RESEARCH ARTICLE

ENHANCEMENT OF FUZZY LOGIC CONTROLLER WITH RULE-VIEWER FOR RESTORATION SCHEME IN POWER SYSTEM.

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Abstract

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The paper entails the development of a Fuzzy Logic Controller with Rule viewer for industrial application i.e. temperature control of any electrical machine. The work is related to restoration scheme in power system and alarm analysis. Artificial neural network also plays an important role in system accuracy even when fault occurs.

Introduction:-

The basic idea of fuzzy logic control was suggested by Prof. L. A. Zadeh. The first implementation of a FLC was reported by Mamdani. FLC provides a no analytic alternative to the classical analytic control theory, but the striking point is about its most important and visible application today is in an unanticipated pattern when fuzzy logic was conceived, namely, the realm of fuzzy logic based process control, as per today's world there are two types of control i.e. Classic control and Fuzzy control.

Classic control is based on a detailed I/O function OUTPUT= F(INPUT) which maps each high-resolution quantization interval of the input domain into a high-resolution quantization interval of the output domain. Finding a mathematical expression for this detailed mapping relationship F may be difficult, if not impossible, in many applications.

Fuzzy control is based on an I/O function that maps each very low-resolution quantization interval of the input domain into a very low-low resolution quantization interval of the output domain. As there are only 7 or 9 fuzzy quantization intervals covering the input and output domains the mapping relationship can be very easily expressed using the if-then formalism. (In many applications, this leads to a simpler solution in less design time.) The overlapping of these fuzzy domains and their linear membership functions will eventually allow achieving a rather high-resolution I/O function between crisp input and output variables.

Fuzzy controller system is associated with artificial intelligence. [1] Fuzzy variables of controller include the input variable a, Δa and the output U, where a is taken as the deviation of reference, Δa is taken as the change rate of change of a and U is taken as output as hot (or, we can say as temperature).

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Suppose, a ϵ [-4,4],
        Δa ϵ [-2,2],
        U ϵ [20,24]

The corresponding fuzzy subset is as below:
  a ϵ [NB, NM, NS, ZR, PS, PM, PB]
 Δa ϵ [NB, NS, ZR, PS, PB]
  U ϵ [NB, NM, NS, ZR, PS, PM, PB]

There are several methods to design a fuzzy controller. The design of fuzzy controller involves formation of membership function and rule base.

Here, this paper has taken the rule base for simulation of the fuzzy controller. These rules are shown in table1. The table is read in following way: If the error is negative small (NS) and the change of error is positive big (PB), then the control action is

positive medium(PM):-
It identifies the variables of any electrical machine or plant. [2] Partition of the universe of discourse or the interval of each variable into a number of fuzzy subsets, assigning each a linguistic label. It assigns, or, determines a membership function for each fuzzy subset. It assigns the fuzzy relationships between the inputs or states fuzzy subsets on the one hand the outputs fuzzy subsets on the other hand, thus forming the rule-base. By Choosing an appropriate scaling factors for the input and output variables in order to normalize the variables to the [0,1] or the [-1,1] interval. It will Fuzzify two inputs to the controllers. It Uses Fuzzy approximate reasoning to inter the output variables in order to normalize the variables to [0,1] or the [-1,1] interval. It aggregates the fuzzy outputs recommended by each rule. It applies De fuzzification to form a crisp output. The output of fuzzy logic controller gives to the any electrical machine which has certain parameters. Also, by connecting some parameters, like signal builder, scope etc. in mat lab software. After the connection of all inputs, the program would be in run condition and we obtain the output. This paper has observed the result both in scope and rule viewer.

[7] The design of Artificial Neural Networks used here are basically layers of neurons connected in cascade, there are three layers- input layer, output layer and hidden layer. Hidden layer may be one or more hidden layers. The choice of the number of hidden layer(s) nodes is a compromise between efficiency and accuracy.

Here the set value is Error and the process value is dError. Fuzzy Logic Controller with Rule-viewer calculates an error difference value between measured process variable and desired set point. Consider the query "Is water colorless?" The answer to this is a definite Yes/True, or, No/False, as warranted by the situation. If Yes/true is assigned a value of 1 and No/False is assigned a value of 0, this statement results in a 0/1 type of situation. Such a logic which depends a binary (0/1) type of handling is termed crisp in the domain of fuzzy set theory. On the other hand, consider the statement, "Is ram honest?" The answer to this query need not be a definite "Yes" or "No". Considering the degree to which one knows Ram, a variety of answers spanning a range such as "extremely honest", "extremely dishonest", "honest at times", "very honest" could be generated for instance. "Extremely honest" is to be assigned a value of 1 at the high end of the spectrum, then "honest at times" and "very honest" could be assigned values of 0.4 and 0.85 respectively. The situation is therefore so fluid that it can accept values between 0 and 1, in contrast to the earlier one which was either 0 or 1. Such a situation is termed fuzzy. In above figure there are many terms like fuzzification, de fuzzification and inference engine.

Fuzzification: It is the first step in the fuzzy inference process. This involves a domain transformation where crisp inputs are transformed into fuzzy inputs. Crisp inputs are exact inputs measured by sensors and passed into the control system for processing, such as temperature, pressure, rpm etc.

De fuzzification: It is a process in fuzzy logic of producing a useful outcome from fuzzy data. It is a process of producing a quantifiable result in fuzzy logic, given fuzzy sets and corresponding membership degrees. It is typically needed in fuzzy control systems.

Inference Engine: The inference engine implements the reasoning mechanism and controls the interview process. Inference mechanism is for manipulating the symbolic information and knowledge in the knowledge base from a line of reasoning in solving a problem.

User Interface: Enable to communicate with an expert system. It is a means of communication with the user. The user interface is generally not a part of the expert system technology. It was not given much attention in the past. In this paper Mamdani Inference System is used and for de fuzzification, Mean-maximum membership is used. Mean-maximum membership method is also known as middle of maxima, is closely related to the first method expect that the locations of the maximum membership can be non-unique (i.e. the maximum membership can be a plate rather than a single point). This method is given by the expression-

$$\sum* = (a + b)/2$$

In this paper rule base is used because in this design and implementation of fuzzy logic controller rule-viewer is use so, rule base relates with supervised learning. In supervised learning, to solve any problem previous data would be used in this thesis, at first, it is proposed to make rule in rule-viewer, so that we can totally base on supervised learning

Fuzzy Logic Controller with Rule-viewer calculates an error difference value between measured process variable and desired set point.

Output of a Fuzzy Logic Controller with Rule viewer consists of following three terms:
1.   One proportional to the error signal.
2.   Another one proportional to integral error signal and
3.   The third one is proportional to the derivative of error signal.

These terms can be interrupted in time based on current rate of change for dError, the gain is stabilized by the proportional controller and the steady state error is produced by generating the gain of the proportional term, increases the speed of the system response and reduces the steady state error. The steady state error is reduced or, eliminated by the integral controller; integral term removes the steady state error. It tends to destabilize the system because of the extra phase lag it introduces. The rate of change of error is reduced by D controller, the derivative term is used to speed up the transient response, it introduces a phase lead and that has a stabilizing effect.

A scheme of systemic analysis that uses linguistic variables, such as hot, cold, very, little, large, small etc. as opposed to Boolean or binary logics which is restricted to true or false states.

The Fuzzy Logic Controller with rule-viewer algorithm involves three separate constant parameters, and is accordingly sometimes called three-term control: the proportional, the integral and derivative controls. [3] These values can be simply put and interpreted in terms of time: P depends on the present error, I on the accumulation of past errors, and D is a prediction of future errors, based on current rate of change. The weighted sum of these three actions is used to adjust the process via a control element, such as, the position of a control valve, a damper, or, the power supplied to a heating element. So output of fuzzy logic controller fed to any electrical machine. Here electrical machine made of many components like local/island pre disturbance data, two artificial neural networks, auto encoder, particle swarm optimizer etc. basically it is made of IRS. By using this type of concept the system will be more accurate, supervised and regulated.

Motivation and problem statement:-
In the last few decades, a lot of research has been conducted in the field of fuzzy logic controller. It has been used in control systems like kitchen appliances, car control systems, and aerospace vehicle. It has been used in Image processing and decision making, route-planning. However, there still remain some problems which have not been answered satisfactorily. First and foremost, problem is of temperature control of any electrical machine by using fuzzy logic controller and there is some other problem like still in development and testing for safety critical systems. It has already been tested in some instances like small satellite attitude control. Researchers all over the globe are working in the direction of achieving a fuzzy logic controller for temperature control of any electrical machine. In this work, we have to identify such problems and tried to provide an effective solution to these problems. Apart from this development and testing for safety critical system suffers from many problems. To overcome this problem just design a fuzzy logic controller for temperature control of any electrical machine.

Recently a accident happen in Chabara power plant, there had a blast happen in transformer due to increasing in temperature So that in this project design a fuzzy logic controller with rule-viewer to control the temperature.

For example, a power line thermal monitoring scheme will allow the system operator to know the exact safety margin of a power line, and to temporarily overload some power lines to ride through emergencies without exceeding their thermal limits. An echo-state network(ESN) approach was proposed by Yang to identify the power-line thermal dynamics and estimates the real-time line temperature directly from the current measurements.

For problem statement by using the fuzzy logic controller, the temperature of any electrical machine can be controlled. Main Problem is that many incidents used to happen in power plants like increasing of temperature of any electrical machine regularly, so that due to this thing sensor will not work properly. So in this thesis, a perfect system is being proposed to control the temperature of any electrical machine. In this the design and implementation of fuzzy logic controller with rule-viewer of any electrical machine can be revised and observed. [4] First generation simple fuzzy logic controllers can generally be depicted by a knowledge base module and some other factors. The knowledge base module contains knowledge about all the input and output fuzzy partitions. It would also include the term set and the corresponding memberships functions defining the input variables to the fuzzy rule base system and the output variables or control actions to the plant under control.

Step 1: Identify the variables of any electrical machine or plant.
Step 2: Partition the universe of discourse, or, the interval of each variable into a number of fuzzy subsets, assigning each a linguistic label.
Step 3: Assign, or, determine a membership function for each fuzzy subset.
Step 4: Assign the fuzzy relationships between the inputs, or, the states of the fuzzy subsets. There would be the outputs fuzzy subsets, and on the other hand, it would form the rule-base.
Step 5: Choose appropriate scaling factors for the input and output variables in order to normalize the variables to the [0,1] or the [-1,1] interval.
Step 6: Fuzzify two inputs to the controllers.
Step 7: Use Fuzzy approximate reasoning to enter the output variables in order to normalize the variables to [0,1] or the [-1,1] interval.
Step 8: Aggregate the fuzzy outputs recommended by each rule.
Step 9: Apply Defuzzification to form a crisp output.
Step10: The output of fuzzy logic controller gives the appropriateness with respect to parameters to the any electrical machine which have certain parameters.
Step 11: Also connect some parameter like signal builder, scope etc. in mat lab software.
Step 12: After the connection of all inputs it would be suggested to run the program and the output is obtained.
Step 13: The result can be observed in both scope and rule viewer.

Development of fuzzy logic controller for restoration scheme:-

In this paper there are many configuration parameters like start time, stop time. [6] The value of Fixed-step size and the type of solver and many other parameters are used. Iteration time of system is 0.005. Iteration time of system is also known as Fixed-Step Size. The value of start time is 0.00 and stop time 180, fixed step solver type, solver name ode3 (Bogacki-Shampine) are used. Signal builder allows you to create some interchangeable groups of signal sources and quickly switch these groups into and out of a model. Signal groups can greatly facilitate the testing of a model, especially when used in conjunction with Simulink assertion blocks and the optional model coverage tool. A scheme of systemic analysis that uses linguistic variables, such as hot, cold, very ,little, large, small etc. as opposed to Boolean or Mamdani's fuzzy inference method is the most commonly seen fuzzy methodology. Mamdani's method was one of the first control system built using fuzzy set theory. It was proposed by Mamdani(1975) as an attempt to control a steam engine and boiler combination by synthesizing a set of linguistic control rules obtained from experienced human operator. Mamdani's effort was based on Zadeh's (1973) paper on fuzzy algorithm for complex system about decision process. After the aggregation process, there is fuzzy set for, each output variable that needs de fuzzification. It is possible and in many cases, it is much more efficient to use a single spike as the output membership functions rather than a distributed fuzzy set. Sometimes, it is known as a singleton output membership function.

it can be thought as a pre fuzzified fuzzy set. [5] It enhances efficiency of the de fuzzification process because it greatly simplifies the computation required by general Mamdani method, which finds the centroid of a two

dimensional function rather than integrating across the two dimensional function to find the centroid. Fuzzy logic controller with rule-viewer is perhaps the most well-known and most widely used controllers in modern industries: statistics has shown that more than 90% controllers used in industries. Although it is possible to design a fuzzy logic type, which is a simple modification of the conventional ones, via inserting some meaningful fuzzy logic of IF-THEN rules into the control system.
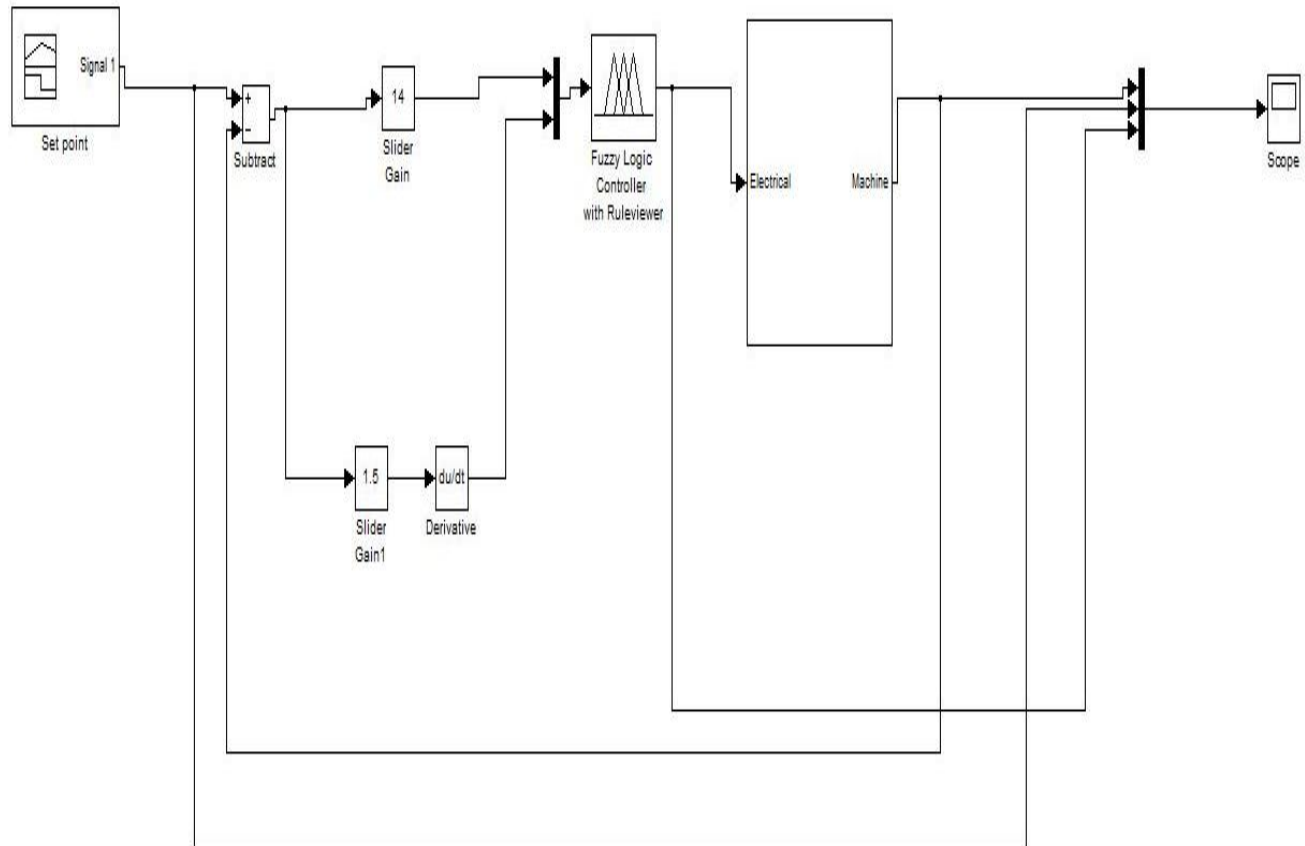

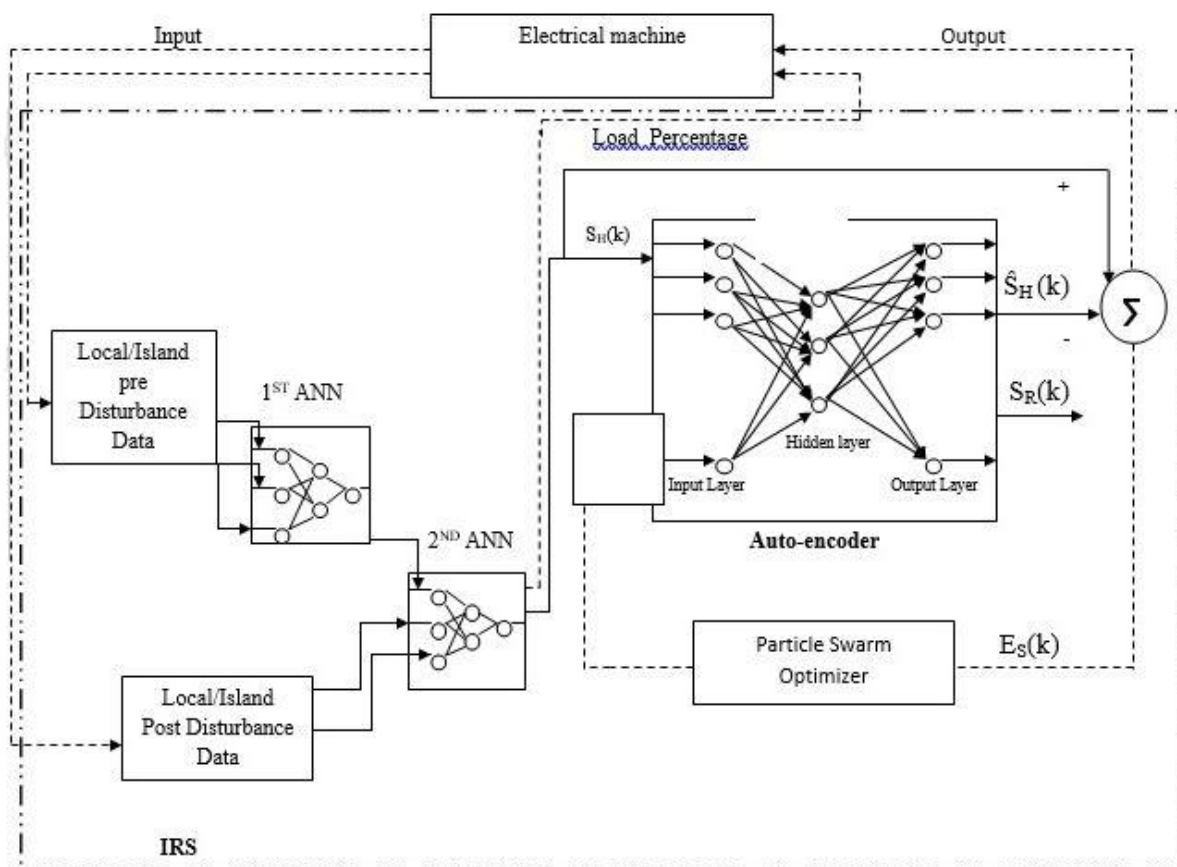**Fig. 1:-** Model of Fuzzy Logic Controller with Rule-viewer for Restoration Scheme.

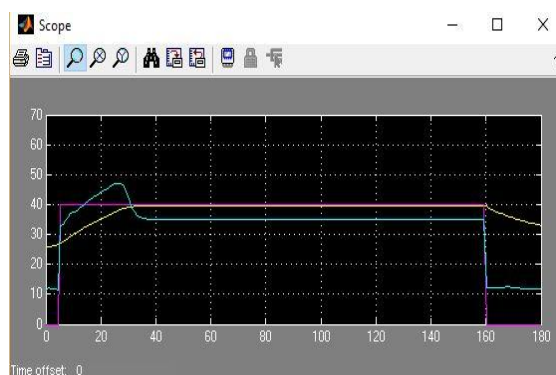Fig 2: Restoration Scheme Layout

Fig. 3:- Scope Diagram of System.

Scope diagram shows between time and amplitude. Initially temperature rises slowly but then it is rising very sharp so we can control this temperature by using fuzzy logic controller with rule viewer and we can also regulate the system parameter by changing the values of different parameters.
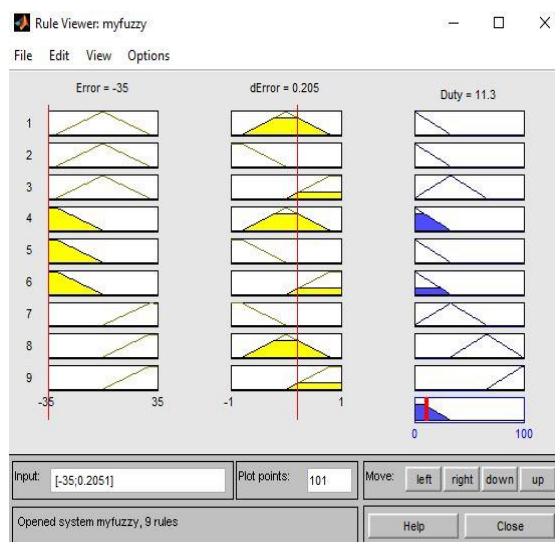
Fig.4:- Rule-viewer Diagram of System.

Fig.4: shows the changing values of different parameters like Error, dError and Duty. The values are like: Signal Builder Time Value = 0-180(Sec.)

Signal Builder Amplitude Value = 0-40

Slider Gain1 Set Value = 12

Slider Gain1 High Value = 15

Slider Gain2 Set Value = 1.2

Slider Gain2 High Value = 2

Error = -35

dError = 0.205

Duty = 11.3

Conclusion:-

In the Fuzzy Logic Controller with Rule-viewer, it is observed that a scheme of systematic analysis that uses linguistic variables, such as hot, cold, very, little, large, small etc. as opposed to Boolean or binary logics is restricted to true or false states. So rules can be easily generated along with membership, functions etc. In the proposed research work, the temperature control of any electrical machine by using Fuzzy logic controller with rule viewer has been studied and It can be used in industrial application. The simulated results significantly recommend the use of the computer as an operator aid instead of the use of predefined operating procedures for restoration. The restoration scheme with auto-encoder requires multidisciplinary research and engineering efforts, and more importantly, intelligence and innovations in context to the aspects of electrical power engineering.

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