Design of Fault Diagnostic and Optimization System through Data Analysis from Industrial Perspective

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Abstract: ***The economic growth of the country depends on the effective supply to the demanded need of the people to lead normal life. Among the variety of influencing industries, energy industries plays vital role which serves the needs of human in all aspects like consuming energy for using electronic devices, mode of transport in terms of different categories of vehicles etc. The study focuses on the impact of rapid growth of fuel demand due to the increase in the habit of vehicle usage. The need emerges to design an intelligent system that predicts the diagnostic aspects of elements involved in the production process. The proposed work mainly focuses to design fault diagnostic and optimization system to enhance power plant efficiency through optimal design criteria. The outcome of the study is expected to reduce different categories of heat loss through internal and external factors.***

Index Terms: Energy, Knowledge, Optimal , Performance

I. INTRODUCTION

The population size increases day by day which cause to use the resources in an effective manner. Irrespective of the area, the usage habit of the humans to using the individual vehicle for the purpose of travel is rapidly increasing. The correlated relationship emerges that increase in vehicle results in increase in fuel also. It is the responsibility of the power generating industries to make their production more effective. The demand ratio must be equally satisfied by the ratio of production. Frequent data analysis must be carried out to determine the criteria which affect the Performance of the traditional system. Infinite number of internal and external factors exists that causes the traditional production process to deviate from the expected outcome. It is highly tedious to analysis the processing data and extracting the crucial attribute among the huge collection.

Data mining techniques support to have effective data analysis process in the field of required domain. The effectiveness of the traditional algorithm is decided based on the outcome of the experiments learned through the literature survey. AndrewKusiak&Zhe Song (2006) proved that the data analysis carried out through the methodologies is effective in predicting optimal strategies in order to improve the performance of a boiler system. The efficiency of the boiler system is diagnosed and optimized by scaling the controllable parameters. Zhe Song &Andrew Kusiak (2007) states that the data extracting approach is suitable to determine optimal values needed to enhance the efficiency of utility boiler though suitable clustering process.Andrew Kusiak&Zhe Song (2008) showed the capabilities of clustering techniques to increase the process and performance of boiler systems by designing a model with selected process variables. Zhe Song & Andrew Kusaik (2009a) parades the effectiveness of applying hybrid approach of assimilating data excavating algorithms, evolutionary techniques and model projecting control by springy efficient optimization practice of boiler ignition. Andrew Kusiak et al. (2009) offered the mutual approach of evolutionary policy and data driven methods over turbine to regulate control policies that are crucial to improve performance correctness by optimizing the operative variables such as blade pitch and yaw angle. Andrew Kusiak et al. (2011) appraises the competence of data focused algorithms by developing models by using ancient turbine data and computational ethics verifies that the neural network method products accurate and likely results. The virtual wind speed sensor model is established using four dissimilar facts mining systems.Andrew Kusaik&AnoopVarma (2011) estimated the determination and estimation of status patterns using data excavating techniques in wind turbine that yields the finest result and used to ripen a component needed for routine monitoring and control tactics.

Andrew Kusaik&AnoopVarma (2012) shown that data determined procedures are highly suggested in solving engineering difficulties. Diverse data excavating methods are implemented in guessing the process of various burdens that occur in wind turbine.Ali Ashebi et al.(2006) pragmatic supervised and unsupervised knowledge methods like k-means clustering in combination with evolutionary computing techniques will produce effective enhancement. Andrew Kusiak et al.(2011) shows the operative tactic of combining data driven techniques and evolutionary strategies. The evolutionary process performs based on the information given by the data ambitious method and the predictive model is improved with enhanced multi neutral particle swarm optimization system.

The computing abilities of several data excavating algorithms are evidently assumed through suitable illustrated outcomes with proper developed case study. The literature survey clearly shows the impact of

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The rmodynamic study of steam generation method is measured. All the over head studied parts are motivated to carry out the unbiased mining of hidden information from the thermal data. The quarried information may helpful in mounting optimal enterprise values.

II. DOMAIN ARCHITECTURE

The basic requirement to frame the guidelines that supports the operators and users to utilize the traditional procedures to operate the designed fault diagnostic and optimization system are specified. The guidelines support to attain operative maneuvers that effect in lower consumption. First, to originate operative and conservation inferences to improve the burden analytic complications. Second, to project optimization model that embraces all vital and assessed control policies. Third, to abstract corollaries and trends that aids plant machinist, producer and seller to carry out normal operations. Fourth, to control origin causes that distress plant routine to reduce conservation effort and scheme complexity. Fifth, to understand the vapor generation route. Sixth, to investigate the dissimilarities of competence by using dissimilar qualities of coal. Seventh, to understand the computational viewpoint of boiler element. Eighth, to regulate the heat produced at burning chamber and to recognize the proportion of heat harms.

The opportunity of this proposed work of mining knowledge from thermal practice has been applied for modeling, optimization and estimate to control the regular task in a broader range of energy requests. The sub goals integrated in the proposed effort are shown as diagrammatic representation is as follows.

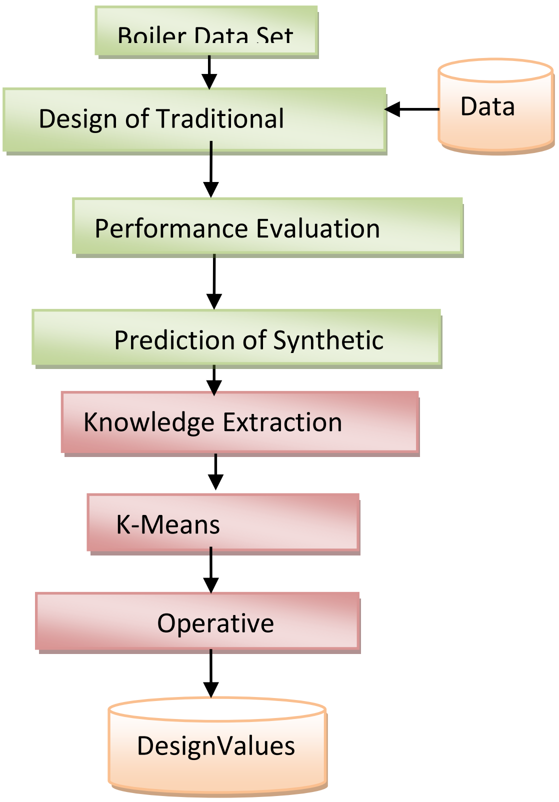

Fig: Schematic representation

III. PREDICTION OF SYNTHETIC DATA

A. Working Principle of Vander Monde Matrix

The Vander monde matrix is a scientific model that is recycled to find an interposing polynomial desirable to produce artificial data. The replacement of the crucial points into the gained polynomial crops a arrangement of linear equivalences in the co-efficient of the polynomial that could be cracked by consuming gauss elimination technique. The matrix is represented as m * m matrix that permits row wise appraisal of m monomials such as the first row is the original fact which initiates the appraisal at each of the m monomials, the second row is the subsequent fact to achieve estimation over m monomials and it replicates for all the rows seems in the matrix. To regulate the incorporating polynomial, originallyparadigm the generation, based on the points elected from the problem field, that is denoted by mfacts as follows,

$$(a1, b1), (a2, b2), \dots\dots, (am, bm)$$

The ensuing steps were tailed to spring a polynomial of degree (m-1) that allows replacement of facts to gaindirect system.

1. Outline the overall polynomial of degree (m-1).
2. Evaluate the polynomial at the given points (a_1, a_2… a_m).
3. Deciphering the evolving arrangement of linear equations.

In this projected learning, five facts are measured and the interpolating polynomial is defined as

$$P(a) = f_4a^4+f_3x^3+f_2a^2+f_1a+f_0$$

where P is represented as interpolating polynomial of ‘f’facts, f_4, f_3, f_2, f_1, f_0 are the co-efficient of a^4, a^3 , a^2 ,a. These are the given facts of the problem. Invent the co-efficient of the defined polynomial by solving the system,

$$P(f_i \mid X_i) = Z_i , \quad i \in \{ 0,1,2,3,4,5 \}$$

The input data of F_i and X_i are replaced in the definite matrix and relate matrix lessening method using any one of the following mechanism,

1. Do exchange the values among rows.
2. Reproduce the row values with non-zero number.
3. Addition of multiplied value of one row to another.

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$$\begin{bmatrix} F_0^4 & F_0^3 & F_0^2 & F_0 \\ F_1^4 & F_1^3 & F_1^2 & F_1 \\ F_2^4 & F_2^3 & F_2^2 & F_2 \\ F_3^4 & F_3^3 & F_3^2 & F_3 \\ F_4^4 & F_4^3 & F_4^2 & F_4 \end{bmatrix} \begin{bmatrix} X_0 \\ X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix} = \begin{bmatrix} Z_0 \\ Z_1 \\ Z_2 \\ Z_3 \\ Z_4 \end{bmatrix}$$

$[m*m]$ where $m=5$

The besieged matrix is the condensed matrix that will be characterised in stratum form. The stratum form comprehends the left most non-zero entry in each row as 1 and every column comprising a foremost co-efficient as zero. Here, F_i is the capacity specified by the user for diverse grades of coal and Z_i be the grown heat energy of all the thermal machineries. The polynomials are definite and co-efficient are determined to expect the energy result of all apparatuses to have stable combustion practice.

The industrial samples were used to generate synthetic data that are sufficient to perform prediction and diagnostic tasks. The vander monde matrix is used to compute the synthetic data without losing the originality.

IV. KNOWLEDGE EXTRACTION PROCESS

A. K-Means Procedure

The K-Means proceduretails the basic viewpoint of gettingresponse from the user, accomplish the essential computation and picturize the gained results. The ladderstangled in this algorithm is itemized as,

Step:1 Reset the input values.

Sample Data (TD_s) = { m_1,mr_2, …m_n } - set of elements. I = Desired number of clusters.

Step:2 Postulate the target output.

CS =Cluster Set.

Step:3 Executional charge.

a) Arbitrary assignment of original centroid (b_1, b_2, ……. , b_n).

b) Recap

i) Allotevery data item (V_i) from TD_s to the cluster that contains the adjacent centroid value.

ii) Calculatenovel centroid value for each cluster.

Until termination criteria is met.

The synthetic data set is used for the purpose of clustering based on the similarity exist between the instances. The efficiency of the clustering technique depends on the number of iterations performed to reach termination criteria. The interpretation of the clustering outcome relies from the perspective of the analyser.

V. OPTIMAL DESIGN VALUES

The stable combustion process requires optimal design criteria to avoid inefficient and unsafe conditions. The average optimal designs values of thermal components are derived from two categories of clustering techniques with respect to different grades of coal are tabulated below. These optimal values are useful to maintain the boiler combustion process in a stable manner. The values are suited only to the associated loads specified in the unit. The Table 4.1 shown below illustrates the derived optimal values of different grades of coal for 250MW.

Elements/Grade	Q1	Q2	Q3
E1	184982	196535	187966
E2	18104	19887	19607
E3	56551	54808	54375
E4	17120	18420	18796
E5	39102	39210	38266
E6	23490	23553	23678
E7	4731	5500	5804
E8	7595	7437	7237

Table: 1.1 Optimal Designs Value 270 MW

The above mentioned optimal values are used to predict the operative value for any grade of coal with user specified megawatt. This will support scheduling stage enquiries, distinguish inter relationships occur among inner and outwardfeatures , Deliver support to regulate root cause forroutine deviations ,attaincorrect diagnosis that pointers to effective optimization, Signifying trends through well-organized data acquisition method, Measure component efficiency and produce guidelines to start test procedures that aids to authorize data to guarantee that the products are reliable with morals based on concertfeatures.

The ideal facts acquired from the K –Means clustering techniques are utilized to ensure its accuracy. The analyses recognize that the error rate that occurs is negligible and it won't diverge the performance. An optimal design norm for dissimilar grades of coal with several loads aids in learning the individualities of energy and leanings of operational constraints.

VI. DISCUSSION ON RESULTS

The main aim of knowledge extraction is to express hidden information in machine readable form that supports to the emergence of the intelligent system. The effectiveness of the intelligent system needs a rich enough knowledge to express the dynamic solution to the unpredictable problems. In the initial stage, the industrial data were analysed to understand the impact of operative parameters. Next, synthetic data were generated using vander monde matrix that provides sufficiency to carry out the analysis.

The generated synthetic dataset were used to clustering the instances based on their nature. K-Means clustering is used to extract the hidden information from the energy dataset and results in extraction of meaningful patterns. By interpreting the clustering result the optimal values for different quality of grade with specific load is derived. The optimal data is used to predict the outcome of each thermal element and result in effective fault diagnostic aspect on individual elements that supports to take precautionary measures to overcome the factors affecting the performance.

VII. CONCLUSION:

The limited industrial operational data were considered for this analytical study. Only the impact of parameters was understood and the number of instances is not sufficient for data analysis. So the sufficient synthetic data were generated that simulates the originality of the industrial data using the computing technique. The K-Means clustering is applied over the synthetic dataset and results in deriving informative patterns. The patterns were interpreted to formulate the optimal design values for each individual element of the thermal plant for the specified load. This optimal value will support to predict the outcome energy of the overall plant also with individual component.

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