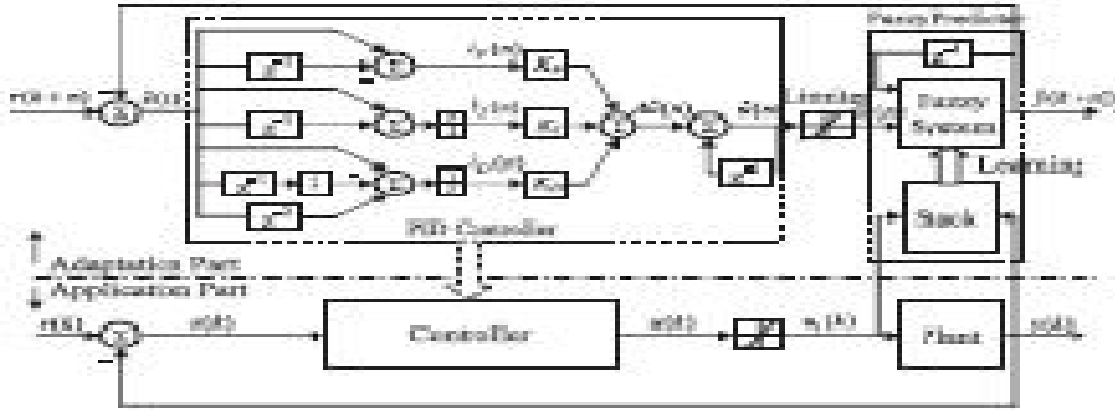
IV. INTELLIGENT CONTROLLER

The adaptation part includes the PID controller and the fuzzy predictor The PID controller computes the control actions. The predictors constructed only from the measurement of the input–output data of the actual process as a fuzzy model, without requiring a first principal model of the process which is usually very difficult to obtain. the multi step ahead predictions of the process output are provided by fuzzy predictor. The fuzzy predictor output is used to adjust the gains by minimizing the sum of the squared errors between the predictions and the referenced over the prediction horizon.Thefuzzypredictoristrainedonlinetoadapttothevariationsinplantparameters, and thus improve the prediction accuracy
 .

FIG; 2 –(**Proposed Intelligent Controller For Losses Control Loop)**

A certain history of the actual plant inputs and outputs is stored in first-in first-out stack, providing the online training data at each training step The PID controller gains and the predictor fuzzy system parameters are both adjust. The actual plant is controlled by a PID controller identical to that oadaptation phase, the gains of which are transfer at each control cycle

V. RESPONSES OF CONTROLLERS

We can see that intelligent system (adaptive fuzzy neural net work) is significantly better than any control method. This control system has shorter adjusting time. When load changes it has better adaptability
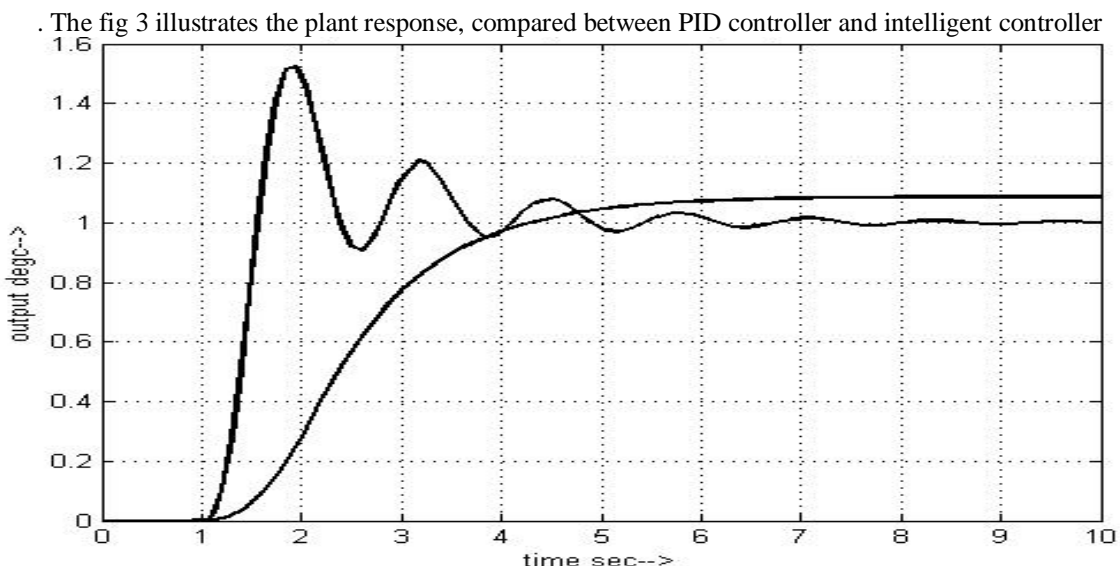
. The fig 3 illustrates the plant response, compared between PID controller and intelligent controller

FIG: 3 (–**Response Of Conventional And Intelligent Controller**)

. As can be observed, better performances are showing using the intelligent controller to Conventional PI controller. Intelligent system has faster anticipation in any change in the process variable.

VI. CONCLUSION

As discuss in this paper a clearly designed optimal regulator realizes considerable improvement of control performance in thermal power plants. Prior to implementation, it is advisable to perform simulation studies on a plant model. The programs for system analysis and controller design should be prepared in the plant computer so that plant engineers are able to understand the basic concepts, analyze the plant dynamics, adjust the feedback gain, and also are able to transfer the techniques to the next generation.

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BIOGRAPHY

Prof. Subodh Panda has completed his bachelor   in Electronics& communication engg. And Masterin tech. in Computre science engg and Post Graduate diploma in Industrial Instrumentation. He hasServed 11 years in various process industries specially in Power generating unit, before switch over to academic on 2007. Presently he is working as Associate Professor in Department of Applied Electronics & Instrumentation in GIET, Gunupur, Odisha, India. His interest filed of research is Application of Artificial Intelligent for Losses Control at Process Industries. Presently he is perusing his Ph.D at SSUTMS, Bhopal.

Dr. Nalini Kanta Barpanda received the B.E. in Electrical Engineering from Utkal University and M.Tech. in Communication System Engineering from Biju Pattanaik University of Technology respectively. He got his Ph.D. in the field of Computer Science & Engineering from Sambalpur University. He is currently working as Associate Professor Department of Electronics Engg., G.I.E.T, Gunupur Odisha, India. He has more than 20 publications in different national and international Journals and Conferences. His Research interest includes Dependibility, Reliability and Fault-tolerance Analysis of Communication Interconnection Network and Soft Computing Applications to Electrical and Electronics Systems.

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