

# INTELLIGENT SYSTEMS DESIGN WITH LINGUISTIC EQUATION PROPOSED MODELING FOR PROCESS INDUSTRIES

Subodh Panda<sup>1,\*</sup>, N. K. Barpanda<sup>2</sup>, P. S. Ratha<sup>1</sup>, R. P. Singh<sup>3</sup>

<sup>1</sup>Dept of Electronics, Ph.D Scholar, SSSUTMS, Bhopal, India

<sup>2</sup>Dept .of Electronics,Reader, Sambalpur university,sambalpur, Odisha, India

<sup>3</sup>Pro-Vice-Chancellor, SSSUTMS, Bhopal, (India)

## ABSTRACT

Non-linearity specially in multivariable which include thermal electricity plant software systems linguistic equations are extra beneficial , better and more accurate selection-making because of the model-based approach and systematic understanding control is the main advantage. adaptation techniques computerized era of structures, version-based strategies for fault diagnosis and forecasting for these days's power plant.. The linguistic equation will increase the performance by combining numerous specialised fashions in a case-primarily based approach. The LE technique is very efficient as a modelling approach: fashions can be generated from statistics, numerous varieties of fuzzy rule-based totally models may be represented with the aid of LE models, and any LE model may be converted to fuzzy rule-based fashions. The LE technique is correctly prolonged to dynamic modeling up to terrific critical thermal power plant.

Key phrases :thermal power plant , linguistic equation, fuzzy model.nonlinear, multivariable, fault diagnosis, machine manipulate, smart device.

## 1.INTRODUCTION

The cutting-edge strength plant face sizeable control demanding situations, particularly in the steady production of excessive best steam, extra green use of electricity and raw substances, and solid operation on exceptional conditions. The complete operation and manner are nonlinear, complicated, multivariable and tremendously interactive. normally most of the case the essential pleasant variables can be envisioned only from other measured variables available.. . diverse time-delays rely strongly on working situations and can dramatically restrict the overall performance of the closed loop gadget. Uncertainty is an unavoidable part of the thermal process control in actual international applications.

For the general steam era approaches, the manage systems deal with numerous sub tactics. as an instance the general overall performance of turbine can be rated to the operating performance, which depends on de-

superheated, furnace, feed water and its treatment, economizer, air-gasoline and so many....

elements that exist and cannot be measured and interactions between physical and chemical elements.

various things are emphasised in the thermal technique, however the manner manipulate needs to be increasingly adaptive in all such business regions. The production manager must utilise the ranges of freedom within the system control in converting operating conditions to reschedule the manufacturing on a favored way.. Fuzzy systems can improve these aspects in many waiting for approaches. Linguistic equations offer a better method for combining understanding and reviews to make the manager less complicated. The approach has been tested correctly in technique manager and designing,.. due to very flexible and extra friendly implementation, those systems may be prolonged to any linear/non linear, multivariable complicated method .

Linguistic equations together use diverse wise modelling techniques on a given schedule and platform . essentially it changed into firstly developed for wearing out big expertise bases statistics in manner design information-driven modelling function have added the ANN techniques Fuzzy modelling and control has many utility region. residences of the LE approach are continuously stepped forward everyday and prolonged on the idea of industrial enjoy for numerous application areas, .The LE technique is already used on top of things in clever analysers in fault analysis and in model primarily based manipulate layout

Fault analysis gadget and clever analysers technique are mixed in model-based totally diagnostical system analysis (MDPA) [9]: the ensuing systems can be used in various approaches in the main appropriate for all software sensors, threat evaluation propose and detection of numerous sensor disasters. sophisticated trend information can be utilised by means of temporal reasoning at the recent procedure records. The MDPA methodology has been tested with proper simulations approach,, professional knowledge available and actual records gathered..

For each converting operating conditions, the looking ahead to problems includes following subproblems:

- type: Fault analysis is primarily based on class technique.. working conditions have to additionally be detected before forecasting, on account that they will define the method dynamics.

- Dynamic modelling: Dynamic models are advanced for each case on the premise of the correct records cluster. Fuzzy set structures integrate those fashions into a easily running common version.

This modular approach can aid in understanding the hassle. structures used for multilevel linguistic equation controllers are relevant to dynamic modelling and forecasting as nicely. information analysis is normally connected with assessment based on expert knowledge, specifically in huge case-based structures

same methodology may be used in pricing and manufacturing scheduling commonplace for every commercial area. The pricing have to have the appropriate connection to the actual manufacturing system so one can gain green manufacturing additionally with a few remaining moment changes in the manufacturing plan since the real production cost relies upon on manner conditions. The production scheduling eventually defines how nicely this can be finished in real production.

understanding-based intelligent manager

The demands can't be met with the aid of conventional manage techniques most effective, and consequently diverse methodologies have been evolved with a purpose to enlarge the applicability of the control systems. seeing that PID algorithms cannot safely compensate numerous interactive disturbances, those issues are from time to time solved by using the creation of diverse nonlinear PID modifications in which the controller parameters rely on the error or on the parameter scheduling maximum commercial programs of fuzzy control are based on the usage of expert expertise. Fuzzy modelling can growth the performance of controllers considerably. The adaptive fuzzy manage is likewise specially related with version-primarily based techniques. The linguistic equation technique extends the overall performance of the fuzzy control in many approaches..

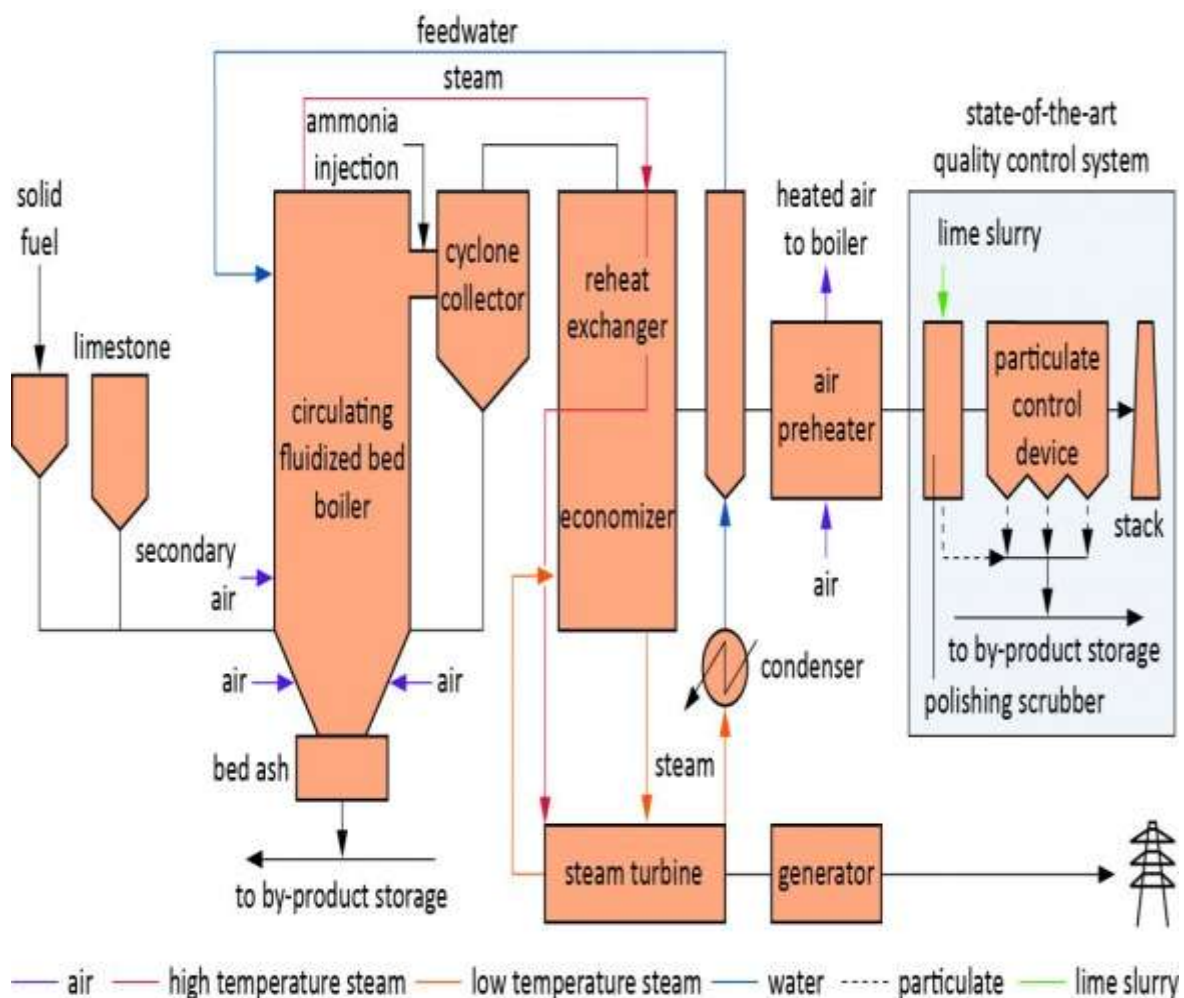


FIG :1 modern plant with required intelligent system

## **II.FUZZY LOGIC CONTROL**

A massive quantity of surprisingly a success fuzzy control packages are carried out in manner enterprise. A fuzzy good judgment manipulate device may be interpreted as a real-time expert device combining symbolic if-then policies with qualitative, fuzzy variables connected to the real international via club functions. traditional expert systems can be represented by using fuzzy professional systems with plenty much less guidelines if nonlinearities are taken under consideration in membership features. consequently, complex professional control strategies may be included to practical manage.

traditionally, the rule of thumb base of the fuzzy controller is constituted of professional knowledge via trial-and-errors, and maximum applications are still based on this technique. various methodologies have been advanced for automated technology of fuzzy systems and inverting fuzzy models, i.e. fuzzy structures may be regarded as bendy mathematical approximation gear. but, the bushy controllers should be saved transparent to interpretation and analysis on the premise of expertise the system behaviour in view that this insight is greater crucial than near correlation to experimental statistics.

Many fuzzy controllers are carried out as two dimensional fuzzy good judgment choice tables in which manipulate movements and enter conditions are expressed in phrases of club functions. the rule of thumb base is largely linear, and the nonlinearity may be brought through adjusting membership functions or by using enhancing policies. modified rule bases are utilized in multivariable controllers, specially for feedforward purposes. a few experiments with automated manipulate based on deterministic choice tables were carried out already earlier than fuzzy manipulate.

## **III.LINGUISTIC EQUATIONS**

Linguistic equations have been utilized in changing and growing control guidelines for FLCs. This method can effortlessly be mixed with other tactics for FLC layout, e.g. to a conventional way of acquiring information from professionals through interviews. The traditional fuzzy structures described by way of if-then rules are represented via matrix equations if nonlinearities are treated by means of membership features. membership features can generated from club definitions on a designated partition

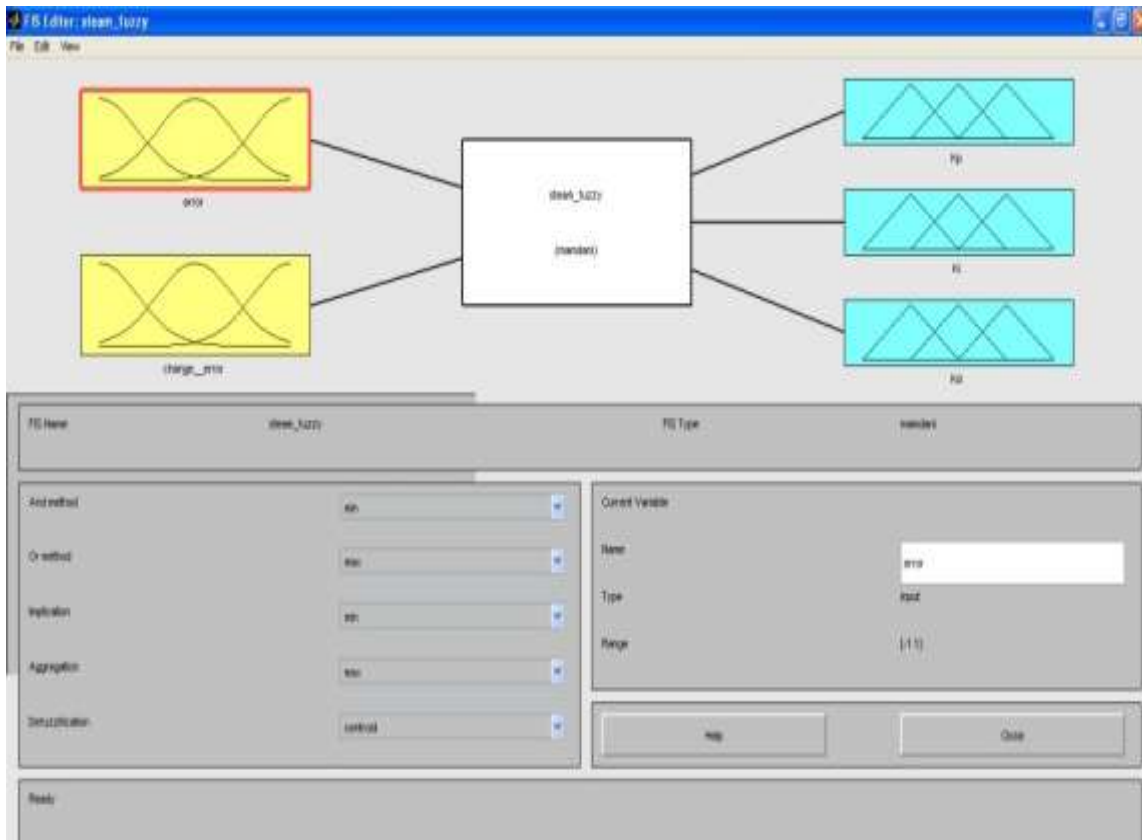
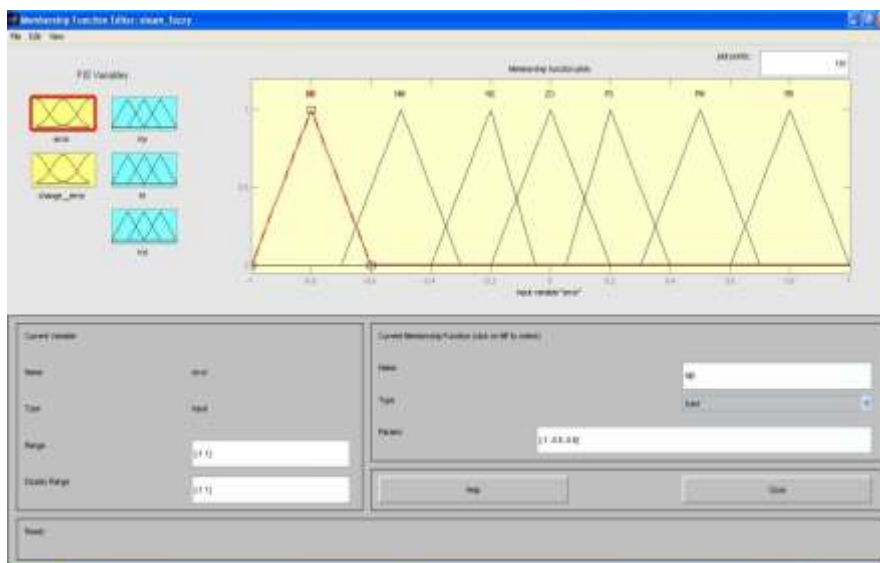


Fig : 2 Structre of fuzzy controller with input and out put

Fig :3 Membership function representation fuzzy controllerf



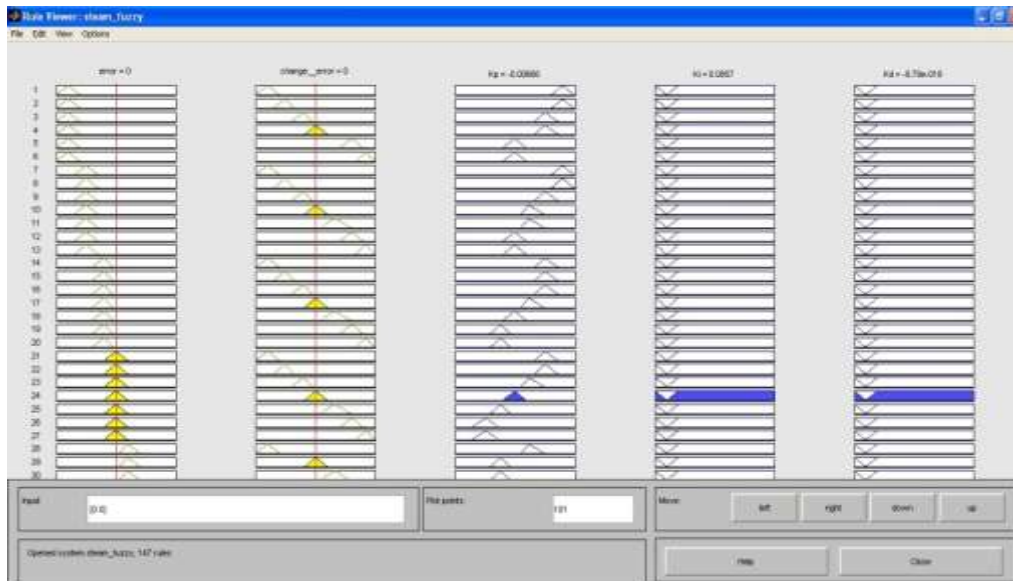


Fig ;4 ,IF –THEN RULE at out put stage

original approach has been extended to fuzzy and real valued linguistic equations with variable specific partition levels

A set of linguistic relations can be changed into a compact equation

$$\sum_{j=1}^m A_{ij} X_j + B_i = 0, \quad (1)$$

where  $X_j$  is a linguistic level for the variable  $j, j=1\dots m$ . In the original system the linguistic values very low, low, normal, high, and very high were replaced by integer numbers -2, -1, 0, 1 and 2. The direction of the interaction is represented by coefficients  $A_{ij}$ , originally there were only three different coefficients  $\{-1,0,1\}$ . This presentation is easily generalised for finer fuzzy partitions and transferred between the programming systems. The bias term  $B_i$  was introduced for fault diagnosis systems.

Several sets of linguistic relations can be combined by matrix presentation

$$A X + B = 0, \quad (2)$$

In order to solve this problem, a sufficient number of these variables should be known or varied. Because of nearly singular matrices, some of these combinations cannot be used. However, only the integer solutions are required, and exactly the same set of solutions is obtained by any combination.

The *interaction matrix* consists of several models, and each of these models replaces a set of linguistic rules. Similar sets have been used in linguistic model of electrical resistance and importance of a scheduling filter \ For management applications, *constraints* have an essential effect on the aggregated sets of relations, especially

on coarse partition levels. Feasible prices are based on differential constraints represented by fuzzy numbers. These constraints relate the feasible prices to price ranges of the competitors. The result is an aggregated set of those linguistic relations which are relevant if the process constraints described by the complete set of linguistic equations are taken into account. For three variables, the equation replaces a set of 25 linguistic relations if each variable has five linguistic values. Interactions reduce the number of relations, e.g. in the case of five linguistic levels from  $5^3=3125$  to 557. Correspondingly, only a fraction of all possible alternatives  $9^6$  was required in the pricing support system

#### IV.LINGUISTIC EQUATION CONTROL

The linguistic equation approach extends the performance of the fuzzy control in many ways. For a symmetrical fuzzy PI type controller, all the rules can be obtained from a single linguistic equation.

The control surface of the fuzzy PI controller can be obtained by using the integer valued linguistic equation together with trapezoidal membership functions. Alternatively, fuzzy rule bases are represented by real valued relations. The LE controller is also applicable on any fuzzy partition, and the procedure produces always a rule set which is complete, consistent, and continuous. If a non-complete set is satisfactory, a part of the rules can be deleted already before tuning. The best similarity with the LE controller is achieved if the positions of all the fuzzy sets are coordinated

with the real valued linguistic equations, i.e. linguistic values are replaced by real numbers. Feed forward controllers based on steady state models can have interactions with different strengths. A fairly smooth control surface is also obtained by the fuzzy controller with seven consequent fuzzy numbers described by triangular membership functions. Linguistic equation controllers implemented on the basis of real valued equations need only the *membership definitions*. Nonlinearity is introduced to the system by membership definitions, which correspond to membership functions used in fuzzy logic controllers. This is the main difference to the fuzzy logic controllers where the nonlinearity is handled through the rule base.

Error e(t)		Change in error Δe(t)		Controller output u(t)	
NB	Negative Big	NB	Negative Big	NB	Negative Big
NM	Negative Medium	NM	Negative Medium	NM	Negative Medium
NS	Negative Small	NS	Negative Small	NS	Negative Small

ZO	Zero	ZO	Zero	ZO	Zero
PS	Positive Small	PS	Positive Small	PS	Positive Small
PM	Positive Medium	PM	Positive Medium	PM	Positive Medium
PB	Positive Big	PB	Positive Big	PB	Positive Big

Fig : : Linguistic variables in fuzzy inference system

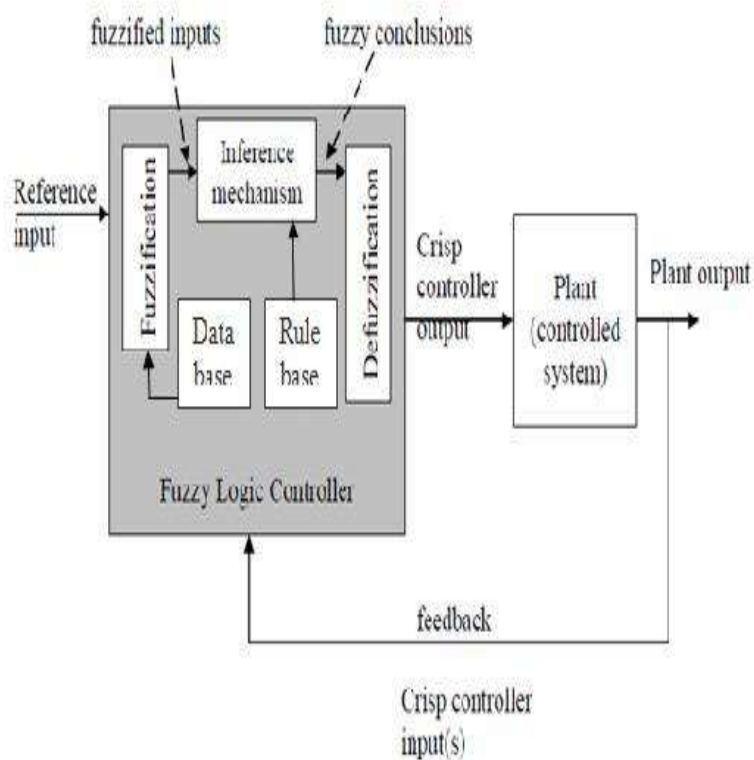


Fig 5 : \_ Fuzzy controller internal structure and functionality



## V.APPLICATION

### **Machiniray Operation**

Membership definitions are required for error, change of error, change of control, original error, trend, correction coefficient and all the working point variables. Modularity is beneficial for the tuning of the controller to various operating conditions, and most important is that the same controller can operate on the whole working area. For the high level control, calculation of state indices can be represented by linguistic equations. Actually, the linguistic value of the control change is at the same time a measure of the state deviation. These linguistic values can be used in selecting priorities for the control actions obtained from different control objectives.

### **Process Fault Diagnosis**

Fault diagnosis applications require various specialized knowledge and large amounts of data. from complete operation process. Although the system development can be started either from knowledge or from data, an appropriate performance is achieved only by combining both data and knowledge. The forecasting problem is closely related to the dynamic simulation.

The effect of different process variables on the sensitivity has been analyzed using actual measurements from a machine. In addition to the actual measurements, the data also contains information of the break occurrence. The development work is concentrated on the consistency of the machine and other variables effecting the operation.. The indicators compare online data to example cases in the database and give a numerical estimation of the risk level of an output. Both versions have been tested with off-line data and also some online experiments have been carried out. According to these results, both versions indicator seem to operate as planned.

*Functional testing* is the main method to prevent defective products to be delivered to customers. Test personnel has a lot of knowledge on reasons of different kind of failures. An adaptive and intelligent system has been developed using process failure information in the functional testing . Only few human experts with long experience can handle the complicated relations to the production process. Most common failures are easy to find based on failure information, but additional measurements are often needed.. A fuzzy rule base has been generated by personnel interviews and data collected from databases. The steps of various measurements are variables and they are grouped as a group of measurements.

### **Intelligent Analyzers**

Forecasting is based on the same approaches as dynamic simulation and intelligent analysers. Dynamic LE models have been tested in control design for a power plant Modularity is beneficial for the tuning of the controller to various operating conditions, and most important is that the same controller can operate on the whole working area This multimodel approach based on fuzzy LE models can applied to different forecasting problems. Some properties of the fuzzy multilevel approach can be transformed into new structures similar to those used in the multilevel LE control.

## VI.CONCLUSION

The linguistic equation approach is successfully extended to case-based modelling and dynamic modeling. Case-based approaches have used in fault diagnosis. These applications provide a good basis for wider use of intelligent systems together with other techniques in improving fault diagnosis and forecasting in thermal power plant. Linguistic equations are useful for taking into account non-linearity especially in multivariable application systems as stated with real time example .The practical outcome is better and more accurate decision-making due to the model-based approach and systematic knowledge management facilities... The linguistic equation approach generally increases the performance by considering various specialised models . The LE approach is very efficient , specially as a modelling technique: models can be generated from data, various types of fuzzy rule-based models can be represented by LE models, and any LE model can be transformed to fuzzy rule-based models

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**Prof. Subodh Panda** has completed his bachelor in Electronics&communication engg. And Master in tech. in Computre science engg and Post Graduate diploma in Industrial Instrumentation. He has served 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(Autonomous), Gunupur, Odisha, India. His interest filed of research Intelligent Control for Losses Prevention& Modernization of Process Industries. . Presently he is perusing his Ph.D at SSUTMS, Bhopal..

